29th Annual Meeting of the Associated Professional Sleep Societies, LLC

Scientific Highlights/Abstracts of Original Investigations

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This abstract supplement unites *SLEEP* and the science of the SLEEP 2015, the 29th Annual Meeting of the Associated Professional Sleep Societies, LLC (APSS), and provides a glimpse into the most current ideas and latest research taking place in the field of sleep.

All abstracts presented at SLEEP 2015 held June 6–10, 2015, in Seattle, Washington are included in this special issue. This year, 1,247 abstracts will be presented at the meeting. 196 will be presented in an oral presentation format, and the remainder will be presented in a poster format. In addition, individuals in training programs will be presenting posters of case reports, which are contained in the supplement, and abstracts, which, although not included in this supplement, will be an exciting portion of the meeting.

The abstracts are divided between basic and clinical sleep science and then assigned to one of 28 subcategories. Each abstract has a unique four-digit number to facilitate identification and location both within this issue and at SLEEP 2015. The four-digit number in the abstract supplement matches the four-digit code published in the SLEEP 2015 Final Program.

The SLEEP meeting fosters an environment in which members and attendees obtain education on the latest basic science, clinical science and technologies, which will further promote the continued growth of the field through the dissemination of new knowledge. We look forward to sharing in the success of this pivotal event.

David F. Dinges, PhD
Editor-in-Chief
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SLEEP-RELATED OSCILLATORY PHENOMENA INDUCED BY NR2B SUBUNIT-SPECIFIC NMDA RECEPTOR BLOCKADE

Pittman-Polletta BR,1,2,3,4 Bercea C,1,4 Hu K,2,3 Kocsis B1,2,4,5
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Introduction: NMDA receptors are implicated in various neuropsychiatric diseases. NMDA antagonism induces changes in brain rhythms and their coordination, and the cognitive disorganization in these conditions may be mediated by altered rhythmic coordination. However, NMDA receptors are not homogeneous; NR2B-specific antagonism is neuroprotective, and proposed as a treatment for depression, Alzheimer’s, and neuropathic pain. Recently, NR2B-specific antagonist Ro25-6985 was shown to induce rapid eye movement sleep (REMS)-specific increases in gamma power (Kocsis, Sleep 2012). Here, we examined whether Ro25-6985 administration induced other REMS-associated oscillatory phenomena—including high-frequency oscillation (HFO, ~120–160 Hz) power and theta-HFO cross-frequency coupling—in a state-dependent manner.

Methods: In 6 rats, frontal, occipital, and hippocampal EEG was recorded 3 hours before and 20 hours after systemic injection of saline and 3 NMDA antagonist drugs: non-specific MK801, NR2A-prefering NVP-AAM077, and NR2B-selective Ro25-6985. ~16 s epochs were scored as active waking, REMS, and quiet waking/non-REMS. Spectral, cross-frequency coupling, and phase coupling measures were calculated for each epoch, and percent increases from baseline were compared to saline for each state.

Results: We observed state- and location-specific patterns of altered oscillatory power and coupling following Ro25-6985 administration. Widespread increases in 20–50 Hz gamma and increased frontal and hippocampal theta-HFO coupling were REMS-specific. Increased HFO power, occipital theta-HFO coupling, and 90–140 Hz phase locking between hippocampus and visual cortex occurred during active waking. In contrast, animals exhibited prolonged wakefulness following MK801 and NVP-AAM077 injection, and different patterns of oscillatory power and coupling.

Conclusion: Our findings suggest a special role for the NR2B receptor in controlling REMS-specific information processing, visual cortical processing, and hippocampal-occipital coupling. REMS disturbances are associated with both depression and neuropathic pain; it is tempting to hypothesize that the therapeutic effects of NR2B antagonism are in part mediated by the poteniation of REMS-associated cognitive processing in patients in whom REMS may be deficient.

Support (If Any): NSF grant DMS-1042134 to BRP; NIH grants R00-HL 102241 and P01AG009975 to HK; NHLBI P01 HL095491 to BK; NIMH MH100820 to BK.

NOVEL AND HIGHLY SELECTIVE OREXIN 2 RECEPTOR ANTAGONISTS PROMOTE NREM AND REM SLEEP ACROSS MAMMALIAN SPECIES

Mercer Research Laboratories, West Point, PA

Introduction: Orexin receptor antagonism has emerged as an effective mechanism to promote both NREM and REM sleep in insomnia patients. Suvorexant and other dual orexin 1 and 2 receptor (OX1R, OX2R) antagonist (DORAs) have been evaluated clinically, while the efficacy and sleep architecture induced by OX2R selective antagonists (2-SORAs) has not been fully explored. Genetic and pharmacological evidence suggests that orexin-mediated arousal is predominantly mediated by OX2R, the blockade of which is expected to be sufficient to promote sleep, while OX1R has a lesser role in arousal, but may be involved in sleep stage regulation, particularly into REM sleep.

Methods: Binding to mammalian OXRs and inhibition of OXR activity by MK-1064 and MK-3697, two novel 2-SORAs, was measured in radioligand displacement and calcium mobilization assays. Sleep efficacy and architecture in mice, rats and canines was evaluated by polysomnography in radiotelemetry-implanted animals. Dose and exposure dependent OX2R occupancy by MK-1064 and MK-3697 was evaluated in transgenic rats expressing hOX2R. Canine cataplexy potential was evaluated by the food elicited cataplexy test (FECT).

A. Basic Sleep Science

0001

SLEEP-RELATED OSCILLATORY PHENOMENA INDUCED BY NR2B SUBUNIT-SPECIFIC NMDA RECEPTOR BLOCKADE

Pittman-Polletta BR,1,2,3,4 Bercea C,1,4 Hu K,2,3 Kocsis B1,2,4,5
1Boston University, Boston, MA, 2Harvard Medical School, Boston, MA, 3Brigham & Women’s Hospital, Boston, MA, 4Cognitive Rhythms Collaborative, Boston, MA, 5Beth Israel Deaconess Medical Center, Boston, MA, 6University of Edinburgh, Edinburgh, United Kingdom

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Methods: In 6 rats, frontal, occipital, and hippocampal EEG was recorded 3 hours before and 20 hours after systemic injection of saline and 3 NMDA antagonist drugs: non-specific MK801, NR2A-prefering NVP-AAM077, and NR2B-selective Ro25-6985. ~16 s epochs were scored as active waking, REMS, and quiet waking/non-REMS. Spectral, cross-frequency coupling, and phase coupling measures were calculated for each epoch, and percent increases from baseline were compared to saline for each state.

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Conclusion: Our findings suggest a special role for the NR2B receptor in controlling REMS-specific information processing, visual cortical processing, and hippocampal-occipital coupling. REMS disturbances are associated with both depression and neuropathic pain; it is tempting to hypothesize that the therapeutic effects of NR2B antagonism are in part mediated by the poteniation of REMS-associated cognitive processing in patients in whom REMS may be deficient.

Support (If Any): NSF grant DMS-1042134 to BRP; NIH grants R00-HL 102241 and P01AG009975 to HK; NHLBI P01 HL095491 to BK; NIMH MH100820 to BK.

0002

THE SLEEP-PROMOTING AND HYPOTHERMIC EFFECTS OF GLYCINE ARE MEDIATED BY NMDA RECEPTORS IN THE SUPRACHIASMATIC NUCLEUS

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Introduction: Glycine, a non-essential amino acid, has been physiologically and pharmacologically implicated in sleep regulation. Human studies show that oral glycine stabilizes sleep state and shortens the latency of slow-wave sleep, with no alterations in sleep architecture. However, the mechanisms underlying sleep-improving effects of glycine are still unknown, but sleep enhancement by glycine is often associated with a decrease in core body temperature (CBT). In this study, we investigated the site of action and sleep-promoting mechanisms of glycine in rats.

Methods: Laser doppler imaging was performed to detect rat cutaneous blood flow (CBF) under anesthesia. For intracerebroventricular (icv) or intracerebral injections, cannula was surgically implanted to the lateral ventricle or medial preoptic area (MPO), dorsal subparaventricular zone (dSPZ), or suprachiasmatic nucleus (SCN). c-Fos expression was examined after glycine administration. For sleep studies, adult male rats were implanted with EEG and EMG electrodes along with a transmitter to record CBT. Glycine was orally administered with a new cage exchange at ZT2, which induces stress and acute insomnia. SCN-lesioned rats were used for glycine administration with the cage exchange at ZT2.

Results: In acute sleep disturbance, oral glycine induced NREM sleep and shortened NREM sleep latency with a simultaneous decrease in core temperature. Oral and icv injection of glycine elevated CBF, resulting in heat loss. Pretreatment with N-methyl-D-aspartate (NMDA) receptor antagonists AP5 and CGP78608 but not the glycine receptor antagonist strychnine inhibited the CBF increase caused by glycine injection into the brain. Induction of c-Fos expression was observed in the hypothalamic nuclei, including the MPO and the SCN shell after glycine administration. Bilateral microinjection of glycine into the SCN elevated CBF in a dose-dependent manner, while no effect was observed when glycine was injected into the MPO and dSPZ. In addition, microinjection of D-serine into the SCN also increased CBF, while these effects were blocked in the presence of L-701324. SCN ablation completely abolished the sleep-promoting and hypothermic effects of glycine.

Conclusion: These data suggest that exogenous glycine promotes sleep via peripheral vasodilatation through the activation of NMDA receptors in the SCN shell.

Support (If Any): This study was supported by Ajinomoto Co., Inc.

0003

NOVEL AND HIGHLY SELECTIVE OREXIN 2 RECEPTOR ANTAGONISTS PROMOTE NREM AND REM SLEEP ACROSS MAMMALIAN SPECIES

Mercer Research Laboratories, West Point, PA

Introduction: Orexin receptor antagonism has emerged as an effective mechanism to promote both NREM and REM sleep in insomnia patients. Suvorexant and other dual orexin 1 and 2 receptor (OX1R, OX2R) antagonist (DORAs) have been evaluated clinically, while the efficacy and sleep architecture induced by OX2R selective antagonists (2-SORAs) has not been fully explored. Genetic and pharmacological evidence suggests that orexin-mediated arousal is predominantly mediated by OX2R, the blockade of which is expected to be sufficient to promote sleep, while OX1R has a lesser role in arousal, but may be involved in sleep stage regulation, particularly into REM sleep.

Methods: Binding to mammalian OXRs and inhibition of OXR activity by MK-1064 and MK-3697, two novel 2-SORAs, was measured in radioligand displacement and calcium mobilization assays. Sleep efficacy and architecture in mice, rats and canines was evaluated by polysomnography in radiotelemetry-implanted animals. Dose and exposure dependent OX2R occupancy by MK-1064 and MK-3697 was evaluated in transgenic rats expressing hOX2R. Canine cataplexy potential was evaluated by the food elicited cataplexy test (FECT).
TRANSLATIONAL PHARMACOLOGY APPROACHES ENABLING THE DISCOVERY AND DEVELOPMENT OF OREXIN RECEPTOR ANTAGONISTS FOR INSOMNIA


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Introduction: The orexin/hypocretin neuropeptides signal through the orexin receptors (OX1R and OX2R) and serve as key regulators of wakefulness across species. Selective antagonism of these receptors with small molecule antagonists results in the blockade of wakefulness and thereby enables sleep. A series of antagonists were extensively characterized in preclinical and clinical studies, leading to the first regulatory approval of an orexin receptor antagonist for the treatment of insomnia.

Methods: The in vitro and in vivo pharmacology of orexin receptor antagonists and their resulting effects on wake/sleep dynamics across species will be presented. The utility of translational preclinical models to demonstrate the safety, efficacy and differentiating attributes of dual and selective orexin receptor antagonists will be discussed. The results of these studies will be placed in context with clinical characterization of orexin receptor antagonists.

Results: Suvorexant is a potent, selective and reversible orexin receptor antagonist that dose dependently reduces wake and proportionally increases NREM and REM sleep in rodents, dogs, monkeys and humans. In a variety of preclinical studies, suvorexant and other orexin receptor antagonists significantly differentiate from GABAA receptor modulators in their effects on sleep architecture, qEEG spectra, arousability to salient stimuli, tolerance, locomotor activity, alcohol interaction, and cognitive performance.

Conclusion: Pharmacological blockade of orexin signaling safely and effectively reduces wake and promotes sleep across species. Belsomra (suvorexant) is the first approved orexin receptor antagonist, providing a novel approach for the treatment of insomnia.

Support (If Any): This research was funded by Merck & Co., Inc.

CHRONIC INTERMITTENT HYPOXIA (IH) EXACERBATES VASCULAR DYSFUNCTION IN DIABETIC MICE

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Introduction: Obstructive sleep apnea (OSA) is characterized by chronic intermittent hypoxia and occurs frequently in diabetics. This study examined the effects of chronic IH on endothelial dysfunction in diabetic mice.

Methods: Adult male BKS.Cg-Dock7m +/- Leprdb/J (db/db) mice (8–10 weeks) and their heterozygote littermates were subjected to IH or intermittent air (IA) for 8 weeks. Mice were separated into 4 groups: IH-DB, IA-DB, IH and IA. IH exposure occurred during the daytime (during sleep) and alternated a hypoxic mixture (6–7% oxygen) with room air every 30 s (IH group); half received IA every 30 s instead of the hypoxic mixture (IA group). Endothelium-dependent relaxation was measured using a wire myograph. Plasma asymmetric dimethylarginine (ADMA-inhibitor of NO production), 8-isoprostane (oxidative stress marker) and interleukin-6 (IL-6, inflammatory marker) were measured.

Results: Endothelium-dependent relaxation was significantly impaired (Emax: 33.8 ± 2.4% of induced tone) in the IH-DB group compared to the other three groups (IA-DB: 60.4 ± 2.1%, IH: 73.0 ± 1.4%, IA: 94.5 ± 0.7%, p < 0.01 all groups compared to IH-DB). Basal NO production was impaired in both IH and IA-DB groups (area under the curve after phenylephrine administration: 53.5 ± 2.5, 65 ± 3.2, respectively) when compared to IA group (146 ± 10.1, p < 0.01); the PE AUC was lower in IH-DB (23.2 ± 2.8, p < 0.01). ADMA, 8-isoprostane and IL-6 levels were 2–3 fold higher in IH and IA-DB groups compared to IA group, with these changes being more pronounced in the IH-DB group.

Conclusion: IH exacerbates endothelial dysfunction in diabetic mice. Also, inflammation and oxidative stress markers were greater in IH-DB together compared to IH and DB alone.

Support (If Any): CIHR Sleep Team Grant, VCHRI Clinician Scientist Award
or vehicle was delivered prior to 6 h of sleep deprivation or spontaneous sleep and sleep states [non-rapid eye movement sleep (NREMS), rapid eye movement sleep (REMS), and wake] and slow-wave activity (SWA) were determined. Additionally, TSA or vehicle was administered prior to sleep deprivation and HDAC activity and IL1β mRNA expression were assessed in the somatosensory cortex and hippocampus after sleep deprivation.

**Results:** TSA attenuated sleep deprivation enhancements in NREMS and SWA compared to the vehicle responses. TSA administration did not alter REMS responses to acute sleep deprivation. Administration of the vehicle followed by sleep deprivation enhanced HDAC activity and IL1β mRNA expression in the somatosensory cortex and hippocampus compared with the time-of-day matched spontaneous sleep treatment. However, somatosensory cortex and hippocampus HDAC activity and IL1β mRNA expression after the administration of TSA followed by sleep deprivation were similar to those occurring during time-of-day matched spontaneous sleep.

**Conclusion:** Our findings show that HDAC inhibition in the central nervous system can attenuate sleep, SWA, and brain inflammatory responses induced by acute sleep deprivation and suggest that HDAC inhibition might be an effective strategy to reduce the detriments of sleep loss.

**Support (If Any):** 5T32MH016259-35

**0007**

PIOGLITAZONE ADMINISTRATION INCREASES SENSITIVITY IN GENETICALLY OBESE MICE WITH INTERRUPTED HYPOXIA

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**Introduction:** Obstructive sleep apnea (OSA) is characterized by intermittent hypoxia (IH). Obesity is the predominant risk factor for both OSA and the development of insulin resistance, hyperglycemia and type 2 diabetes mellitus (t2DM). The KKAy mice are recognized as obese rodent models of human’s t2DM. Pioglitazone (PIO), the thiazolidinedione, is used for the treatment of t2DM to improve insulin resistance. We determine whether the PIO administration with IH expose impacted metabolism.

**Methods:** Seven weeks old KKAy mice weighing 35–40 g were fed either normal chow (control group; n = 6) or a diet containing 0.02% PIO (PIO group; n = 5) for three weeks. At day 8, these mice started to display intermittent hypoxia (IH) for two weeks. Then, intraperitoneal (ip) glucose tolerance test (IPGTT) was performed to measure the blood glucose at 0, 15, 30, 60, 120 minutes after a 1 g/kg ip bolus of D50 at time 0.

**Results:** PIO administration decreased body weight (37.0 ± 0.9 g vs 39.4 ± 0.4 g; p = 0.032), lowered area under curve of blood glucose (20369 ± 1781 mg/dl*min vs 25113 ± 1484; p = 0.037), but did not affect each time point of blood glucose.

**Conclusion:** PIO can lower body weight and reduce insulin resistance in genetically obese mice and could represent a potential adjunct to CPAP therapy for patients with unresolved metabolic conditions.
PERIPHERAL CANNABINOID RECEPTOR AGONISTS CHROMENOPYRAZOLE 13A AND HU-308 ATTENUATE SLEEP APNEAS IN RATS

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Introduction: We previously demonstrated that systemic administration of dronabinol, a nonselective cannabinoid agonist, attenuated sleep apneas both in chronically instrumented rats and in human subjects; however, the mechanisms underlying this effect remain unclear. Injections of dronabinol into the nodose ganglia of anesthetized rats inhibited vagal reflex apnea, suggesting the potential importance of peripheral sites for cannabinoid action. Moreover, both CB1 and CB2 receptors can contribute to this attenuation of reflex apnea. The aim of the present study was to define the role peripheral CB1 and CB2 receptors in attenuation of spontaneous sleep apneas in conscious rats.

Methods: EEG, nuchal EMG and respiration (100 Hz LPF; digitized 256/s) were recorded in chronically instrumented Sprague-Dawley rats during repeated 6 h sessions separated by at least 3 days. Respiration was registered by whole-body plethysmography. Selective CB1 (Chromenopyrazole 13a) and CB2 (HU-308) receptor agonists non-permeable at the blood-brain barrier were administered IP. Each animal was recorded on 4 occasions beginning 15 minutes after IP injection of vehicle or 0.1, 1.0 or 10 mg/kg of one of the agonists, in randomized order. Sleep was scored in 30 s epochs. Apnea indices (apneas/hour of sleep) were assessed for NREM, REM and total sleep. Effects of cannabinoid compounds were determined using t-tests, p < 0.05.

Results: Chromenopyrazole 13a attenuated apneas in a dose-dependent manner. Apnea index was effectively suppressed at doses 1 mg/kg (AI: 5.8 ± 0.9 versus 11.4 ± 1.3 for vehicle, p = 0.05) and 10 mg/kg (4.8 ± 2.2, p = 0.01). In contrast, HU-308 did not reduce apnea index in total sleep at any dose (1 mg/kg: 10.8 ± 1.1 versus 9.38 ± 1.2 at vehicle, p = 0.4; 10 mg/kg: 9.6 ± 1.2, p = 0.9).

Conclusion: The results suggest an important role for peripheral nervous system cannabinoid CB1 receptors in modulation of sleep apnea propensity in rats. These findings may have implications for pharmacotherapy of human sleep apnea syndrome

Support (If Any): UICentre Grant (drug discovery @ UIC)
II. Cell and Molecular Biology and Genetics

**0012**

SPECIFIC HLA-DPB1 AND HLA CLASS I ALLELES CONFER RISK AND PROTECTION FOR NARCOLEPSY


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**Introduction:** Narcolepsy is caused by a lack of hypocretin (orexin) and it is so strongly associated with HLA class II DQA1*01:02–DQB1*06:02 (DQ0602) that very few non-DQ0602 cases have been reported. A known triggering factor for narcolepsy is pandemic 2009 influenza H1N1, suggesting autoimmunity that is triggered by upper airway infections. Additional effects of other HLA-DQ alleles have been reported consistently across multiple ethnic groups.

**Methods:** We used a large sample of over 3,000 narcoleptics and 10,000 controls of European and Asian background and examined the effects of other HLA-DQ alleles that very few non-DQ0602 cases have been reported.

**Results:** After careful matching of HLA-DR/DQ, we found strong protective effects of DPA1*01:03–DPB1*04:02 (DP0402) (OR = 0.51 [0.38–0.67], P = 1.01*10–6), DPA1*01:03–DPB1*04:01 (DP0401) (OR = 0.61 [0.47–0.80], P = 2.07*10–5) and predisposing effects of HLA class II independent associations were also seen across ethnic groups in the HLA class I region with HLA-A*11:01 (OR = 1.32 [1.13–1.54], P = 4.92*10–4), B*35:03 (OR = 1.96 [1.41–2.70], P = 5.14*10–5), and B*51:01 (OR = 1.49 [1.18–1.86], P = 1.09*10–5).

**Conclusion:** These effects may reflect modulation of autoimmunity, or indirect effects of HLA class I and DP alleles on response to viral infections such as influenza.

**Support (If Any):** Wake Up Narcolepsy, NIH NS23724, Sigrid Juselius Foundation, the Paivikki and Sakari Sohlberg Foundation, Orion Research Foundation and 973 Program 2015CB856405 and NSFC81420108002.

**0013**

IMPACT OF COMMON VARIATION AT DIABETES TRAIT LOCI MTNR1B AND CRY2 ON SLEEP, CIRCADIAN AND MELATONIN PHYSIOLOGY


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**Introduction:** Abnormalities in sleep quantity, sleep quality, circadian alignment, and melatonin regulation increase the risk of type 2 diabetes (T2D). Common genetic variants at loci harboring a receptor for the circadian-regulated hormone melatonin (MTNR1B) or the core clock gene Cryptochrome2 (CRY2) are associated with increased fasting blood glucose and T2D risk. Whether sleep or circadian disruption mediates this risk is unknown. Our aim was to determine if MTNR1B and CRY2 risk variants associate with measures of sleep, circadian, and/or melatonin physiology.

**Methods:** We examined two sets of data with complementary strengths: 1) intensive in-laboratory protocols (n = 193) with precise measures of endogenous circadian physiology; 2) cross-sectional questionnaire (n = 10,332) and polysomnography (n = 3,026) data from 7 community-based cohorts participating in the Candidate Gene Association Research (CARe) consortium. Subjects from in-laboratory protocols had phenotype measures of circadian rhythm timing (phase, amplitude, length, period), and melatonin physiology using hourly plasma melatonin concentrations and core body temperature collected over a minimum of 24 hours. Subjects from the CARe cohort had self-reported measures of sleep timing, duration, and quality, as well as over-night home PSG measures of sleep duration and stage.

**Results:** The MTNR1B variant significantly associated with a greatly delayed circadian phase of dim-light melatonin offset (1.37 h) and a substantially longer duration of elevated melatonin levels (41 min) in laboratory studies. The effect of MTNR1B rs10830963 on dim-light melatonin offset was partially mediated through delayed offset of melatonin synthesis. We did not identify associations with self-reported or PSG sleep measures in CARe.

**Conclusion:** Our results show alterations in the circadian melatonin profile by genotype, a potential mechanism whereby variation in MTNR1B could influence fasting glucose and risk of T2D. Ultimately this research could lead us towards new therapeutic interventions which adjust the timing of melatonin, thereby modifying cardiometabolic risk.

**Support (If Any):** This study was conducted with support from NIHDK NIH R21 (DK089378), Harvard Catalyst of the Harvard Clinical and Translational Science Center, T32 HL07901, F32, AG316902, R01 HL094806, NIDDK R01, U01HL53941, U01HL53916, U01HL53934, U01HL 53937 and U01HL63429, and U01HL 63463. R01AG06072, R01HL077453, R01AG09975, FA9550, R21AT002571, R01HL080978, R01NS054277, R01MH45130, R01AG06072, P01AG09975, R01HL093279, HFP01601, R01HL094654,
II. Cell and Molecular Biology and Genetics

0014
HYPOXIA INDUCIBLE FACTOR - REGULATED PERIPHERAL BLOOD CHANGES IN CHRONIC INTERMITTENT HYPOXIA FROM OBSTRUCTIVE SLEEP APNEA
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Introduction: Obstructive sleep apnea (OSA) assessment involves the measurement of frequency of oxygen desaturations without incorporation of measures of the extent of hypoxemia. Chronic intermittent hypoxia (CIH) secondary to OSA leads to a variety of pathologies ranging from cardiovascular to metabolic dysfunction. We used hypoxia inducible factor (HIF) regulated gene activity to assess the severity of CIH. HIF-activity changes were correlated with reactive oxygen species (ROS), mitochondrial mass and catalase.

Methods: Twenty OSA patients (Apnea-hypopnea index (AHI) 6–87/hour; mean 25.2 ± 24.3) were studied before and after polysomnography (PSG), and after 2–3 months of optimal continuous positive airway pressure (CPAP) therapy. Their blood reticulocyte transcripts of HIF-regulated genes (HK1, GLUT1, PDK1, TFRC), its negative regulator EGLN1 (PHD2), ROS, and genes involved in ROS homeostasis (Catalase - CAT, and hypoxia inducible microRNA that downregulates CAT - miR21) were measured by QT-PCR and FACS. Reticulocyte’s mitochondrial autophagy HIF-regulated BNIP3L expression was also measured.

Results: GLUT1 and PDK1 transcripts were increased in OSA patients, normalized after CPAP therapy and correlated with significant increases in EGLN1 levels. ROS levels in reticulocytes, platelets, granulocytes, T and B lymphocytes and mitochondrial mass were increased in OSA and normalized with CPAP therapy. CAT mRNA and activity increased following CPAP treatment along with decrease in miR21. Plasma erythropoietin in OSA patients decreased significantly following CPAP therapy (p = 0.0054). There were significant correlations between mRNAs of HIF-regulated genes (GLUT1, TFRC, CAT and BNIP3L) measured post-PSG with indices of hypoxemia (time below 89% saturation, 4% oxygen desaturation index and lowest oxygen saturation). AHI correlated only with post-PSG GLUT1 expression.

Conclusion: 1. In untreated OSA, HIF-dependent gene transcripts, mitochondrial mass and ROS in peripheral blood reticulocytes are increased and correlate significantly with a number of OSA-associated oxygenation abnormalities. These normalize with CPAP therapy. 2. Even though increased erythropoiesis can be expected from increased erythropoietin levels in OSA, increased ROS with concomitant decreased CAT-ROS protection leads to accelerated erythrocyte destruction; both normalize with CPAP. 3. Gene expression correlated better with indices of oxygenation as compared to AHI. Understanding expression of HIF-dependent genes and genes involved in ROS expression can delineate the effects of CIH from OSA and provide a marker for OSA severity.

Support (If Any): P01CA108671 Project #1 PI: Prchal - Genetic Basis of Polycythemia Vera

0015
THE EVOLUTIONARY CONSERVATION OF SLEEP: SHARED GENETIC ARCHITECTURE WITH REPRODUCTIVE FITNESS IN DROSOPHILA MELANOGASTER
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Introduction: Although sleep is universal, its evolutionary conservation is not understood. One possibility is that sleep shares a genetic basis with other traits critical to reproductive fitness. Here, we seek to verify effects of 23 genes previously identified as impacting sleep and fitness by genome wide association studies in the fruit fly Drosophila melanogaster. We investigated pleiotropy by determining whether these genes affect sleep in males and females as well as the number of ovarioles in female flies.

Methods: We measured 16 sleep parameters in 48 male and female flies and ovariole number in 30 female flies from 24 P-element insertion- and RNAi-expression knockout Drosophila lines. To identify genes impacting sleep and ovariole number, we compared measures in the knock-down lines to isogenic control lines with wild-type expression levels of our target genes.

Results: We verified effects on sleep for 23 genes (P < 0.05). Extreme effects on sleep duration (> 100 minutes) were observed for the transcriptional regulators ps, bin3, bru-3 and slim, the transmembrane transporter VACHT, the developmental protein fred, the putative ABC-transporter CG33970, and the putative GTPase activator CG34408. Twenty genes affected multiple sleep parameters. All genes showed significant sexual dimorphism (P < 0.05), with male and female flies differing in the direction, magnitude, and number of sleep parameters impacted. Of the 19 genes tested for pleiotropic effects, 5 (bru-3, bin3, fas, kirre, CG42389) affected both sleep and ovariole number.

Conclusion: The 23 genes with verified Drosophila sleep phenotypes are novel targets contributing to the genetic basis of sleep variation across species. Additionally, our results indicate widespread pleiotropy and sexual dimorphism in the genetic basis of Drosophila sleep which may also be conserved. Pleiotropic effects of genes on sleep and on reproductive fitness may explain why sleep has been so strongly conserved over evolutionary time.

Support: This work is supported by the Intramural Research Program of the National Heart, Lung, and Blood Institute (HL006147-02).
II. Cell and Molecular Biology and Genetics

0016

INVERSE RELATIONSHIP BETWEEN A GENETIC RISK SCORE FOR OBESITY AND EXCESSIVE DAYTIME SLEEPINESS IN 9,832 INDIVIDUALS OF EUROPEAN ANCESTRY FROM THE CARE STUDY

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Introduction: Daytime sleepiness, poor quality and insufficient sleep are associated with obesity. Common genetic variants for body mass index (BMI) reside near genes expressed in hypothalamic regions of the brain important in sleep regulation; however it is unknown whether these variants contribute to sleep quality. The aim of this study was to examine whether genetic variants previously associated with BMI also associate individually or in aggregate with measures of sleep quality.

Methods: In cross-sectional analyses within the Candidate-gene Association REsource (CARe) Study (n = 9,823 individuals of European ancestry), we examined the association between five questionnaire-assessed measures of sleep quality and obesity. A weighted genetic risk score of 18 genome-wide significant BMI variants were genotyped and tested for association with sleep quality traits using regression adjusting for age, sex, and ancestry.

Results: Sleep disturbances were positively associated with obesity, with the prevalence of excessive daytime sleepiness (EDS), early morning awakening, and frequent naps increased in obese individuals compared to normal weight (p ≤ 0.005). In contrast, a weighted BMI genetic risk score was significantly associated with a decreased risk of EDS (OR 0.96 [0.95–0.98], p = 1.74x10–05). This association remained significant after adjusting for BMI, mood, sleep apnea, and season and was consistent across CARe cohorts. The highest BMI genetic risk score quintile had 25% lower odds of EDS with 14 of the 18 BMI risk loci demonstrating an inverse association with EDS (p = 0.012). The strongest individual SNP associations were observed for variants at BDNF (rs10767664, OR 0.90 [0.82–0.97], p = 0.005) and FTO (rs1421085, OR 0.91 [0.85–0.98], p = 0.006). No significant associations were observed with the remaining sleep traits.

Conclusion: Genetic loci for BMI show a pleiotropic inverse association to EDS, early morning awakening, and frequent naps increased in obese individuals compared to normal weight (p ≤ 0.005). In contrast, a weighted BMI genetic risk score was significantly associated with a decreased risk of EDS (OR 0.96 [0.95–0.98], p = 1.74x10–05). This association remained significant after adjusting for BMI, mood, sleep apnea, and season and was consistent across CARe cohorts. The highest BMI genetic risk score quintile had 25% lower odds of EDS with 14 of the 18 BMI risk loci demonstrating an inverse association with EDS (p = 0.012). The strongest individual SNP associations were observed for variants at BDNF (rs10767664, OR 0.90 [0.82–0.97], p = 0.005) and FTO (rs1421085, OR 0.91 [0.85–0.98], p = 0.006). No significant associations were observed with the remaining sleep traits.

Support (If Any): NIH Grant OD011185, NIH Grant HG006332

0017

ANALYSIS OF SLEEP TRAITS IN KNOCKOUT MICE FROM THE LARGE-SCALE KOMP2 POPULATION USING A NON-INVASIVE, HIGH-THROUGHPUT PIEZOELECTRIC SYSTEM

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Introduction: In our current study we employed a non-invasive, high-throughput piezoelectric system to characterize sleep-wake phenotypes in a large population of control and single-gene knockout mice; recorded as part of the KOMP2 studies at JAX.

Methods: Knockout mice (15 weeks) generated on a C57BL6/NJ background were phenotyped for sleep-wake parameters as part of the phenotyping pipeline at JAX under baseline conditions for 5 days under 12:12 LD conditions using a non-invasive Piezoelectric system and compared to control (C57BL6/NJ) mice. The Piezoelectric system consists of a sensor pad placed at the bottom of the mouse cage which records gross body movements. The pressure signals thus generated are classified by an automated classifier into sleep and wake. The system characterizes traits that include sleep time over 24-hrs, as well as during the light and dark phase, or any desired time interval. Likewise, the distribution of sleep bout length (or sleep fragmentation) is assessed, in addition to activity onset. The piezoelectric system has been validated with EEG and human observations, and demonstrates a classification accuracy of over 90%. Thus far, we have recorded over 1000 BL6/NJ mice, males and females. The number of animals in each of the 130 knockout mouse groups range from 4–17.

Results: C57BL6/NJ female mice exhibited shorter bout length and less total sleep compared to males. Significant sleep-wake differences in both light and dark phases were also found for a number of knockout lines and inbred mice strains compared to control mice.

Conclusion: We present the results of the sleep phenotyping for a variety of inbred strains, single-gene knockouts, and control mice. A number of genes influencing various sleep traits have been identified, and these data will also be compared and correlated with non-sleep traits assessed in these same mice. Recently improved algorithms now allow classification of REM vs. non-REM sleep as well.

Support (If Any): NIH Grant OD011185, NIH Grant HG006332

0018

THE FABP7 GENE REGULATES SLEEP CONSOLIDATION IN MOUSE AND MAN

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Introduction: The astrocyte brain-type fatty acid binding protein (Fabp7) gene expression cycles globally throughout mammalian brain based on time-of-day. However the influence of Fabp7 expression on circadian locomotor rhythms and sleep/wake states in mammals has
not been reported. In this study, we examined whether Fabp7 is necessary for normal circadian rhythms and sleep/wake behavior. **Methods:** Adult 2–4 month old male C57BL/6j wild-type (WT) mice were compared to age-matched isogenic Fabp7 knock-out (KO) mice using standard wheel-running (N = 15 WT; N = 9 Fabp7 KO), and EEG/EMG (N = 13 WT; N = 8 Fabp7 KO) techniques to examine circadian rhythms and sleep, respectively. Actigraphy measures of sleep in human adult male Fabp7 T61M mutant carriers (N = 29) were compared to age-matched male non-carriers (N = 265). The 7 day sleep profiles were assessed from the actigraphy records in conjunction with sleep diaries, and genotypes were blinded for the analysis. **Results:** Fabp7 KO mice showed a reduction in diurnal locomotor running wheel activity, with a subtle increase in circadian period length under constant free running conditions. Fabp7 KO mice also have decreased average 24 h sleep bout duration (p < 0.05) and an increase in the number of sleep bouts (p < 0.01) compared to control mice. Humans which carry a Fabp7 Thr61Met missense mutation showed a decrease in average 7 d sleep bout duration (p < 0.01) and an increase in the number of sleep bouts (p < 0.05) compared to non-carriers. **Conclusion:** These results suggest Fabp7 regulates normal sleep consolidation in both mice and humans, and provide novel evidence for a molecular lipid-signaling pathway regulating sleep in astrocytes. **Support (If Any):** T32 HL07713, R01 MH099544

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**0019 DISSECTION OF C. ELEGANS SLEEP AND HOMEOSTATIC COMPENSATION**

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**Introduction:** Conserved pathways regulate sleep across species and all animals sleep, suggesting that this behavior is essential. Sleep deprivation results in increased compensatory sleep and/or deeper sleep with increased arousal thresholds. This is consistent with homeostatic mechanisms and pathways responding to sleep need. One pathway required for sleep homeostasis in C. elegans requires the FOXO transcription factor, DAF-16. We reported previously that, while greatly reduced Notch pathway signaling decreases C. elegans sleep, modestly diminished Notch signaling causes increased sleep with low arousal thresholds. The mechanisms underlying this apparent homeostatic response were unclear. **Methods:** A microfluidic chamber/camera-based assay system was used to measure C. elegans sleep. Mechanical stimulation was used to induce sleep deprivation. We developed an inexpensive system to test arousal threshold during sleep using endogenous response to light. The role of DAF-16 FOXO and other genes was examined by testing sleep quantity, arousal threshold, and using other behavioral/genetic/molecular techniques. In addition, other genes required for sleep and arousal in C. elegans were identified in a classical genetic screen or by bioinformatic approaches. **Results:** We find that compensatory increases in sleep due to modest loss of Notch pathway function are dependent on FOXO DAF-16 function. However, complex relationships exist between sleep, mechanical perturbation, and genetic background. Additional genes that are required for sleep, arousal threshold changes, or homeostatic compensation were identified. **Conclusion:** Dissection of sleep, arousal, and homeostatic response in C. elegans reveals conserved pathways and genes that likely regulate sleep, homeostasis, and arousal across species. **Support (If Any):** NINDS R01 NS055813 (ACH), BIBS UTRA (DH), NPNI/BIBS Translational Fellowship (HH), IMSD R25 GM083270 (HLB)

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**0020 SLEEP REGULATION AT THE POSTSYNAPTIC DENSITY IN DROSOPHILA MELANOGASTER**

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**Introduction:** Metabotropic glutamate receptors (mGluRs) modulate a wide range of processes in the central nervous system such as synaptic plasticity and neuronal signaling. At the postsynaptic density of glutaematergic synapses, mGluRs are scaffolded to proteins that regulate sleep. However, the direct involvement of mGluR signaling in sleep has not yet been established. In this study, we investigated the role of mGluR signaling in sleep and wake regulation in Drosophila melanogaster. **Methods:** We determined the behavioral sleep effects of pharmacologically and genetically inhibiting the single Drosophila mGluR – known as DmGluRA. We fed female wCS10 flies food containing LY341495, a type II mGluR antagonist and induced DmGluRA RNAi in neurons of adult flies using an inducible UAS/GAL4 system. Additionally, we examined the binding dynamics of DmGluRA and Homer, a sleep- and wake-regulating adaptor protein that links mGluRs to ionotropic glutamate signaling as well as to calcium signaling in the endoplasmic reticulum. **Results:** LY341495-treated flies display a 20% sleep reduction during the day (P < 0.01) and a 10% reduction in sleep time during the night (P < 0.01) while RNAi-mediated genetic inhibition of DmGluRA signaling in the neurons in adult flies decreased sleep time by 50% during the beginning of the night, between ZT12 and ZT14 (P < 0.05). Co-immunoprecipitation of DmGluRA and Homer confirm that DmGluRA and Homer physically interact in Drosophila. Furthermore, preliminary western blot analysis indicates that levels of Homer/DmGluRA protein interaction are higher during the day than during the night. **Conclusion:** Our results suggest that DmGluRA signaling modulates sleep in Drosophila and suggests that its involvement in sleep regulation may be mediated by binding to Homer proteins. These results have important implications for our understanding of the molecular mechanisms underlying sleep and wake and provide a link between sleep and other biological processes in the brain that depend on mGluR and Homer signaling.

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**0021 MOUSE STRIATAL GENE NETWORKS REVEAL MOLECULAR UNDERPINNINGS OF THE INTERACTIONS BETWEEN SLEEP AND STRESS: IMPLICATIONS FOR CENTRAL NERVOUS SYSTEM DISORDERS**


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**Introduction:** An accumulating body of literature has documented comorbidities of sleep dysfunction, stress susceptibility and a range of central nervous system disorders. However, molecular pathways and networks underlying such connections remain largely unknown. Our previous work has demonstrated that multi-scale approaches integrating phenotypic, genotypic and gene expression data are powerful tools to elucidate gene regulatory networks underlying complex phenotypes such as sleep. **Methods:** We screened a large number of sleep and stress phenotypes (N = 328, categorized into 29 categories) in 338 chronically stressed (B6 x A/J) F2 mice. This comprehensive set of phenotypic data were then integrated with genotypic data across the genome and RNA-Seq
II. Cell and Molecular Biology and Genetics

A. Basic Sleep Science

We tested 40 tissue-specific drivers involved with previous sleep phenotypes. Effects of these loci are mediated by striatal gene expression of a number of genes as indicated by a causality test. Construction of striatal gene co-expression networks revealed functionally and cell-type specific gene co-regulatory modules linking stress and sleep, including a mitochondria/synaptic module most relevant for both REM sleep after restraint stress and behavioral responses to novel environment. Remarkably, key network regulators of this module are overrepresented with GWAS candidate genes associated with neuropsychiatric disorders. Furthermore, a number of sleep/stress-relevant modules also appeared to be enriched with gene signatures of neurodegenerative diseases.

Conclusion: Our findings suggest the interplay between sleep, stress, and neuropathology emerge from genetic influences on gene expression and their collective organization through complex molecular networks. This comprehensive dataset provides a valuable resource for future investigations of the mechanisms underlying sleep, stress susceptibility, and related central nervous system disorders.

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0023
ENRAGED HUMAN MALIGNANT MELANOMA CELLS DANCE TO BOTH CIRCADIAN AND DIURNAL RHYTHMS; A POTENTIAL APOPTOSIS ROLE FOR DIURNAL VITAMIN D3 IS IDENTIFIED IN THE CIRCADIAN CLOCK CONTROL OF HUMAN MALIGNANT MELANOMA CELLS
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Introduction: Night shift workers have increased risk of several cancers including malignant melanoma. Experimental interference with circadian pathways is associated with an increase in cancer incidence. One suggested mechanism is disruption of the 10–20% circadian clock controlled gene expression. Circadian controlled genes mitigate UVB DNA damage, but are themselves damaged by UVB. Under physiological conditions, Vitamin D3 production is in phase with the circadian rhythm. Murine studies suggest Vitamin D has roles in apoptosis and inhibiting malignant cell growth. We investigated the effects of vitamin D3 on in vitro human malignant melanoma cell lines, to better understand Vitamin D as a potential confounder in circadian clock controlled cancer prevention.

Methods: Commercially available WM 115 (primary), and WM 266-4 (metastatic), human malignant skin melanoma cell lines were cultured and exposed to three concentrations of Vitamin D3, 0.25 micromolar, 0.5 micromolar and 1.0 micromolar. Cell lineage was confirmed using MITF and Mart-1 immuno-histological staining. Cellular viability was assessed using Trypan blue uptake. TUNEL apoptosis was investigated with immuno-histochemical fluorescence.

Results: Reduction in cell viability was seen: following exposure to one of three increasing doses of Vitamin D3 in both primary (40%, 49%, 79%) and metastatic cell lines (5%, 36%, 62%). Apoptosis rates increased significantly in cells exposed to the higher vitamin D3 concentration of 1.0 micromolar (p < 0.01) and in borderline significance in exposure to the intermediate dose of 0.5 micromolar (p < 0.056), when compared with rates of apoptosis at 0.25 micromolar concentration levels.

Conclusions: Apoptosis and lost viability were proportional to Vitamin D3 doses. Vitamin D3 concentration related apoptosis rates should be considered in future circadian studies on human malignant melanoma. While initial studies of cancer risk in shift work focused on nocturnal light mediated melatonin suppression; the role of reduced diurnal light exposure and Vitamin D levels warrant further study.
THE CHANGE OF PATHOLOGIC CARDIAC HYPERTROPHIC AND OXIDATIVE STRESS MARKER IN OSA MOUSE MODEL USING CHRONIC INTERMITTENT HYPOXIA  

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Introduction: Obstructive sleep apnea (OSA) is a common condition characterized by chronic intermittent hypoxia (CIH) and frequent arousals from sleep. Recent evidence suggests that OSA is directly linked to high cardiovascular mortality and morbidity. The aim of this study was to make OSA mouse model by exposing to chronic intermittent hypoxia and to identify pathologic changes which are related to cardiovascular disorder in OSA patients.  

Methods: C57BL/6J mice were used. Briefly, a gas control delivery system was designed employing programmable solenoids and flow regulators, which controlled the flow of air, nitrogen, and oxygen into cages. Normoxic control mice were placed in neighboring chambers under room air. Chronic intermittent hypoxia and normoxic were administered during the light phase for 12 hours to coincide with the mouse sleep cycle and the duration of exposure was 8 weeks. Heart and lung tissues were harvested and real-time PCR was performed. During each cycle of intermittent hypoxia, the FiO2 decreased from 21 to 5%.  

Results: This regimen induced oxyhemoglobin desaturations from 90% to ~ 70% sensed from mouse foot. The pathologic cardiac hypertrophic markers, such as Beta-MHC and BNP mRNA were significantly elevated the heart from CIH group compared to normoxic group. However, oxidative stress markers such as p22phox, NOX2, NOX4, HIF-1a in between CIH and normoxic group were not different. From the lung tissues, interestingly, p22phox, NOX2, HIF were significantly elevated in CIH group. However, cardiac hypertrophic markers were not different between two groups.  

Conclusion: We developed OSA mouse model using chronic intermittent hypoxia. CIH with our experimental setting caused changes of pathologic cardiac hypertrophic and oxidative stress markers in heart or lung tissue. Their influences on cardiovascular pathologic phenotypes and involved mechanisms are under investigation. OSA mouse model using CIH should be a useful research model for investigating pathophysiology of OSA.  

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CAVEATS OF USING IN VIVO TETRACYCLINE-INDUCIBLE GENE EXPRESSION IN SLEEP RESEARCH  

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Introduction: Conditional transgenic and knock-out mice are popular scientific tools often featured in high profile journals. The advantages of such models allow for timed and select tissue- or cell-specific manipulation of a gene and avert developmental carryover effects inherent in constitutive mutant mouse strains. Despite these advantages the use of these genetically engineered approaches, such as Tet-OFF or Tet-ON constructs, are not without problems. In the current study, we used a Tet-OFF model to overexpress miRNA-132 in the mouse forebrain via a CAMKIIa promoter of the tTA and made polysomnographic recordings prior to and after of the removal of doxycycline (DOX) from these mice.  

Methods: All mice (including breeders) received DOX (50 ug/mL) via drinking water. This DOX concentration was previously shown to maintain physiological levels of miR-132 (Hansen et al., 2012). Wild-type (WT), tTA expressing, miR-132 expressing (132) or double transgenic (tTA::132) male littermates (n = 5–6) were implanted with EEG/EMG electrodes and allowed to recover. A 48 h EEG/EMG baseline was recorded during the DOX regimen, after which DOX was removed and recordings continued for 21 days. Baseline and no-DOX days 1,2,5,11 and 21 were manually scored.  

Results: DOX removal resulted in elevated time in NREMS during the light and suppressed NREMS during the dark in WT, tTA, and 132 mice. The effect was present on day 5 and became more pronounced on days 11 and 21. In tTA::132 mice changes in sleep amounts were restricted to the light during which NREMS was increased and REMS was suppressed.  

Conclusion: If DOX isn’t given to tTA mice throughout development, abnormal brain morphology manifests. Yet the EEG effects of DOX withdrawal after prolonged administration are quite robust in control strains and consequently obscure interpretation of the more subtle changes of miR-132 up-regulation in tTA::132 mice.  

Support (If Any): WSU-PDS grant and NIH-NINDS grant NS085605.
TRAVELLING SLEEP SLOW OSCILLATIONS AND MYELINATION IN PRESCHOOL CHILDREN

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Introduction: Deep sleep EEG slow oscillations (SOs; < 1 Hz) result from membrane potential fluctuations of cortical neurons. In adults, SOs originate prefrontally and sweep the scalp in highly reproducible propagation patterns, reflecting cortical and subcortical fiber connectivity. We examined the maturation of SO traveling patterns and associations with myelination in preschool children.

Methods: At-home sleep hEEG was obtained in 14 subjects (2–5 y, 8 m). A 0.5–40 Hz bandpass filter was applied, artifacts were removed, data were re-referenced to mastoids and filtered (4 Hz low-pass). Waves (0.25–1 Hz) were detected with 200–1000 ms proximity, negative peak below −80 μV, and negative-to-positive peak amplitude exceeding 140 μV. Using a quantile average reference wave, we calculated wave speed, duration, traveling distance and origin. Myelin-water-fraction (MWF) maps were examined (mcDESPOT-MRI) and normalized to custom pediatric templates (Gaussian kernel smoothing).

Results: Recordings contained 1278–2691 SOs, with 4.8 ± 0.3 m/s (M ± SE) speed, 49.4 ± 1.1 ms duration, 8.6 ± 0.2 cm distance (longest streamline), and involved 11.9 ± 0.7% of electrodes per SO. SOs originated predominantly over central regions. SOs became more “local” towards the morning (~2.9% electrodes per SO from the first to the last 400 waves; p < 0.05), and traveling distance decreased by 0.81 cm. MWF in the optic radiation was positively correlated with SO duration (r = 0.65), and negatively with SO speed (r = −0.62). The latter was also negatively associated with WMF in the corpus callosum (r = −0.57). Whole-brain MWF did not predict SO variables.

Conclusion: Increased SO speed and the central predominance of wave origins in children stands in contrast to the frontal wave origins in adults, revealing highest cortical excitability over sensorimotor regions in children. Increasing local myelin content across development may decelerate SOs but increase their duration. Spatial and temporal SO characteristics may reflect the developmental fine-tuning of functional connectivity related to alterations in synaptic strength and connecting fibers.

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SLEEP IN PRESCHOOL CHILDREN: ASSOCIATIONS BETWEEN SLOW SPINDLE ACTIVITY AND PROCESSING SPEED

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Introduction: Cognitive development is impacted by maturational changes in processing speed (PS), a construct reflecting the rapidity with which an individual carries out cognitive operations. Sleep spindles are associated with cognitive ability and processing speed in adults and adolescents, however, little is known about this relationship in early childhood. We examined associations between topographical spindle activity and processing speed in a cross-sectional sample of preschool children.

Methods: Ten 2–5-year-olds (4.3 ± 1.0; 4 females) were monitored during one night of sleep using high-density EEG (128 channels). Data were filtered (0.5–50 Hz), down-sampled (128 Hz), artifacts were removed, and data were re-referenced to the average across all channels. EEG power in the spindle frequency range (Slow, 10–13 Hz; Fast, 13.25–17 Hz) was calculated for the maximum common length (3.23 h) of non-REM sleep across recordings. PS assessments measured simple reaction time (RT) for the initiation of a response to a stimulus on a touch screen. Pearson correlations were calculated for all channels.

Results: Average RT was 1408.8 ± 251.4 ms, slow sigma power was 2.7 ± 1.2 μV2, and fast sigma power was 0.7 ± 0.2 μV2. Maximum slow and fast spindle activity was located over central areas; however, correlations with PS occurred in an electrode cluster over parietal regions (p < 0.05, −0.8 < r < −0.6, two-tailed), such that higher slow spindle power was associated with faster PS.
Conclusion: The associations between parietal slow spindle activity and PS suggest that spindles are a marker of cognitive ability in preschool children. Additionally, these results may indicate that slow spindles are involved in network connectivity maturation, as suggested for central regions in adults and adolescents.

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0029
DEVELOPMENTAL CHANGES IN SLEEP EEG COHERENCE ACROSS AGES 5 TO 9 YEARS
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Introduction: Waking EEG and MRI studies suggest that brain connectivity increases from mid to late childhood. Sleep, a time when the brain is largely unaffected by outside stimuli, provides a unique opportunity to measure the maturation of both structural and functional connectivity. The aim of the current study was to examine developmental changes in brain connectivity, as measured by sleep EEG coherence, in a cross-sectional study of children ages 5 to 9 years.

Methods: All-night sleep EEG recordings in 380 participants in the Childhood Adenotonsillectomy Trial (202 girls; mean age = 6.9 (± 1.6) years) were analyzed. Coherence was measured for NREM sleep only for the sigma band. Coherence values were averaged across all possible pairs within the right and left hemispheres (intra-hemispheric) and across hemispheres (inter-hemispheric). A linear regression analysis was conducted for each frequency band to characterize potential differences in coherence as a function of age.

Results: Regression analysis showed an overall linear increase in left (r = 0.11; p = 0.03) and right (r = 0.12; p = 0.02) intra-hemispheric coherence with age during NREM sleep only for the sigma band. By contrast, inter-hemispheric coherence increased with age for the delta (r = 0.12; p = 0.02), alpha (r = 0.14; p = 0.008), and sigma (r = 0.14; p = 0.008) bands.

Conclusion: Small increases in coherence in the sigma band may indicate strengthening of thalamocortical circuits during childhood development. On the other hand, increase in inter-hemispheric coherence may mark maturation of the corpus callosum.

Support (If Any): Research supported by NIH R01HL083075-01, R01HL098433, R01HL098433-02S1, U34HL105277-01, 1R01HL110068-01A1, 1R01HL113338-01 and a research agreement with the Emma B. Bradley Hospital/Brown University supported by the Periodic Breathing Foundation.

0030
SLEEP SPINDLE-FREQUENCY EEG ACTIVITY IS ASSOCIATED WITH OVERNIGHT MOTOR SKILL IMPROVEMENT IN CHILDREN WITH ATTENTION-DEFICIT-HYPERACTIVITY-DISORDER
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Introduction: Pediatric attention-deficit-hyperactivity-disorder (ADHD) is associated with motor learning deficits and sleep abnormalities. In adults, Stage 2 sleep spindles predict improvements in motor learning following sleep. This association is poorly characterized in children, and particularly in pediatric ADHD.

Methods: Following a standardized at-home stabilization period and an in-lab adaptation night, polysomnographic sleep was monitored (~10 hr) in seven children with ADHD (2F, 11.9 ± 0.9 years, abstaining from medication; ADHD-status confirmed from diagnostic interviews) and 14 typically-developing controls (4F, 11.7 ± 0.9 years). All children trained on a validated motor sequence task (MST) in the evening (~1 hr prior to bed) with retesting the following morning (~1 hr after awakening); analyses focused on MST accuracy (correct sequences as a proportion of all keystrokes). Performance was summarized in the evening as the average of the final two learning trials and in the morning as the average of the first two learning trials.

Results: Mixed-effects models confirmed a main-effect of sleep; MST accuracy improved overnight (Wald-χ2 = 17.56, p < 0.001). A significant condition-x-group interaction (Wald-χ2 = 6.08, p = 0.014), however, indicated that accuracy improved overnight in children with ADHD (Wald-χ2 = 16.61, p < 0.001) but not in controls (Wald-χ2 = 2.23, p = 0.135). Although evening accuracy was lower in ADHD (Wald-χ2 = 3.90, p = 0.048), morning accuracy did not differ between groups (Wald-χ2 = 2.23, p = 0.135), suggesting an overnight normalization of performance. Stage 2 EEG power spectra were examined to explore a possible mechanism underlying this skill improvement. ADHD-status moderated the association between slow spindle activity (12–13.5 Hz) and overnight accuracy improvement (β = 1.289, p = 0.023); furthermore, spindle-frequency EEG activity positively predicted improvements in ADHD (β = 0.792, p = 0.021) but not in controls (β = 0.056, p = 0.817).

Conclusion: These data indicate that motor skill learning in children with ADHD, as shown in adults, benefits from sleep, particularly sleep spindle EEG frequencies. Sleep disturbance in ADHD, therefore, may in part underlie cognitive deficits commonly observed in this population.

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0031
EFFECTS OF SLEEP RESTRICTION ON ADOLESCENT SUSTAINED ATTENTION, RESPONSE TIME AND SUBJECTIVE SLEEPINESS
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Introduction: Adolescents often obtain inadequate sleep. Biological and psychosocial factors contribute to later bedtimes across adoles-
cience, while rise times are necessarily early for school. Negative effects of sleep restriction on daytime functioning in adults are documented; however, the time course and severity of deficits in sustained attention and response times associated with sleep restriction are little studied in adolescents. The purpose of this research was to assess the effect of five consecutive nights of sleep restriction on adolescents’ psychomotor vigilance task (PVT) performance and subjective sleepiness.

**Methods:** Twelve participants (six male) ages 15–17 years (M = 16.08, SD = 0.9) participated in a ten-day laboratory study. After one adaptation night and one baseline (BSLN) night (10 h time in bed [TIB]), TIB was restricted to 5 h for five nights followed by two recovery (REC) nights (10 h TIB). Test batteries, including a 10 min PVT (lapses and fastest 10% of response times) and the Karolinska Sleepiness Scale (KSS), were completed 5 times per day at 3 h-intervals beginning 1 h after awakening.

**Results:** Mixed model analyses showed significant effects of sleep condition for PVT lapses (F(8,440) = 16.27, p < 0.001), PVT fastest 10% of responses (F(8,440) = 18.84, p < 0.001) and subjective sleepiness (F(8,437) = 48.01, p < 0.001). Post hoc tests for all variables showed worse performance/greater subjective sleepiness during SR compared to BSLN. All three variables showed a decrease in performance/increase in sleepiness from SR1 to SR5. While subjective sleepiness returned to BSLN levels at REC1, PVT lapses and fastest 10% did not return to BSLN levels in REC.

**Conclusion:** Sleep restriction is detrimental to adolescents’ response times, ability to sustain attention and perceived sleepiness. Thus, across a school week, adolescents can accumulate a substantial sleep debt that may have meaningful, negative implications for school performance. Furthermore, weekend recovery sleep may not be adequate to overcome deficits incurred through the week.

**Support (If Any):** University of South Australia Divisional Research Fund Grant and a grant from the Australasian Sleep Association.

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**0032**

**DECLINING SLEEP TIME ACROSS ADOLESCENCE: SLEEP DEPRIVATION OR BRAIN MATURATION?**

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**Introduction:** A fundamental question is whether the decline in sleep time across adolescence is produced by brain maturation or insufficient time in bed (TIB). Sleep loss from partial sleep deprivation disproportionately reduces REM sleep. However, our longitudinal EEG recordings between 9 and 18 years demonstrated that sleep time is reduced by a selective NREM duration decrease of 12 min/year (p < 0.0001); REM duration actually increases 2 min/year (p < 0.0001). This non-interventional EEG study measured sleep on habitual school-night schedules. Here, in different subjects, we examine sleep stage changes induced by experimentally restricting TIB.

**Methods:** Home recordings in children 10–14 years old (N = 36, mean age = 12.3). Maintaining current school day awakening time, subjects completed three nights of 8.5 hours TIB followed by four nights of 7, 8.5, or 10 hours TIB. Subjects completed all three schedules. EEG recordings from the final night of each condition were scored according to AASM criteria. We analyzed TIB effects on total sleep time (TST), NREM and REM duration.

**Results:** At 10 hours TIB, mean TST = 530 min, NREM = 397 min, and REM = 133 min. At 8.5 hours TIB, mean TST = 474 min, NREM = 364 min, and REM = 110 min. At 7 hours TIB, mean TST = 406 min, NREM = 320 min, and REM = 86 min. Mixed effect analysis showed that TST decreased 41 ± 2 min per hour TIB reduction, NREM duration decreased 25 ± 2 min/hr TIB reduction, and REM sleep decreased 16 ± 2 min/hr TIB reduction (all: p < 0.0001).

**Conclusion:** In contrast to the selective reduction of NREM sleep that occurs across adolescence, experimental sleep restriction in early teenagers reduces REM as well as NREM sleep. We have proposed that adolescent synaptic elimination reduces the need for the recuperative processes of NREM sleep, explaining its selective decrease. The findings here argue against sleep deprivation due to restricted TIB as the main factor in adolescent sleep decline.

**Support (If Any):** R01MH062521, R01HL116490

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**0033**

**WITHDRAWN**

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**0034**

**NADPH-OXIDASE MEDIATED WHITE MATTER DAMAGE IN PERINATAL MOUSE BRAINS ELICITED BY MATERNAL EXPOSURES TO SLEEP APNEA-FEATURED INTERMITTENT HYPOXIA DURING PREGNANCY**

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**Introduction:** Recent findings indicate that EPO, IL-6 and IGFBP-1/2 are significantly increased while IGF-1 is down-regulated in the cord blood of infants who experienced maternal OSAS during gestation, suggesting an abnormal brain development. We previously reported that maternal intermittent hypoxia (IH) exposures during pregnancy lead to brain white matter injury (WMI) in mouse offspring. In the present study, the potential underlying mechanism was investigated.

**Methods:** Timed pregnant mice (between 8.5–18.5 day-post-coitus) were exposed to IH for 10 days (8% O2/20.9% O2/120s switch/12 hrs during the light cycle), or intermittent air (IA). After gestational IA or IH exposures, pregnant mice were immediately terminated for embryo collection or transferred to room air conditions for delivery. The perinatal brain tissues were collected at different post-exposure days for immunostaining and Western blots. The statistical significance was considered as p < 0.05.

**Results:** The cytotoxic and membrane-bound components of NADPH oxidase and its activity were significantly elevated in fetal brains subjected to maternal IH exposures. Meanwhile, expressions of iNOS and eNOS, but not nNOS, were enhanced in maternal IH-exposed fetal brains. A large amount of superoxide, lipid peroxidation and protein oxidation were produced in e18.5 fetal brains by detecting 4-Hydroxynonenal (4-HNE) and nitrotyrosine (NT). Contrasting to WMI in offspring after birth, neuronal differentiation and synaptogenesis were disturbed after 10 days of maternal IH exposures at e18.5 by inhibited expression of NeuroD2, MAP2, phosphorylated GAP43, and synapsin I, however, all changes return to normal levels after birth, suggesting a quick recovery occurring when maternal IH exposures were withdrawn. Administration of apocynin, a selective inhibitor of NADPH oxidase complex, to IH-exposed pregnant mice prevents lipid peroxidation/protein tyrosine nitration and restores myelin/axon proteins in perinatal brains.

**Conclusion:** These findings suggest that NADPH-Oxidase mediated oxidative stress may play an important role in the pathogenesis of adverse fetal outcomes, including perinatal WMI.

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III. Sleep and Development

0035
PRENATAL INTERMITTENT HYPOXIA AFFECTS BODY GROWTH AND CARDIOVASCULAR FUNCTION IN RATS
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Introduction: The prevalence of obstructive sleep apnea (OSA) in pregnancy is approximately 5%. Chronic intermittent hypoxia (CIH) is one of the consequences of OSA. Since the fetus is already exposed to a hypoxic environment, periodic drops in maternal O2 saturation could have negative consequences in the development of the fetus. We hypothesized that maternal exposure to CIH impacts body growth and cardiovascular function in offspring—potentially via an increased sympathetic tone which influences cardiac function, lipid metabolism and long bone growth.

Methods: Sprague-Dawley pregnant dams were exposed to CIH (Alternate 1 min of 5% O2 with 1 min of 21% O2 for 8 daytime hours), or room air (controls; C), from pregnancy days 3–19. Studies were done in male offspring (18 CIH and 17 C). At 8 weeks of age, we measured: body weight (BW), tail cuff blood pressure (BP), echocardiography, and, following euthanasia, tibia length (TBL) and total weight of abdominal fat pads (FPW).

Results: Compared to C, CIH exposed offspring had significantly lower BW (259 ± 21 vs 278 ± 18 g; p < 0.01) and TBL (32.2 ± 0.68 vs 33.1 ± 0.62 mm; p < 0.01), but higher FPW (4.41 ± 1.02 vs 3.19 ± 1.41 g; p < 0.05), FPW/BW ratio (1.7 ± 0.4 vs 1.4 ± 0.3%; p < 0.05) and FPW/TBL ratios (0.13 ± 0.03 vs 0.10 ± 0.04 mm/gm; p < 0.05). CIH exposed offspring had greater systolic BP (126 ± 23 vs 95 ± 18 torr; p < 0.01), left ventricular (LV) ejection fraction (67 ± 6 vs 59 ± 8%; p < 0.01), LV fractional shortening (38 ± 5 vs 33 ± 6%; p < 0.01), stroke volume index (0.72 ± 0.14 vs 0.62 ± 0.11 ul/g; p < 0.05), and LV mass index (5.0 ± 0.5 vs 4.6 ± 0.5 mm/g; p < 0.05).

Conclusion: Prenatal CIH exposure affects fetal growth and cardiovascular function during post-natal development. These may increase risks for abdominal obesity, hypertension, and cardiac hypertrophy in adults.

0036
CORTICAL MORPHOLOGY OF ADOLESCENT MICE SUBMITTED TO NEONATAL SLEEP LOSS
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Introduction: Sleep is a predominant behavior in early-life that seems to contribute with somatosensory development. Sleep loss can lead to functional and structural changes in somatosensory cortex. We tested the hypothesis that neonatal sleep restriction induces long-term alterations in cortical morphology altering somatosensory cortical thickness.

Methods: Neonatal Balb/c mice at postnatal day (PND) 12 were randomly assigned to either a control (CTRL), a maternal separation (MS) or a sleep restriction (SR) groups. MS and SR were performed 2 h/day for 10 days (PND 12 until PND 21). The gentle handling method was used to prevent sleep (from 8 am to 10 am). At PND 35 mice were perfused intracardially, brains were harvested, coronally sectioned and stained with cresyl violet. Layers boundaries of the primary somatosensory cortex were defined by changes in cell size and density. Quantitative analysis of total cortical thickness and the thickness of layers I, II/III, IV, V and VI were measured using a computerized image analysis program.

Results: Cytoarchitecture analyses of primary somatosensory cortex showed no significant effect of sleep restriction in the cortical thickness. All groups exhibited similar total thickness, as well the thickness in the cortical layers I, II/III, IV, V e VI.

Conclusion: Repeated exposures to sleep loss during early-life were unable to induce long-term morphological changes in primary somatosensory cortex.

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0037
SLEEP HOMEOSTASIS IN TODDLERS: EEG REGIONAL ASPECTS IN RESPONSE TO A MISSED NAP
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Introduction: Findings from adult studies of sleep EEG topography suggest the degree of recovery following sleep loss, as measured by sleep slow-wave activity (SWA; EEG power in 0.75–4.5 Hz range), is most pronounced over frontal regions. Early childhood is a time of dramatic changes in brain development; however, little is known about the brain’s response to sleep loss during this maturational period. The present study examined the effects of sleep restriction via a missed nap on regional aspects of the sleep EEG in toddlers.

Methods: Eighteen healthy children (8 males; 30–36 months) followed a strict sleep schedule for ≥ 3 days before two non-consecutive, 24-h sleep EEG recordings (derivations Oz, Fz and the average of C3 and C4 [C], average mastoid reference): i) Baseline – daytime nap and subsequent night sleep occurring at habitual bedtime and ii) Sleep Restriction – missed daytime nap and night sleep occurring after 13 h prior wakefulness (habitual bedtime). Recovery sleep was quantified in each derivation as mean SWA (Sleep Restriction/Baseline night for the minimal common sleep duration) and slow-wave energy (SWE; cumulative SWA; Sleep Restriction/Baseline nap + night sleep).

Results: Mean SWA recovery was lower in Fz compared to C (1.11 ± 0.15 versus 1.15 ± 0.14 ratio; t(17) = 2.98, d = 0.25, p < 0.01). SWE showed a similar but non-significant trend (0.94 ± 0.10 versus 0.96 ± 0.09 ratio; t(17) = 1.91, d = 0.20, p = 0.07). We observed no differences in SWA and SWE ratios between Oz and the other derivations.

Conclusion: Our finding of a predominance of recovery sleep in central regions stands in contrast to reports in adults. These data may be reflective of greater sleep need in central cortical regions during early childhood, which could have important links to brain morphology and functional outcomes.

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0038
NAPS IMPROVE INFANTS’ MOTOR LEARNING
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Introduction: For adults, sleep enhances memory consolidation for learning new motor skills. For infants, a similar relationship has been demonstrated for sleep and language learning, but no studies have examined whether sleep facilitates motor learning in infancy. In the first study to address this gap in the literature, we hypothesized that infants who received a nap after learning a novel locomotor task would show improved performance at retest over infants who did not sleep after learning.
Methods: Fifteen novice walkers, within a week of having given up crawling (mean age = 13.02 months), participated in a “tunnel task,” which involved placing infants upright at the opening to a nylon tunnel (47 cm x 180 cm). Experimenters followed a training protocol controlling for when and how to demonstrate postural strategies as infants learned the task. Training ended after infants went through the tunnel one time to reach a goal at the other end. Next, participants either napped (n = 9) or did not sleep (n = 6) during a delay. After the delay participants were retested on the same task. Both sessions were videotaped. Speed measures included latency and restarts (number of within-session trial starts). Accuracy measures included body-awareness errors, postural shifts, and number of prompts necessary for learning the task.

Results: From training to test, the Nap group improved on latency (speed) and postural shifts (accuracy), whereas the No Nap group did not improve on any measure. No score decreased from training to test suggesting that fatigue did not affect performance at test for infants who did not sleep.

Conclusion: Thus, sleep enhances motor learning for infants. This finding has implications for how the interruption or regimentation of the natural sleep cycle impacts learning. Caregivers may need to take steps to ensure adequate daytime napping conditions, including the flexibility to respond to changes in individual children’s sleep needs coinciding with learning experiences.

0039 CHRONOTYPE IS ASSOCIATED WITH SLEEP-DEPENDENT EXECUTIVE FUNCTION IN HEALTHY TODDLERS
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Introduction: Chronotype is a construct reflecting inter-individual differences in sleep timing and diurnal preference. An established literature indicates that a preference for eveningness is associated with an array of negative behavioral and health outcomes (e.g. academic performance, depression) in school-age children, adolescents, and adults. Data in early childhood, however, are scarce. This study investigated the association between chronotype and sleep-dependent executive function performance (EF) in toddlers.

Methods: Data were collected on regularly napping children (n = 19; 8 females; 30–36 months). Parent-reported mid-sleep time on “free” days (MSF) was used to assess chronotype as measured by the Children’s Chronotype Questionnaire (CCTQ). Children participated in two counterbalanced in-home behavioral assessments: one following a regular nap (baseline) and the other after a missed nap (sleep restriction). Assessments included the Dimensional Change Card Sort, a 7-level executive function task (i.e., mental flexibility) requiring children to sort cards based on different dimensions (color and shape) of increasing difficulty. Pearson correlations between MSF and the highest level passed were computed for both the baseline and sleep restriction conditions.

Results: On average, MSF was 1.46 ± 0.36; highest EF level passed was 1.68 ± 1.20 for baseline and 2.05 ± 1.31 for sleep restriction. We found no significant association between MSF and executive function (r = 0.017, p = 0.47) when children performed after baseline sleep. Yet, a later MSF was associated with decreased executive function performance (r = −0.577, p < 0.01) when children were assessed after acute sleep restriction.

Conclusion: Sleep loss modifies the relationship between chronotype and executive function in toddlers: the influence of chronotype on executive function is less important when children have adequate sleep versus when they miss sleep, specifically, a daytime nap. Thus, our findings suggest that children exhibiting a preference for eveningness (but not morningness) may be more dependent on naps to restore executive function performance.

Support (If Any): R01-MH086566 to MKL; HHMI Grant to SAN

0040 NIGHTTIME SLEEP RESTRICTION IN EARLY CHILDHOOD: EFFECTS ON EMOTION REGULATION
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Introduction: The preschool-aged years are a sensitive period in the development of both sleep and emotion regulation (ER), as well as a time when problems in both domains begin to emerge. Although sleep loss is a recognized risk factor for decrements in emotion processing in adolescents and adults, such relationships remain understudied in early childhood. This experimental study examined the effects of acute nighttime sleep restriction on ER in 4- to 6-year-old children.

Methods: Healthy, non-napping children (n = 10; 5 females; 5.2 ± 0.6 years) followed a strict sleep-wakefulness schedule for ≥ 5 days before 2 counterbalanced assessments occurring in the morning following a night of habitual sleep (HS: 598.32 ± 35.83 min) and restricted sleep (RS: 474.50 ± 41.79 min; -3 h bedtime delay). Children were videotaped during a laboratory ER task designed to elicit frustration by “freezing” while children played a computer game. Coping strategies and displays of frustration were later coded according to frequency, intensity, and duration, and then averaged to create frustration and coping scores. Paired t-tests (one-tailed) were computed.

Results: When sleep restricted, children expressed more frustration (HS: 11.0 ± 9.1; RS: 19.2 ± 11.3; d = −0.85, p = 0.0095) and fewer coping behaviors (HS: 41.7 ± 16.6; RS: 24.2 ± 10.6; d = 1.3, p = 0.0095) than in the baseline condition.

Conclusion: Sleep restriction impaired children’s adaptive ER coping strategies and increased children’s frustration displays when challenged. Our experimental data in young children support findings in adolescents and adults, as well as our recent results in toddlers. Future studies should target the preschool years and measure ER through other methodologies, including physiological responses, to examine the extent of impairment of sleep loss on ER.

Support (If Any): R01-MH086566 to MKL

0041 SEX DIFFERENCES IN TODDLER’S EMOTIONAL RESPONSES TO SLEEP RESTRICTION
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Introduction: Sleep and emotion regulation patterns develop rapidly during early childhood, and growing literature suggests that insufficient sleep impedes effective emotion processing. Although sex differences have been identified in early emotion regulation, little is known about whether young girls and boys respond differently to sleep loss. This study used an experimental paradigm to examine sleep-dependent sex differences in toddlers’ emotional responses to a challenge task.

Methods: Healthy toddlers (n = 22; 9 males; 45.8 ± 2.2 months) followed a stabilization sleep schedule for ≥ 3 days before 2 counterbalanced assessments: one on a morning following a habitual nap and
night sleep (baseline) and another on a morning following a missed nap and a 3 h delayed bedtime (sleep restriction). Children attempted an unsolvable puzzle (one piece did not fit). Assessments were videotaped and later coded for positive and negative emotion expressions using the AFFEX Coding System. Percent time expressing each emotion was computed for the 5 seconds after the examiner prompted the child to “finish the puzzle” (time of greatest challenge). Two-way repeated measure ANOVAs were used to examine sex-by-condition (baseline versus sleep restriction) effects in positive and negative emotion responses.

**Results:** We observed main effects of sex for negative but not positive emotion. Girls showed more negative emotion than boys regardless of condition (F = 6.453, p = 0.019, eta² = 0.244). There were no effects of condition for positive and negative emotion (Positive: F = 1.735, p = 0.203, eta² = 0.080; Negative: F = 2.851, p = 0.107, eta² = 0.125). Finally, we observed sex-by-condition effects in negative emotion. Girls showed more negative emotion relative to baseline while boys showed the opposite pattern (F = 4.823, p = 0.040, eta² = 0.194).

**Conclusion:** Our findings suggest that girls and boys respond differently to acute sleep restriction when presented with a challenge task. Girls’ more negative emotional responses to being prompted to finish the puzzle, compared to boys may reflect sex differences in stress regulation. Sex may be an important factor in understanding individual differences in the emotion-related response to sleep loss across the lifespan.

**Support (If Any):** R01-MH086566 to MKL and K01-MH066139 to ALM

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**0042**

**NAPS ENHANCE SUBSEQUENT EMOTIONAL LEARNING IN PRESCHOOL CHILDREN**

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**Introduction:** According to the synaptic homeostasis hypothesis, synaptic strength increases over wake and decreases over sleep. This suggests that sleep may benefit subsequent learning as reduced synaptic strength across the brain favors plasticity. During the preschool years, children develop emotional control and awareness. For this reason, the function of daytime naps on subsequent new learning of emotional stimuli was studied in preschool children (33–60 months). We hypothesized that if decreased synaptic strength over sleep provides a ‘clean slate’ for new memories, then encoding would be better after a nap than after an equivalent interval awake.

**Methods:** A within-subjects comparison of two different conditions was used: wake and nap promotion. In the nap condition, children napped for 1–2 hrs prior to the task. In the wake condition, children rested quietly on their cots or mats. The task was an emotional face recognition task in which children viewed neutral expression faces paired with either mean or nice descriptions. Recall of these faces was probed immediately following encoding and again the following day.

**Results:** A paired-samples t-test showed an overall greater performance accuracy of the nap compared to the wake condition. Memory performance was greater following a nap for immediate recall, although this did not reach significance (p = 0.083). However, when memory was tested the next day, a benefit of having napped prior to learning was evident for memory for ‘nice’ faces (p = 0.019). Thus, mean faces were preferentially remembered in both conditions, but only in the nap condition was memory for the nice faces protected. Additionally, only in the wake condition was delayed recall accuracy significantly better for the mean faces compared to the nice faces (p = 0.001).

**Conclusion:** These results suggest that naps promote emotional memory acquisition for young children and may contribute to reduced emotional reactivity observed following sleep.

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**0043**

**ACUTE SLEEP RESTRICTION IN ADOLESCENTS MAY INFLUENCE RISK TAKING AND REWARD MOTIVATION**

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**Introduction:** Early adolescence is marked by changes in sleep patterns as well as increased risk-taking behavior. Sleep deprivation is also prevalent: as many as 69% of high schoolers report averaging less than 7 hours of sleep on school nights. It has been demonstrated in adult subjects that sleep deprivation may increase risk-taking and reward-motivated behaviors; however, this has not been explored in adolescents.

**Methods:** Participants (n = 52) ranged from 11.5–14.5 years of age, with normal sleep patterns and no history of mental illness. Participants underwent one of two experimental conditions, lasting 48 hours: two nights of either (1) sleep restriction (i.e., 4 hours time in bed) or (2) sleep extension (10 hours time in bed). Following the second night, participants completed a behavioral task to earn money within the context of threat. The task consisted of simultaneously operating between two computer screens: the first screen allowed participants to earn a fixed reward by pressing a button 30 times/reward; the other displayed a constantly increasing threat meter estimating a probability of losing money. A separate button switched between screens, and participants could reduce the threat meter by pressing another button on the threat screen. The task lasted 10 minutes was completed with two different levels of reward ($0.05 and $0.50), in randomized order.

**Results:** Participants switched between the threat and reward screens significantly less often while sleep restricted than otherwise (F = 5.93, p = 0.017), and also allowed the threat meter to rise to higher levels before reducing threat (F = 5.95, p = 0.017). Furthermore, sleep-restricted participants incurred significantly more total loss penalties by allowing the threat meter to rise too high (F = 6.73, p = 0.011), being 6.4 times (95% CI: 1.72–23.7) as likely to incur such a penalty (p = 0.006).

**Conclusion:** The data may indicate that sleep-restricted adolescents place lower value on risks, greater value on rewards, and/or show poorer vigilance to threat.

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**0044**

**THE EFFECTS OF INTERMITTENT HYPOXIA ON THE MICROSTRUCTURE OF GROWING CRANIOFACIAL BONES**

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**Introduction:** Obstructive sleep apnea syndrome (OSAS) is a common respiratory disorder characterized by partial or complete upper airway obstruction during sleep, causing intermittent hypoxia (IH). In children with OSAS, the low oxygen saturation during sleep can induce systemic growth retardation. Moreover, changes in the bone microstructure are associated with altered skeletal growth. However, the effects of IH on the microstructure of growing craniofacial bones remain unclear. This study aimed to investigate the influence of IH on the microstructure of the growing mandibular bone in peripubertal rats.
**Methods:** Seven-week-old male Sprague-Dawley rats were randomly divided into an experimental group and a control group. Rats in the experimental group were subjected to IH at the rate of 20 cycles/h (nadir 4% O2 to peak 21% O2 with 0% CO2 for 8 h/day) for 4 days (n = 5). The control group rats were made to breathe room air for 4 days (n = 4) or 3 weeks (n = 5). The trabecular bone structure in the subchondral and alveolar bones of the mandible were analyzed with regard to bone mineral density (BMD), bone volume/tissue volume (BV/TV), trabecular thickness (Tb.Th), and trabecular number (Tb.N) using micro-computed tomography (micro-CT). The tibial bone was used as a reference. Statistical analyses were performed using the Mann-Whitney U-test (P < 0.05).

**Results:** In the experimental group, BMD was increased in the cancellous bone of the temporomandibular joint, indicating osteoclastic changes in the subchondral bone. In addition, both BMD and BV/TV of the alveolar bone in the first molar region were affected in the experimental group.

**Conclusion:** The findings of this study suggest that IH induces changes in the microstructure of growing craniofacial bones, leading to skeletal growth disturbances.

**0045**

**INTERMITTENT HYPOXIA INDUCES CHANGES IN THE EXPRESSION OF THE ANGIOGENIC FACTOR, NITRIC OXIDE SYNTHASE 3, WITH IMPAIRED GROWTH OF THE NASAL AIRWAY**

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**Introduction:** There has been a reported prevalence of pediatric obstructive sleep apnea syndrome (POSAS) as well as obstructive sleep apnea syndrome (OSAS) in adults. Subjects with POSAS are likely to have nasal obstructions that are caused by inflammation and these obstructions lead to exacerbation of nasal respiratory disturbances. Intermittent hypoxia (IH) is one of the main symptoms of POSAS and is known to cause systemic inflammation and pathological angiogenesis. However, detailed investigations have not been performed on the role of IH in chronic inflammation of the nasal mucosa in children. The aim of this study was to elucidate the relationship between inflammation of the nasal mucosa and IH in growing lab rats.

**Methods:** Seven-week-old Sprague-Dawley male rats were divided into two groups: the experimental group (n = 5), which was exposed to IH at a rate of 20 cycles/h (nadir 4% O2 to peak 21% O2 with 0% CO2), and the control group (n = 5), which was exposed to room air. After 3 weeks, maxillofacial structures in both groups' surface area, cross-sectional area, and volume of the nasal cavity were evaluated using microCT. Expressions of nitric oxide synthase (NOS) in the nasal mucosa were evaluated using qPCR to elucidate the pathways of angiogenesis and inflammation.

**Results:** The experimental group showed significantly smaller cross-sectional area and volume of the nasal cavity than the control group. Although there was no significant difference in the surface areas, the area in the experimental group tended to be smaller than that in the control group. Moreover, qPCR showed that mRNA levels of NOS3 were significantly lower in the experimental group than in the control group.

**Conclusion:** Our findings suggest that IH exposure regulates NOS3 mRNA expression and influences growth of the nasal cavity.
resistance and prevent stress-evoked anxiety and depression. It may be possible, therefore, that a diet containing prebiotics can prevent stress-evoked anxiety and depression and protect the sleep/wake cycle. Thus we tested the hypothesis that prebiotic blend would increase Bifidobacterium spp. and Lactobacillus spp. species, modulate the sleep/wake cycle prior to stress, and protect the sleep/wake cycle following stress.

**Methods:** Male F344 rats, postnatal day 24 (P24), were placed on either prebiotic blend or a control diet ad-libitum. In the first experiment, body weights and food consumption were measured and weekly fecal samples were collected. In the second experiment, biotelemetry devices were implanted on P59, to examine real-time differences in the sleep/wake cycle across rodent development due to prebiotic blend. Rats were exposed to an acute stressor on P87 in order to examine the potential protective effects of prebiotic blend on stress-induced disruptions of the sleep/wake cycle.

**Results:** Fecal cultures confirmed that rats fed prebiotic blend had increases in stress-protective Bifidobacteria and Lactobacillus when compared to rats fed the control diet. In the second experiment, rats fed prebiotic blend had greater NREM sleep consolidation in early adulthood (P71, P72) compared to control diet. In addition, rats fed prebiotic blend also displayed enhanced REM rebound following stress exposure (P87) compared to rats fed the control diet.

**Conclusion:** These results demonstrate that prebiotic blend increased stress-protective gut bacteria, increased NREM sleep consolidation, and conferred stress-protective effects on REM sleep following acute stress. Our results suggest that modulation of the gut microbiota with prebiotic blend improves sleep architecture and may help reduce the incidence of stress-induced disruptions to the sleep/wake cycle.

**Support (If Any):** Mead Johnson Nutrition

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**0048**

**UP-REGULATION OF INFLAMMATORY PATHWAY THROUGH INTERLEUKINS AND NOS IN THE GENIOHYOID MUSCLE IN GROWING RATS EXPOSED TO INTERMITTENT HYPOXIA**


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**Introduction:** Exposure to intermittent hypoxia (IH) causes systemic inflammation in obstructive sleep apnea syndrome (OSAS). Systemic inflammation serves a novel role in skeletal muscular dysfunction in chronic OSAS. The atrophic change and the mitochondrial dysfunction occur in the upper airway (UA) muscles in OSAS. However, the role of IH in muscular inflammation in the growing UA is poorly understood. The aim of this study was to elucidate the inflammatory pathway in the geniohyoid (GH) muscle under IH using a rat model that recapitulate OSAS pathology.

**Methods:** Seven-week-old male rats were exposed to IH at a rate of 20 cycles/h (nadir of 4% O2 to peak of 21% O2 with 0% CO2) or normoxic air for 8 h/d for 3 weeks. After the experimental period, qPCR and immunoblot of the GH muscle were performed for IL-1β/6, TNF-α and iNOS, which are accelerators in the inflammatory pathway under hypoxia. Both nNOS and eNOS levels were analyzed as a mediator of neurotransmission and metabolism in the skeletal musculature. PCG-1α was evaluated as a key regulator in mitochondrial energy metabolism and insulin resistance. The gastrocnemius muscle was analyzed as a reference.

**Results:** qPCR showed that exposure to IH significantly elevated mRNA level of IL-1β/6 (IL-1, 3.3-fold change vs. the normoxia; IL-6, 1.6-fold change vs. the normoxia) and TNF-α (1.9-fold change vs. the normoxia) in the GH muscle, whereas these mRNA level did not significantly change in gastrocnemius muscles. Immunoblot showed a consistent expression of IL-1β and IL-6. iNOS and eNOS significantly increased mRNA level in the GH muscle. PCG-1α mRNA and protein levels in IH-rats significantly decreased in the GH muscle, but not in the gastrocnemius muscle.

**Conclusion:** Findings suggest that IH induces inflammation with the down-regulation of muscular metabolism in the growing rats.

**Support (If Any):** This study was financially supported in part by Grants-in-Aid for Scientific Research (23593020, 22792042) from the Japanese Ministry of Education, Culture, Sports, Science and Technology to JH.

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**0049**

**HIGHER RETROSPECTIVELY REPORTED MATERNAL CARE IS ASSOCIATED WITH BETTER SLEEP QUALITY AND LESS ANXIETY IN YOUNG ADULTS**

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**Introduction:** There is little research on the effects of parental bonding on young adults’ sleep and mental health symptoms. The focus of the present study is to examine the association between retrospectively reported parental bonding (care and overprotection) from both mothers and fathers, sleep, and symptoms of depression and anxiety in college freshmen. Poor attachment is associated with more infant sleep problems. Parental control is associated with child anxiety disorders, and observed low parental care and high parental overprotection are associated with child depressive symptoms.

**Methods:** Freshman college students (N = 277) completed the Pittsburgh Sleep Quality Index (PSQI) to assess sleep, the Generalized Anxiety Disorder 7 (GAD-7) and Patient Health Questionnaire 9 (PHQ-9) to measure symptoms of generalized anxiety and depression, and the Parental Bonding Instrument (PBI; care and overprotection) to retrospectively assess parental bonding levels with mothers and fathers separately.

**Results:** For both parents, higher levels of care and lower levels of overprotection were correlated with lower global PSQI, PHQ9, and GAD-7 scores, with the exception of paternal over-protection on global PSQI (r = 0.14, p = 0.07). A series of multiple linear regressions indicated significant effects for higher levels of maternal care predicting lower symptoms of anxiety (β = −0.21, SE = 0.08, p = 0.01) and better sleep quality (β = −0.04, SE = 0.01, p < 0.01), when controlling for other PBI subscales and after employing Bonferroni corrections.

**Conclusion:** Findings are consistent with previous research suggesting that maternal bonding is associated with sleep and mental health outcomes in children. These results suggest that there may also be a relationship between paternal care and sleep, although this effect may not be as strong as maternal care. Future studies should include a longitudinal design to assess whether sleep is a possible mediator between parental bonding and mental health.
III. Sleep and Development

0050
MATERNAL SHIFT WORK AND ADOLESCENTS’ SLEEP PATTERNS AND QUALITY OF LIFE: THE ROLE OF MATERNAL MENTAL QUALITY OF LIFE
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Introduction: Physiological, behavioral and social factors have been indicated as possible contributors to the decline in adolescents’ sleep quality in recent years. Parental and especially maternal behaviors, including sleep, have been associated with sleep patterns in adolescence. Although it is well documented that shiftwork affects maternal sleep quality as well as mental and physiological quality of life (QOL), no study to date has investigated the influence of maternal shiftwork on adolescents’ sleep patterns. We explored associations between habitual sleep and QOL in adolescents and their sleep-working and day-working mothers.

Methods: Seventy-eight nurses who work either rotating shifts (n = 38) or day shifts only (n = 50) and their adolescent children (ages 11–16) participated in this study. Mothers and their adolescent children completed self-reports about their sleep (Pittsburgh Sleep Quality Index and School Sleep Habits Survey), and mental and physical QOL (SF-12 and PedsQL-SF-15), respectively.

Results: As previously found, maternal shift work was related to inferior quality of sleep and life. Most importantly, maternal shift work was related to longer sleep latencies, more daytime problem behaviors related to sleep, and poorer physiological aspects of QOL in adolescents. Moreover, maternal mental quality of life mediated these links, but not maternal sleep quality or physiological quality of life.

Conclusion: The current study reveals the process by which maternal shiftwork affects adolescents’ quality of sleep and quality of life. In addition, it raises the importance of taking into account contextual factors such as maternal shiftwork, when investigating the relationships between mothers’ and adolescents’ sleep quality, of life, and possibly other health and functional outcomes.

0051
CYCLE-BASED EVALUATION OF NEONATAL SLEEP ARCHITECTURE INDICATES DIFFERING SLEEP PRESSURES THAN WINDOW-BASED OBSERVATION
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Introduction: Neonatal sleep architecture is traditionally reported as a behavioral state proportion within observation windows of convenience. Because a more biologically relevant unit is the sleep cycle, we explored neonatal sleep cycle organization during the first two days after birth.

Methods: Uninterrupted cycles of active/quiet sleep lasting ≥ 30 minutes from male (n = 21), and female (n = 32) neonates were analyzed for proportion of Active Sleep, Quiet Sleep, Transitional Sleep and Wake using pressure-sensitive, nonintrusive Motility Monitoring System-recorded respiratory and movement patterns. Males and females did not differ on: maternal age, parity, labor anesthetic, delivery or feeding method, data-relevant infant age, or number of qualifying cycles. 5-minute Apgar scores were all > 7. Circumcised and uncircumcised males presented similar sleep-variable trends.

Results: There was a significant Apgar*Transitional% interaction (p = 0.015). Infants with Apgar = 10 and Apgar < 10 had initially similar Transitional% that increased from day 1 to day 2 only for those with Apgar = 10 (p = 0.005). Male and female cycle durations did not differ on day 1 but males’ cycle duration was longer on day 2 (p = 0.003). A marginal Sex*Time interaction for Quiet% (p = 0.045) and Transitional% (p = 0.051), but not Active% (p = 0.134) in cycles indicated that males’ Quiet% decreased (p = 0.006) and their Transitional% increased (p = 0.039) from day 1 to day 2 while females were stable on all three measures. Cycle Transitional% was inversely related to Quiet% (p = 0.001), but was not related to Active%.

Conclusion: Males’ day 2 cycle duration was longer and their Quiet% was lower than females. The decrease we found in cycle Quiet% is distinct from previous reports that nocturnal (not within cycles) Quiet% increases among circumcised males (who constitute the majority of our male sample) but is consistent with reports of increased wakefulness after circumcision. We suggest that considering neonatal sleep in the cycle context offers a unique perspective on developmental sleep architecture and that cycle features should be evaluated for their utility as a measure of neonatal well-being because of their relation to 5-minute Apgar score.

0052
THE DEVELOPMENT OF SLEEP SPINDLES ACROSS EARLY CHILDHOOD
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Introduction: Sleep spindles, a prominent feature of the electroencephalogram (EEG) during non-rapid eye movement (NREM) sleep, are linked to cognitive ability. Although cross-sectional data indicate age-related changes in spindle features (i.e., frequency, density, duration, amplitude), longitudinal data are scarce. This study examined development changes in sleep spindles across early childhood, a time of rapid change in both sleep and cognition.

Methods: At-home sleep EEG was recorded after 13 hours of prior wakefulness in 8 healthy children at ages 2, 3 and 5 years (Y). Sleep was scored using standard criteria; data were resampled to 128 Hz. A spindle detection algorithm (Ferrarelli et al. 2007) utilizing amplitude and frequency criteria [11–16 Hz, rectified (translated into positive polarity), passing an upper threshold of 6 times the mean signal amplitude] was applied to derivations C3A2, C4A1, O1A2 and O2A1. Spindle frequency, density, duration and integrated amplitude were analyzed using repeated measures ANOVA (post-hoc paired t-tests, 2-tailed), including the maximal common length of NREM sleep across individuals.

Results: Spindle density did not consistently change with increasing age in all derivations; however, spindle duration and integrated amplitude increased in all derivations [all ps < 0.05; e.g., C3A2 spindle duration 0.9 ± 0.2 s (2Y); 1.0 ± 0.2 s (3Y); 1.2 ± 0.2 s (5Y); integrated amplitude 806 ± 156 μV² (2Y); 905 ± 208 μV² (3Y); 1254 ± 358 μV² (5Y)]. We also found a small maturational decrease in spindle frequency in all derivations [all ps < 0.05; e.g., C3A2 13.1 ± 0.2 Hz (2Y); 13.0 ± 0.4 Hz (3Y); 12.8 ± 0.3 Hz (5Y)]

Conclusion: Across the preschool years, the duration and integrated amplitude of spindles increases, while frequency decreases. Maturational of spindle characteristics in early childhood may reflect functional changes in thalamo-cortical networks. The association with age supports spindles as a potential neurophysiological marker of maturational changes in the developing brain.

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**A. Basic Sleep Science**

**0053**

AGE-RELATED DIFFERENCES IN EEG DELTA POWER DURING SLEEP IN ADOLESCENTS: INITIAL FINDINGS FROM THE NATIONAL CONSORTIUM ON ALCOHOL AND NEURODEVELOPMENT IN ADOLESCENCE

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**Introduction:** The National Consortium on Alcohol and NeuroDevelopment in Adolescence (NCANDA) is a multisite longitudinal study of normal adolescent development and the effects of alcohol exposure on brain structure, neuropsychological performance, and other processes, including sleep. Here we present initial findings of age-related differences in sleep delta EEG power in a subset of adolescents who completed a baseline sleep study at two of the five NCANDA sites.

**Methods:** Sleep EEG data at 14 scalp locations (Fp1/2, F3/4, FC3/4, C3/4, CP3/4, P3/4, O1/2) referenced to averaged mastoid channels, sampled at 256 Hz and filtered between 0.3 and 30 Hz, were recorded from 37 girls and 41 boys, 12 to 19 years old. Thirty-second epochs were scored according to standard criteria. Time-frequency analysis was conducted using FFT (fast Fourier transform), and power corresponding to the delta band (0.3–4 Hz) was extracted. Linear regression was used to estimate delta power over age.

**Results:** Delta power was greatest at frontal electrode sites and decreased from anterior to posterior electrode sites. It also showed a negative, linear correlation with older age at all electrode locations. Over the ages studied, delta power at frontal electrode sites was approximately 35% less in the older than younger participants, and this difference was greater at more posterior sites (e.g., over 60% at occipital sites). Delta power did not show a significant age-by-sex interaction.

**Conclusion:** Results are consistent with previous cross-sectional and longitudinal research demonstrating a dramatic decline in delta power during sleep across adolescence. As participants are followed up, these results will be used as baseline data for longitudinal analysis to address the hypothesis of Feinberg and Campbell that a decline in delta power across adolescence reflects underlying brain reorganization, and to determine the effect of alcohol use on EEG maturation trajectories.

**Support (If Any):** NIH R01 HL111695-01A1 (R.M.C. Spencer).

**0054**

NOVEL ACTIGRAPHIC MEASURES DEMONSTRATE GREATER SLEEP DISTURBANCE IN YOUNG CHILDREN WITH SYMPTOMS OF ADHD

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**Introduction:** Sleep disturbances are prevalent in children with Attention Deficit Hyperactivity Disorder (ADHD) and are thought to precede the onset of symptoms. However, as yet, evidence of sleep deficits prior to or at the time of diagnosis is scarce and inconsistent. To this end, we used actigraphy and polysomnography (PSG) to examine sleep in young children with (ADHD group) and without (control group) symptoms of ADHD.

**Methods:** Recruited children were assessed with the DSM-IV by a trained clinician. Those with ≥ 6 symptoms of ADHD were included in the ADHD group (n = 8, M = 80 months) while those with ≤ 4 symptoms were included in the control group (n = 7, M = 85 months). Actigraphy was recorded for 3–10 days (M = 7 days). Additionally, 1-night of overnight PSG was collected.

**Results:** Contrary to results from studies in older children with diagnosed ADHD, PSG architecture was not statistically different between groups, including Wake After Sleep Onset (WASO; t(10) = −1.251, p = 0.244). Actigraphic estimates of aWASO showed that it was greater in the ADHD group but the difference was not statistically significant (p = 0.08). However, analysis of the motion data collected by actigraphy showed that the ADHD group had a larger mean activity during the night (16.2 ± 5.2 vs 11.7 ± 1.5 cts/min, p < 0.05) and a larger 95th percentile activity level (p < 0.05). In addition, the activity pattern of the ADHD group had a different distribution of activity values as evidenced by differences in skewness (p < 0.02) and kurtosis (p < 0.03).

**Conclusion:** These data demonstrate an additional information may be obtained from actigraphy data by analyzing motion patterns. This information may detect an early difference in sleep of children with and without ADHD symptoms, which may help identify children who are at-risk for developing ADHD, creating opportunities for earlier diagnosis and intervention.

**Support (If Any):** This study was supported in part by NIH R01 HL111695-01A1 (R.M.C. Spencer).

**III. Sleep and Development**

**0055**

HABITUAL NAPPING IN TODDLERS WITH DOWN SYNDROME

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**Introduction:** Previous studies have suggested that napping plays an important role in sleep-dependent language and memory consolidation, with recent work suggesting that children who nap habitually are better able to retain learned information the following day. However, some studies have found opposing effects in children, and studies in adults have shown that regular nappers have higher levels of obstructive sleep apnea syndrome (OSAS). Therefore, napping might also be a marker of sleep disturbances. Down syndrome (DS), the most common genetic disorder resulting in intellectual disability, is characterized by sleep disturbance, with 60% of this population developing OSAS in early childhood. By examining napping behavior in typically developing toddlers and those with DS, and relations between naps and cognitive development, we will gain more information regarding the nature of diurnal sleep in the developing child.

**Methods:** Napping behavior was measured in toddlers with DS ages 2–5 years old (n 40) in relation to chronological age-matched controls (CA, 2–5 years; n 26). Nocturnal and Diurnal sleep was assessed using actigraphy and sleep diary over seven consecutive days. The MacArthur-Bates Communicative Development Inventory (CDI) measured parent report of developing language.

**Results:** A chi-square test showed more children with DS were habitual nappers (≥ 5 times per week) X2 (1, N = 50) = 3.8, p = 0.05, with equivalent age in both groups (t(44) = −1.5, p = 0.15). Toddlers with DS exhibited more fragmented sleep (p = 0.003) and lower sleep efficiency (p < 0.001). A mixed factorial ANOVA was conducted on vocabulary measured by the CDI, with group (DS, CA) and type of nap behavior (habitual [≥ 5], non-habitual [≤ 2]) as the independent variables. Significant main effects of group and type of nap behavior on CDI vocabulary were found (ps < 0.01), with habitual nappers and DS having lower vocabulary than those who did not nap habitually and CA controls, respectively. The group x nap behavior interaction was significant, F(1, 39) = 8.06, p = 0.007, suggesting that DS had lower vocabulary than CA controls, especially when they nap habitually.

**Conclusion:** These results suggest that toddlers with DS are habitual nappers. Habitual napping related to vocabulary reductions in DS, but not in controls, suggesting that this type of napping pattern (recuperative nap) might not reflect the same learning benefits as a regular nap.
**HERITABILITY OF THE SLEEP EEG IN EARLY ADOLESCENCE: PRELIMINARY RESULTS FROM A TWIN STUDY**

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**Introduction:** Previous studies have shown that the sleep EEG power density spectrum in adolescence is highly variable across subjects. Furthermore, the sleep EEG spectrum undergoes significant changes during this period. In adults, twin studies have found that the variability in the sleep EEG spectrum is largely due to genes. The aim of this study was to examine the degree to which the sleep EEG spectrum during adolescence, a time of significant cortical restructuring, is heritable. To this end, we recorded sleep EEGs in monozygotic and dizygotic adolescent twins between the age of 12–14 years.

**Methods:** All-night high-density (64 channel) sleep recordings were performed in three monozygotic (MZ; n = 6) and three dizygotic (DZ; n = 6) twin pairs. Sleep EEG spectra were calculated for derivation C3 (average reference) separately for NREM and REM sleep and divided into the following frequency bands: delta, theta, alpha and sigma. Heritability, h², was defined as the correlation between MZ pairs minus the correlation for DZ pairs times two and calculated for each frequency band during NREM and REM sleep.

**Results:** We found greater similarity between MZ as compared to DZ pairs in all frequency bands. This was true for both NREM and REM sleep.

**Conclusion:** Our preliminary findings show high heritability of the sleep EEG even during a period of significant cortical development. Many psychiatric disorders have their onset during adolescence and are accompanied by a sleep phenotype. By understanding how genes and environment contribute to the sleep EEG during this period we can open up new avenues for research.

**Support (If Any):** This work was supported by a grant from the Jacobs Foundation (to LT)

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**THE RELATIONSHIP BETWEEN VIGILANCE TOWARDS THREAT AND OBJECTIVE AND SUBJECTIVE MEASURES OF SLEEP DISTURBANCE**

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**Introduction:** Child anxiety is associated with sleep disturbance. Vigilance towards threat (including arousal and attentional processes) is a dimension of anxiety that runs counter to the loss of responsiveness to the environment required for sleep. We hypothesized that threat vigilance would contribute to sleep disturbance beyond the influence of overall anxiety severity.

**Methods:** Participants were 72 youth (ages 9–14) with anxiety disorders (from Child Anxiety Treatment Study; PI: Ryan), and 27 controls. Vigilance to threat was assessed via reaction times and eyetracking from a dot-probe task with 2-second fearful/neutral face-pairs. Anxiety severity was assessed by Pediatric Anxiety Rating Scale (PARS). Sleep was assessed by actigraphy for 5 nights [Total Sleep Time (TST), Sleep Efficiency (SE), Sleep Onset Latency (SOL), and Wake After Sleep Onset (WASO)], and questionnaires [Children's Sleep Habits Questionnaire (CSHQ) and Sleep Self-Report (SSR)].

**Results:** Greater threat vigilance was associated with several aspects of sleep (determined a priori), even after controlling for anxiety (PARS). Specifically, reaction time bias predicted SE (β = −0.236, p = 0.028, f² (Cohen’s) = 0.058), WASO (β = 0.235, p = 0.029, f² = 0.059), and CSHQ Total (β = 0.224, p = 0.012, f² = 0.079). In eyetracking, bias in initial fixation towards threat (β = 0.366, p = 0.001, f² = 0.148), and dwell time on threat (β = 0.220, p = 0.039, f² = 0.051) predicted SOL. Follow-up analyses of the CSHQ Sleep Onset Delay subscale showed an associa-
ASSOCIATION BETWEEN BEDTIME, CHILD TEMPERAMENT, AND EXTERNALIZING BEHAVIORS IN PRESCHOOL-AGED CHILDREN

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Introduction: Sleep and behavior problems are common among children high in temperamental negative affect (NA). Specifically, these children often have inconsistent bedtimes, which have been associated with externalizing behaviors. As bedtime variability and NA have been associated with externalizing behaviors independently, we examined the interaction of bedtime variability (BTVar) and NA in predicting externalizing behaviors during early childhood.

Methods: The sample included 118 children (57 females, M = 53.29, SD = 9.02 months). Sleep was assessed using actigraphy. Externalizing behaviors (i.e., the externalizing behaviors broad scale and attention problems and aggressive behaviors subscales) and NA were measured by caregiver responses on the Child Behavior Checklist and the Children's Behavior Questionnaire, respectively.

Results: Hierarchical linear regression revealed a significant interaction between BTVar and NA (β = 0.057, p = 0.054), with the model accounting for 19% of the overall variability in externalizing behaviors (R² = 0.192, p < 0.001). In a separate model specifically predicting attention problems, the interaction between BTVar and NA was significant (β = 0.013, p = 0.118, R² = 0.159, p = 0.001). In a model predicting aggressive behaviors, the interaction between BTVar and NA was marginally significant (β = 0.044, p = 0.069) with the model accounting for 19% of variability (R² = 0.189, p < 0.001). The associations between BTVar and both externalizing behaviors and aggressive behaviors were significantly stronger among children with high NA, (β = 0.093, p = 0.038 and β = 0.068, p = 0.063) compared to those with low NA (β = 0.022, p = 0.594 and β = −0.21, p = 0.546).

Conclusions: High bedtime variability predicts externalizing behaviors in children with high NA. These findings align with other recent studies suggesting that children with difficult temperament are susceptible to behavioral consequences associated with bedtime variability. Collectively, the results of this study and others suggest that bedtime consistency may minimize externalizing behaviors, particularly in children with high NA.

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0062 SLEEP, PHYSICAL GROWTH AND COGNITIVE DEVELOPMENT DURING THE FIRST YEAR OF LIFE
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Introduction: Infancy is a critical period for growth and cognitive development. We conducted a study to examine the relationships between infants’ sleep and wake patterns and growth and development.

Methods: A total of 473 healthy infants born in nine maternity hospitals were enrolled and followed 1 year. After delivery, we observed and recorded infants’ wake and sleep patterns by acti-watch and sleep diaries weekly during the first month and monthly for the 2nd to 6th months, and 9th and 12th months. Infants’ weight and length were measured at the 1st, 3rd, 6th, 9th and 12th month, and their cognitive development was assessed by standard development evaluation tool BSID at the 6th and 12th month.

Results: The number of night-waking, duration of nocturnal longest uninterrupted sleep, nighttime sleep efficiency (total sleep percentage of nighttime), physical activity level during nighttime sleep and number of naps and nap proportion (total sleep percentage of daytime), all had significant influences on infants’ growth and related velocity. With an increase by one night-waking or nap, or an increase in sleep efficiency by 5%, infant weight increased by 23 g, 41 g, and 63 g respectively, while an increase in nap proportion by 5% resulted in weight decreased by 56 g. On cognitive development, nighttime sleep efficiency and the number of naps had significant influences on infants’ mental development index (MDI). When sleep efficiency increased by 5%, MDI increased by 0.4 on average, while with an increase by one nap, MDI decreased by 1.5 on average.

Conclusion: Sleep and wake patterns influence infants’ growth and development. The high nocturnal sleep efficiency and uninterrupted sleep appears beneficial to infants’ growth and cognitive development and should be evaluated if growth or development delays occur.

0063 PARENT-REPORTED SLEEP PROBLEMS ARE ASSOCIATED WITH HIGHER COGNITIVE FUNCTIONS IN HEALTHY ADOLESCENTS
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Introduction: Childhood subjective sleep problems have been shown to be associated with neuropsychological functioning. However, less is known about this association in adolescence. Since sleep problems disrupt sleep, they may delay neural and skill development and in turn lead to neuropsychological impairments. Of particular interest are tasks of executive function that require the prefrontal cortex—a region with prolonged maturation into young adulthood, that is particularly sensitive to the effects of sleep disruption. Therefore, we investigated the effects of sleep problems and duration on the development of executive functions in early adolescents.

Methods: Cross-sectional data of 24 children (15 females, mean age: 12.49 years, SD: 1.57 years) who underwent neuropsychological testing in verbal learning and memory (German Version of the RAVLT), executive functioning (Regensburger verbal fluency test) and processing speed (Coding, WISC-IV) were examined. Subjective sleep problems were rated by parents; sleep duration and sleep latency was measured using 5 weeknights of actigraphy data. Associations were analysed with two-sided Spearman correlations, controlled for age at testing.

Results: Parent-reported sleep problems correlated negatively with processing speed (r = −0.64, p = 0.001) and executive functioning (semantic fluency: r = −0.45, p = 0.03; semantic category change: r = −0.49, p = 0.02), but not with verbal learning or memory. Furthermore, no association was found between actigraphically measured sleep duration or latency and neuropsychological performance.

Conclusion: Preliminary results revealed that subjective parent-reported problems are correlated with higher cognitive functions (processing speed and executive functions) in early adolescents, but not with learning and memory. This finding suggests that sleep disruption may have a dissociative impact on these processes. In addition, no relationship was found between objective measures of sleep duration and latency and neuropsychological performance, suggesting that disrupted sleep rather than total sleep time may impact risk. Future analyses will examine longitudinal associations between sleep and neuropsychological performance in a larger sample.

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A. Basic Sleep Science

are consolidated over a nap in young children and the physiological mechanisms involved in this process

**Methods:** Preschool-aged children (n = 49; M = 51.55 months, SD = 7.16) were tested on their memory for faces described as either “mean” or “nice.” Children completed a nap and a wake condition (within-subject design). In both conditions, memory was tested immediately following the nap opportunity and after subsequent nocturnal sleep. In a subset of the children (n = 20), polysomnography was used to record the physiology of the nap and of the overnight sleep bouts.

**Results:** The change in performance across the nap opportunity was not significantly different between conditions (F(1,47) = 0.678, p = 0.414). However, the change in performance across the 24-hour period was significantly better in the nap condition (F(1,43) = 4.523, p = 0.039). Across the nap, SWA was negatively correlated with performance change (r = −0.601, p = 0.008), but positively predicted the improvement in memory across nocturnal sleep in the nap condition compared to the wake condition (b = 0.475, t(17) = 2.159, p = 0.046).

**Conclusion:** The delayed benefit of the nap is intriguing, and reflects previous work in juvenile songbirds. In the present study, greater SWA during the nap may reflect greater synaptic remodeling as indicated by poorer initial performance changes; however, those synaptic changes are also associated with a greater overall benefit after additional processing during subsequent nocturnal sleep. SWA across the nap may therefore be necessary for long-term emotional memory consolidation in preschool-aged children.

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**0065**

**USING DENSE EEG TO STUDY OSCILLATORY TOPOGRAPHY IN NAPPING INFANTS, AND THEIR RELATION TO BRAIN AND SKILL MATURATION**

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**Introduction:** Sleep rhythms are thought to play an integral role in infant brain development, and may serve as early biomarkers for several neurodevelopmental disorders. Two spectral microstructure components, spindles and slow wave activity (SWA), have been proposed as electrophysiological measures of brain maturation, and have been linked to cognitive measures in school-aged children, adolescents, and adults. This study aims to characterize the microstructure of non-REM daytime sleep, including slow wave and spindle neurophysiology and topography, using both cross-sectional and longitudinal groups of typically developing infants at 3.5 and 6.5 months.

**Methods:** Infant sleep dEEG data (124 channels) were collected and analyzed using Matlab toolboxes (i.e. SPM, FASST, EEGLAB). Concurrent standardized tests designed to measure infant cognitive and language development were administered. Sleep sessions were scored for NREM sleep stages using EEG and behavioral data. Additional scoring analyses were completed by a certified PSG technician, on a subset of data. Spectral analysis of NREM 2/3 sleep stages was completed on eight topographical regions, using spectral decomposition.

**Results:** The occipital SWA power was higher than the frontal power at both ages (p < 0.001). There was a maturational increase in the left occipital region peak slow wave frequency (p = 0.0015). There was a significant maturational increase in temporal theta power (p = 0.002), which may be representative of the auditory cortical acoustic mapping that occurs during the first year of life. A significant positive correlation between the temporal theta amplitude and the cognitive score was seen at 3.5 months, and may represent hippocampal replay activity.

**Conclusion:** While these results are preliminary, they are the first to include an examination of oscillatory topography during sleep concur rent with standardized cognitive testing at these ages. This research may lead to more detailed studies of sleep microstructure including temporally-bounded sensory information processing and possible links to emerging language and cognitive abilities.

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**0066**

**SLEEPY TEENS AND ENERGY PRODUCT USE: RISK FACTORS FOR TEEN ALCOHOL USE**

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**Introduction:** Adolescence is marked by dramatic increases in sleep problems and alcohol use (AU), and the use of highly caffeinated energy products (EP). Previous research suggests that sleep problems and EP use are associated with increased risk of AU; however, few studies have examined racial/ethnic differences in these associations, despite known racial/ethnic differences in sleep, EP use, and AU.

**Methods:** The current study cross-sectionally examines the association between self-reported measures of trouble sleeping, weekend and weekday total sleep time (TST), and EP use, and past month AU in a racially/ethnically diverse sample of teens (N = 2539; mean age = 15.54; 54.23% female). We also examined associations separately by race/ethnicity. For Whites (N = 533), Hispanics (N = 1115), Asians (N = 532), and “Other” racial/ethnic categories (N = 539). Logistic regressions examined the odds of AU associated with sleep/EP use after controlling for age, sex, sociodemographics and mental health symptoms.

**Results:** In the total sample, shorter TST (weekends and weekdays), trouble sleeping, and use of EP were associated with significantly greater likelihood of past month AU (p’s < 0.05). In race/ethnicity stratified analyses, EP use was significantly associated with AU for all racial/ethnic groups (p’s < 0.05), except for Asians. Additionally, for whites, there was a significant association between shorter weekend TST and AU, whereas for “Other” racial/ethnic groups, there was a significant association between shorter weekend TST and AU (p’s < 0.05).

For Asians, there was a significant association between trouble sleeping and AU (p < 0.05).

**Conclusions:** Sleep problems and EP use are associated with increased AU in teens, even after controlling for sociodemographics and mental health. Findings also highlight the importance of considering racial/ethnic differences in observed associations. Further longitudinal research on sleep and EP use is critical to identify novel prevention and intervention efforts to reduce disparities in the relationship between sleep, energy products, and alcohol use.

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**0067**

**NAPPING, DEVELOPMENT AND HEALTH FROM 0-5 YEARS: A SYSTEMATIC REVIEW**

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**Introduction:** Duration and quality of sleep affects child development and health. Encouragement of napping has been suggested as a health-
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promoting strategy in early childhood however, the effects of napping promotion, although debated, are not clear. In response, a systematic review was conducted to examine the state of evidence and current findings regarding the independent effects of napping on children’s night sleep, behaviour, cognitive functioning and physical health from birth to 5 years.

Methods: Electronic database search following PRISMA guidelines and assessment of research quality following a GRADE protocol was undertaken. We focussed on published, original research articles of any design reporting on outcomes for children aged 0 to 5 years.

Results: Twenty-five articles met inclusion criteria. No study was randomised; all had observational designs. Among the studies quality was heterogeneous. Most did not obtain data on the children’s habitual napping status or the context of napping. Many were reliant on parent report rather than direct observation or physiological measurement of sleep behaviour. The studies variously reported on salivary cortisol, night-sleep, cognition, behaviour, obesity and accidents. The findings regarding cognition, behaviour and health impacts were inconsistent, probably due to variation in age and habitual napping status of the samples. The most consistent finding was an association between napping and later onset, shorter duration and poorer quality of night sleep, with evidence strongest beyond age 3.

Conclusion: There is consistent correlational evidence that night sleep onset, duration and quality are adversely impacted by napping beyond the age of 2 years. Effects of napping on behaviour, cognition and health are less certain. There is an imperative for more systematic studies of effects of napping in early childhood.

0068

MOTOR ACTIVITY DURING SLEEP: ACTIGRAPHIC RECORDINGS FROM INFANCY TO ADULTHOOD


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Introduction: Use of actigraphy in sleep medicine is rapidly increasing. As sleep evaluation by actigraphy is indirect (i.e. validated algorithms), a valuable way to use the tool is to focus on its primary outcome measure—motor activity counts. However, developmental data are still lacking. The aim of the current retrospective study was to quantitatively investigate motor activity pattern during nocturnal sleep in multiple age groups.

Methods: Actigraphic recordings came from the Laboratory of Applied Chronopsychology of the Department of Psychology, University of Bologna and the Department of Counseling and Human Development, University of Haifa. The final sample consisted of 122 healthy participants: 20 aged one year; 17 aged five; 21 aged ten; 16 aged twenty; 15 aged thirty; 19 aged forty; and 14 aged sixty. We analyzed hourly motor activity for the first six hours of sleep.

Results: All groups, except the infant group, showed a clear decrease in motor activity from the 1st to the 2nd hour of sleep. The decrement is statistically significant from age 10 to 40 years. The infant group stood out in a number of ways: (a) a progressive increment of motor activity from 1st to 5th hour of sleep, (b) at the 5th and 6th hour, activity was significantly higher in comparison to all other groups, and (c) low motor activity in the 1st hour of sleep. Lower activity during the 1st hour was also observed in the 5-year-old children.

Conclusion: During the first six hours of sleep, one-year-olds’ motor activity pattern differed from the other groups. This result is probably due to the lack of motor paralysis during REM sleep, which is characteristic of infants. The finding that both the one- and five-year-old groups showed low motor activity during the 1st hour suggests that sleep onset occurs easily in early development.

0069

DOES WEEKEND SLEEP PRODUCE JETLAG-LIKE CIRCADIAN DISRUPTION IN TEENAGERS?

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Introduction: The proverbial surge of hormones during puberty affects many aspects of behavior, including sleep. A delay in hormones driving the sleep-wake cycle compels teenagers to postpone bedtime, especially when mornings are free of early school obligations. Consequently, adolescents are sometimes described as “chronically jetlagged.” One of these hormones, cortisol, is of particular importance due to its role in alertness and cognition. Increased or desynchronized cortisol across the 24-hour period, as has been observed in jetlagged adults, could have profound implications for teens with variable sleep.

Methods: We tracked 17 subjects (8 female) aged 14–17 years across the school week. Using actigraphy and self-report, we measured weekend total sleep time (the difference between bed and wake controlling for any nocturnal awakenings) and weekend sleep delay (the difference in average sleep midpoint from week to weekend). These variables entered into a temporal model predicting daily salivary cortisol collected about the sleep period.

Results: No significant effect was observed for weekend total sleep time on cortisol across the week. However, weekend sleep delay predicts lower cortisol on Monday that increases by Friday morning, β = 0.013, p = 0.03, suggesting that inconsistent sleep yields slower adaptation of cortisol to the new wake up time. More consistent sleep schedules, on the other hand, predicts a decrease in cortisol across the week, β = 0.05, p = 0.01.

Conclusion: Our findings indicate that sleep schedule, but not sleep amount, is associated with circadian effects that mirror jetlag in adults. Namely, cortisol production is suppressed early in the week in teenagers who delay sleep on the weekends, indicating that their internal clock requires several days to adapt to the earlier schedule. A current future direction involves investigating the impact of cortisol on working memory performance as a function of weekend sleep.

0070

PROSPECTIVE SLEEP AND PSYCHOLOGICAL SYMPTOMS IN ADOLESCENTS REPORTING FOR A SLEEP TREATMENT TRIAL

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Introduction: Insufficient sleep and dissatisfaction with sleep are widespread among adolescents, yet the clinical relevance of such reports remains incompletely understood. We examined the relationships between sleep and psychological functioning in a sample of adolescents presenting for enrollment in a sleep treatment trial.

Methods: A community sample of adolescents in 9th–12th grades with self-reported difficulty getting to sleep at an early enough hour (N = 25) completed a baseline assessment where self-report measures of depression (CES-DC) and ADHD symptomatology (Hyperactivity/Impulsivity, Inattention, and Oppositional Defiant Disorder; SNAP-IV-26) were collected. All participants subsequently completed sleep diaries for one week, with variables of interest including sleep initiation time, number and length of naps, number of awakenings, wake after sleep onset (WASO) and total sleep time.

Results: Sleep diaries revealed that adolescents slept 6.87 ± 1.07 hours on weekdays and 8.60 ± 1.92 hours on weekends, with sleep initiation
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0071

RELATIONSHIPS BETWEEN RISK TAKING, DISTRESS TOLERANCE AND SLEEP IN ADOLESCENCE

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Introduction: Evidence for the impact of insufficient sleep on behavioral measures of risk-taking is mixed, with some studies reporting decreases and others noting increases in risk-taking behavior following experimental sleep deprivation. Few studies have examined the influence of naturalistic sleep quantity or quality on risk-taking or its related construct distress tolerance.

Methods: A community sample of adolescents in 9th–12th grades with self-reported difficulty getting to sleep at an early enough hour (N = 25) completed computerized measures of risk-taking (Balloon Analog Risk Task; BART) and distress tolerance (Behavioral Indicator of Resiliency to Distress; BIRD), along with self-report measures of sensation seeking (Sensation Seeking Scale; SSS), sleep quality (Adolescent Sleep Wake Scale; ASWS), and one week of prospectively-kept sleep diaries.

Results: Indices of risk-taking (BART ‘average adjusted pumps’ and ‘exploded balloons’) were positively associated with sensation seeking (r’s ≥ 0.42, p’s < 0.05). Consistent with reports of conservative behavior following sleep deprivation, individuals were less likely to demonstrate risky behavior (BART ‘risk ratio’) if they reported spending less time in bed across the week (p < 0.05), went to bed later on weekends (p < 0.05), or noted greater sleep maintenance disturbance (ASWS ‘re-initiating sleep’) (p < 0.05). Adolescents who demonstrated high distress tolerance on the BIRD (i.e., opted to stick with an increasingly difficult task) similarly reported less daily total sleep time (p < 0.05) and reduced sleep quality (ASWS total p < 0.05) compared to adolescents who chose to quit the task.

Conclusion: Results support the idea that poorer sleep quality and reduced quantity are associated with less risky behavior and higher levels of distress tolerance. Adolescents may be less willing to take risks and test limits when not fully rested.

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0072

IS DAYTIME NAPPING ASSOCIATED WITH INFLAMMATORY MARKERS IN ADOLESCENTS?

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Introduction: Short nocturnal sleep leads to more napping in adolescents, and more napping leads to short nocturnal sleep. Some studies also link short nocturnal sleep to inflammatory markers among adolescents. However, it is unclear whether napping can make up for deficits caused by short sleep, or if napping further exacerbates the influence of short sleep on inflammation. We investigated whether actigraphy-assessed napping was associated with inflammatory markers, independent of nocturnal sleep, and also whether the timing of daytime naps was related to inflammatory markers.

Methods: Participants were 234 healthy adolescents (56% black, 53% female). Nocturnal sleep and daytime napping were assessed with actigraphy across one week. Napping was measured as the proportion of days napped and the average minutes napped across the full week; napping within school days was measured as the average minutes napped and the proportion of school days with at least one nap before 2 p.m., between 2 pm and 6 pm, and between 6 pm and 10 pm. Inflammatory markers included fasting measures of high sensitivity C-reactive protein (hs-CRP) and interleukin-6 (IL-6). Linear regressions were used, adjusting for age, sex, race, average nocturnal sleep duration, and BMI percentile.

Results: On average, adolescents napped 36% of days and 24 minutes per day across the full week. Within school days, adolescents napped before 2 pm on 11% of school days, between 2 pm and 6 pm on 19% of school days, and between 6 pm and 10 pm on 11% of school days; school day naps lasted 22 minutes on average. More days napped across the full week associated with elevated IL-6 [B (SE) = 0.49 (0.21), p < 0.05]. More days napped after school between 2 pm and 6 pm [B (SE) = 0.42 (0.22), p < 0.05] and between 6 pm and 10 pm [B (SE) = 0.66 (0.30), p < 0.05] associated with higher IL-6. More minutes napped on school days also associated with elevated IL-6 [B (SE) = 0.07 (0.07), p < 0.05]. Napping was not associated with hs-CRP.

Conclusion: Actigraphy-assessed napping associated positively with circulating IL-6, a peripheral proinflammatory cytokine known to impact levels of inflammation within the central nervous system, which contribute to sleep regulation. Further examination of the direction of this effect is warranted. IL-6, but not CRP, can cross the blood brain barrier, which might explain their different relationships with napping.

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0073

SLEEP SCHEDULE REGULARITY IN COLLEGE STUDENTS: RELATIONSHIPS WITH MOOD, EMOTION REGULATION, AND MORNINGNESS-EVENINGNESS TENDENCIES

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Introduction: College students are known for having poor sleep and irregular sleep schedules, especially during the first year of college. These sleep habits may contribute to poor academic outcomes down the line. We utilize a new questionnaire to examine the relation between sleep schedule regularity, sleep, and daytime function. We hypothesize that students with more regular sleep schedules will have better overall...
sleep, report better mood, and utilize more adaptive emotion regulation strategies, and that students with more morning tendencies will have a more regular sleep schedule.

**Methods:** Data were obtained from 311 college freshmen (237 females). The Morningness-Eveningness Questionnaire (MEQ) was used to assess morning and evening tendencies. The Sleep Schedule Regularity Questionnaire (SSRQ), created for this study, was used to assess students’ perceptions of their sleep regularity. Higher scores on the SSRQ subscales indicate a more regular sleep schedule. The Emotion Regulation Questionnaire (ERQ) was used to assess emotion regulation strategies.

**Results:** Morning tendencies were associated with a more regular current sleep schedule ($r = 0.28$, $p < 0.001$). More regular sleep schedules were also associated with greater use of reappraisal ($r = 0.18$, $p < 0.01$), fewer sleep complaints ($r = -0.22$, $p < 0.001$), and better mood over the following week ($r = 0.21$, $p < 0.001$). There was no relationship between schedule regularity and use of emotional suppression or total sleep time.

**Conclusion:** Students who keep a more regular sleep schedule in the first year of college have better sleep and daytime functioning that those with more variable schedules. Surprisingly, schedule variability in this sample was unrelated to total sleep time, perhaps due to students’ ability to sleep in on weekends. Additionally, schedule regularity was related to use of positive, but not negative emotion regulation strategies. Finally, students who have more morning tendencies tend to have a more regular sleep schedule across time, consistent with current literature.

0074 REM SLEEP PHYSIOLOGY DIFFERENTIALLY REGULATES SOCIAL THREAT DETECTION IN THE ADOLESCENT AND ADULT BRAIN

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**Introduction:** Adolescence represents a developmental period of profound psychosocial change, one that demands accurate processing of complex emotions. In adults REM sleep physiology is known to contribute to optimal emotional brain processing, however, the role of equivalent REM sleep recalibration mechanisms in adolescents remains uninvestigated.

**Methods:** 31 healthy males—22 adolescents (age: 12.1–15.9) and 9 young adults (age: 18.0–21.1) obtained a PSG-recorded night of sleep, followed the next morning by a complex socio-emotional fMRI task requiring discrimination of “Threatening” from “Affiliative” face stimuli. Analyses focused on limbic-related anterior insula cortex, dorsal anterior cingulate cortex (dACC) and amygdala. Regression models examined both (1) separate effects of age and (adrenergic-related) REM sleep gamma EEG activity (REM-$\gamma$) in predicting accurate emotional-brain discrimination, and (2) their interaction—that is, does the predictive benefit of reduced REM-$\gamma$ vary by age.

**Results:** Significant discrimination activity differentiating threatening from affiliative stimuli was observed in both dACC and the insula in all participants ($p's < 0.05$), and in the amygdala in adolescents ($p < 0.05$). When considered in the regression model, age (corrected for REM-$\gamma$) and REM-$\gamma$ (corrected for age) significantly predicted threat discrimination accuracy in dACC and insula ($p's < 0.03$). Most critical, however, there was a significant age-by-REM-$\gamma$ interaction ($p's < 0.01$) in the dACC and insula, indicating that the neural recalibrating function of low REM-$\gamma$ in these limbic regions varied with age. Specifically, the beneficial effect of REM-$\gamma$ on enhanced emotion discrimination in the dACC and insula cortex emerged as developmental age increased towards adulthood ($\beta_{(age = 21)} < -2.87$), relative to younger adolescents ($\beta_{(age = 12)} > +1.61$).

**Conclusion:** These results suggest a sleep-sensitive window of human emotional brain maturation, one in which the recalibrating benefits of REM sleep physiology emerge during the transition from adolescence to adulthood. Such findings emphasize the critical need for sleep—especially late morning REM-rich sleep—during adolescence, thereby optimizing emotional brain processes that support parent-independent social functioning.

0075 POPULATION-LEVEL SOCIO-DEMOGRAPHIC FACTORS ASSOCIATED WITH INFANTS’ SLEEP PATTERNS AND ENVIRONMENTS IN AOTEAROA/NEW ZEALAND

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**Introduction:** Sleep is associated with development, but limited research exists on infants’ sleep patterns and the role of socio-demographic factors in different facets of babies’ sleep. The study aimed to investigate the association between maternal ethnicity, socioeconomic deprivation and age, and 11–13-week-olds’ sleep in a prospective cohort of infants (Māori: n = 316 and non-Māori: n = 635) and mothers.

**Methods:** Logistic regression models were used to examine independent predictors of parentally-reported infant sleep duration, sleep location, bed-type and day-to-day sleep pattern variability. Maternal ethnicity (Māori/Non-Māori), socioeconomic deprivation (NzDep; a neighbourhood measure of socioeconomic deprivation) and maternal age were independent variables in analyses.

**Results:** Babies of Māori mothers were less likely to have variable day-to-day sleep patterns (OR = 0.65, 95% CI 0.47–0.88), or short (< 2 hrs) diurnal sleep durations (OR = 0.66, 95% CI 0.49–0.89). They were more likely to change sleeping location during the night (OR = 1.77, 95% CI 1.28–2.45) and sleep in parents’ bedrooms (day: OR = 1.73, 95% CI 1.29–2.34; night: OR = 2.42, 95% CI 1.75–3.35) and/or beds (day: OR = 2.28, 95% CI 1.17–4.45; night: OR = 2.15, 95% CI 1.30–3.55). The likelihood of an infant sleeping in their own room (day: OR = 0.91, 95% CI 0.87–0.96; night: OR = 0.93, 95% CI 0.88–0.98) or being held while sleeping (day: OR = 0.89, 95% CI 0.82–0.97) decreased with increasing neighbourhood deprivation. Conversely, the likelihood of sleeping in the parent/s’ bedroom (day: OR = 1.08, 95% CI 1.02–1.13; night: OR = 1.09, 95% CI 1.03–1.15) and/or bed (night: OR = 1.14, 95% CI 1.04–1.25) increased with increasing neighbourhood deprivation. Increasing maternal age was associated with a lower likelihood of sleeping in the parent/s’ bedroom during the day (OR = 0.91, 95% CI 0.86–0.96).

**Conclusion:** Maternal ethnicity, neighbourhood socioeconomic deprivation and maternal age independently predicted how and where 3-month-old infants slept in this sample. Further investigation is needed to ascertain what these differences in sleep patterns and environ-
ments mean for infants’ sleep and development, cross-sectionally and longitudinally.

0076
GROUP NAPPING PATTERNS IN RELATION TO DURATION OF MANDATORY NAPTIMES IN CHILDCARE SETTINGS
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Introduction: Naptime is a routine feature within many childcare settings and may include a mandatory period in which all children are required to lie down without alternate activity permitted. This study aimed to examine the relationship between variation in duration of mandatory naptimes for preschool aged children (3–6 years) and children’s sleep patterns within these settings.

Methods: An observation study of a community sample of 113 preschool rooms attended by 2114 preschool aged children was undertaken. Within each childcare room sleep practices and children’s sleep patterns were observed using a standard protocol. Observations were conducted within in the second semester of the education year. Counts of the number of children asleep were coded in 10-minute intervals. Poisson mixed effect regression models were conducted to map the patterns of the number of children asleep and latency to sleep onset in rooms with different durations of mandatory naptime, whilst controlling for potential confounds of age range, socio-economic status, childcare quality, childcare type and nap start times.

Results: Three-quarters of childcare settings implemented a mandatory naptime with considerable variation in duration (15–145 minutes). Compared to rooms with ≤ 30 minutes of mandatory naptime, there was a two-fold increase in the proportion of children napping within rooms with 31–60 minutes of mandatory naptime, and a four-fold increase for those in rooms with > 60 minutes mandatory naptime. Napping patterns across mandatory naptime groups were similar; increased duration of mandatory naptime was associated with increased napping prevalence, but not the time to nap onset.

Conclusion: The results of the current study suggest that mandatory naptimes are associated with an increase in napping prevalence, but not sleep onset time, within childcare rooms. Future studies should examine the influence of other child and childcare sleep characteristics, including routines, noise and teacher strategies on children’s sleep patterns within these settings.

Support (If Any): This study was funded via a grant from the Institute of Health and Biomedical Innovation at Queensland University of Technology. The E4Kids study, from which the sample is derived, is funded by the Australian Research Council Linkage Projects Scheme, the Victorian Government Department of Education and Early Childhood Development, and the Queensland Government Department of Education and Training.

0077
“IF GIVEN THE OPPORTUNITY WOULD YOU WANT YOUR CHILD TO SLEEP IN CHILDCARE?”
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Introduction: In Australia, approximately 60% of children aged 3–5 attend an ECEC setting. A majority of settings schedule a nap period. Previous research reports that parental decisions regarding children’s sleep patterns are influenced by various factors, including financial conditions, family size, cultural practices and beliefs, parent work schedules and child factors, to name a few. To date, no research has been conducted to examine a) parental preferences towards the daytime sleep/rest period in ECEC settings and b) the underlying reasons behind these preferences.

Methods: A large cohort of parents (N = 1302) of preschool aged children (aged 3–6) attending early childhood services completed surveys. Families were from metropolitan, rural and remote sites and represented the diversity of social groups in Australia. Parents provided a range of demographic data and responded to the question “If given the opportunity would you want your child to sleep in childcare?” They also gave open-ended reasons for their response. Quantitative data were analysed for association with demographic data while thematic analysis assessed open response

Results: 80% of parents did not wish their preschool child to sleep while in non-parental care. Those preferring their child to nap (20%) had younger children and children who spent long days in childcare. Social class variables were not associated with napping preference. The key reasons for parent choice were their perceptions of the cost or benefit to their child’s health and development. Family functioning was also a key theme.

Conclusion: There is currently a disjuncture between practices in childcare settings and parents preference. Many parents report disturbance to their children’s night sleep. The interface between childcare sleep practices and those in the home is important for child health and development and impacts on family functioning. Our data suggest the need for detailed investigation.

Support (If Any): The sampling derives from an Australian longitudinal cohort study, Effective Early Educational Experiences for Children (E4Kids). E4Kids is funded by the Australian Research Council Linkage Projects Scheme (LP0990200), the Victorian Government Department of Education and Early Childhood Development, and the Queensland Government Department of Education and Training.

0078
DIM LIGHT DURATION PREDICTS BODY MASS INDEX OF YOUNG CHILDREN
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Introduction: A potential role for light exposure in appetite, sleep and weight regulation is currently emerging. This study aimed to determine the effects of sleep, activity and light exposure on children’s body mass index (BMI) at baseline and at 12-month follow-up.

Methods: Data was collected from 48 children (25 females; mean age = 57.06 months ± 4.90; ages 45.90–64.66 months) recruited from six childcare services in Brisbane, Australia. Children’s sleep, activity and light exposure were measured via Actigraphy for 14 days. Each child’s height (cm) and weight (kg) were measured objectively for BMI z-score calculations. At 12 month follow-up, parent survey and objective BMI measurements were conducted; 40 (83.33%) children participated.

Results: Cross-sectional analyses of baseline data showed higher BMI z-scores were associated with longer duration of light exposure above a threshold of 2500 lux (r = 0.31, p < 0.05), and earlier exposure to light above 200 lux (r = −0.34, p < 0.05). Linear regression adjusting for activity, total sleep duration, and sleep midpoint, indicated duration of light exposure above 2500 lux did not contribute significant variance however, earlier timing of light exposure above 200 lux (β = −0.419, p = 0.01) independently predicted increased BMI z-score (R2 = 0.273, p = 0.017). At 12-month follow-up, duration of light exposure > 10
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lux was a significant independent predictor of BMI z-score (β = 0.409, p = 0.001) after adjusting for Baseline measures of BMI z-score and sleep midpoint, and accounted for 58.3% of the variance in BMI z-score (p < 0.001).

Conclusion: Exposure to dim levels of light can influence children’s body mass both concurrently and at 12 months post-exposure, independent of sleep and activity. While mechanisms remain unclear, these data suggest that light should be considered as a factor in studies of weight gain and obesity in children.


0079

EFFECT OF MATERNAL SEPARATIONS ON SLEEP AND BRAIN ACTIVITY IN FEMALE OFFSPRING
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Introduction: Early life stress has been shown to alter sleep and lower brain activity during sleep and wakefulness in male rats. Disadvantageous early life conditions may give rise to gender specific behaviour and stress reactivity in adulthood. The present study aimed to investigate effects of maternal separations in early life on sleep parameters and brain activity during sleep and wakefulness in adult female rats.

Methods: During postnatal day 2–14 female rat pups were exposed to either long (LMS; 180 min) or brief maternal separations (BMS; 10 min) (n = 6, both). A telemetric device was implanted subcutaneously and 24 h EEG and EMG recordings performed at 5 months of age.

Results: Adult LMS and BMS rats showed similar total sleep time, as well as duration of different sleep stages and sleep fragmentation during both the 12 h inactive and the 12 h active phase. However, LMS offspring showed higher EEG power within gamma range (35–60 Hz) during REM sleep compared to BMS offspring (p < 0.05). Otherwise, no differences were found for sleep and wakefulness specific EEG frequencies (delta, 0.5–4.5 Hz; theta, 5.5–9.5 Hz; and beta, 19.5–34.5 Hz).

Conclusion: In contrast to male rats, female rats exposed to different early life conditions displayed similar behaviour in terms of sleep parameters in adulthood. Brain activity in the gamma range during REM sleep was however higher in LMS offspring compared to BMS offspring. These findings support the notion of gender specific reactions in adult behaviour and brain activity following early life maternal separation.

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0080

IMPACT OF OBLIGATORY DAYTIME NAP IN JAPANESE NURSERY SCHOOLS ON CHILDREN’S NIGHTTIME SLEEP AND DAYTIME FUNCTIONING
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Introduction: Newborn infants show scarce evidence of circadian rhythm of sleep and wakefulness. Around the 7th week after the birth, the first evidence of sleep circadian rhythm is found in full-term infants (Fukuda & Ishihara, 1997). During 2 to 5 years of age, percentage of the children who take an afternoon nap gradually decreases. At the age of 3, about 60% of children take naps, then the percentage decreased to about 30% at the age of 4, about 15% at the age of 5, then almost none at the age of 6 (National Sleep Foundation, 2004). However, In many Japanese nursery schools, obligatory lengthy daytime nap was taken by children of all ages, i.e., before the entrance to primary schools. The obligatory daytime nap for about 90 min was found to cause the delay of nocturnal sleep onset, morning moodiness, and reluctance to go to preschools.

Methods: The authors conducted surveys on children attend preschools. Informed consent was given by the parents of the children. In Japan, the obligatory nap was taken only in nursery schools, not in kindergartens, because these two preschools are regulated under different laws, and supervised by the different ministries, i.e., ministry of health and labor, and ministry of education and science, respectively.

Results: Nursery school children showed significantly later bedtime, severer morning moodiness, and more frequent reluctance to go to preschools than kindergartners. Children’s bedtime was not associated with parents’ bedtime. The authors recorded children’s activity with an actographic monitoring device to estimate their sleep wake patterns. Preschool children with long obligatory naps showed significantly delayed onset of nocturnal sleep (over one hour) than the children without naps. Authors surveyed the percentage of preschool children who take naps without any persuasion to take naps from adults (including obligatory nap routine and advise from parents, etc.), there are only 30% of children of 3 years old who take naps spontaneously. The number is much lower than that have been reported. The number previously reported was actual number of children who take naps regularly without reference to the naps were advised or not from their guardians. The discrepancy is considered to be attributable to the fact that the naps were spontaneous or not.

Conclusion: The impact of unnecessary lengthy daytime naps on nighttime sleep was confirmed also by the objective measurements.

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THE IMPACT OF GESTATIONAL INTERMITTENT HYPOXIA (IH) ON THE OFFSPRING OF MICE FED A HIGH FAT (HF) DIET

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Introduction: An adverse maternal environment can increase the risk of cardiovascular disease in adult offspring. Obstructive sleep apnea (OSA) is prevalent in pregnant women and may be characterized by chronic intermittent hypoxia and placental insufficiency. The incidence of maternal and neonatal outcomes such as preeclampsia, preterm birth, low birth weights, cesarean delivery and neonatal intensive care unit admission are increased in pregnant women with OSA. This study examined the effects of gestational IH on endothelial function of the adult offspring of mice fed high fat (HF) diet.

Methods: Female WT C57BL/6 mice (8 weeks) were divided in 4 groups: IH or intermittent air (IA) and received either a high fat (HF) or control diet (CD) for one month. Mice were subjected to IH while they were asleep during the daylight cycle; IH was by delivering a hypoxic mixture (12% oxygen) with room air every 30 s; IA received air instead of the hypoxic mixture. Mice were impregnated and kept under IH and received HF diet during the gestation period. After giving birth, IH was halted but the mothers still received HF diet and pups were allowed to breastfeed. After weaning, male mice were maintained on normal diet. Eight weeks later, mice were sacrificed and endothelium-dependent relaxation was measured using a wire myograph.

Results: After 2 weeks of delivery, pups in the CD-IH (4.4 ± 0.2 g) and HF-IH (4.0 ± 0.2 g) groups weighed significantly less than the HF-IA and CD-IA groups (7.9 ± 0.2 g, 7.3 ± 0.3 g, respectively, p < 0.001); these differences remained significant for 4 weeks. Subsequently though, HF-IH and CD-IH pups gained weight until there were no significant difference between the groups at 8 weeks of age. Endothelium-dependent relaxation, however, was not significantly different between the groups (Emax HF-IH: 92.1 ± 0.6%, HF-IA: 95.8 ± 0.5%, CD-IH: 94.9 ± 0.7% and CD-IA: 97.6 ± 0.6% of induced tone, p = NS).

Conclusion: In mice, chronic gestational IH resulted in significant growth impairment in the offspring but this difference was abolished later in adulthood. Neither gestational IH nor high fat diet caused endothelial dysfunction in the adult offspring.

Support (If Any): CHHR Sleep Team Grant, VCHRI Clinician Scientist Award
PARTIAL SLEEP DEPRIVATION INDUCES DNA DAMAGE AND SENESCENCE IN OLDER ADULTS
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Introduction: Biological processes that link sleep deprivation to disease risk have yet to be clearly defined. We hypothesized that molecular changes involved in the etiology of biological aging would be responsive to sleep deprivation, namely DNA damage, cell cycle arrest, cellular senescence, and the expression of the senescence associated secretory phenotype (SASP).

Methods: Community-dwelling older adults aged 61–86 years (n = 29; 48% male) underwent an experimental partial sleep deprivation (PSD) protocol over 4 nights, including adaptation, an uninterrupted night of sleep (baseline), PSD (restricted 3 am–7 am), and another uninterrupted night of sleep (recovery). Blood samples were obtained each morning to assess peripheral blood mononuclear cell (PBMC) gene expression using Illumina HT-12 arrays. Genes were selected a priori representing the DNA damage response, cell cycle arrest (NBS1-CHK2), a senescence marker (p16INK4a), and the SASP.

Results: Analyses revealed that genes associated with DNA damage and cell cycle arrest were significantly elevated from baseline to PSD nights, all p’s < 0.05. Subsequently, the senescence marker p16INK4a was increased at recovery compared to baseline, p < 0.01. SASP markers increased from baseline to PSD nights, p = 0.008, and declined from PSD to recovery, p = 0.04.

Conclusion: One night of partial sleep deprivation activates gene expression patterns in PBMCs consistent with increasing accumulation of damage that initiates cell cycle arrest and increases susceptibility to senescence. These findings causally link sleep deprivation to the etiology of biological aging, and further supports the hypothesis that sleep deprivation may be associated with elevated disease risk because it promotes molecular processes involved in biological aging.

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TOPOGRAPHY OF AGE-RELATED MODIFICATIONS IN QUANTITATIVE REM SLEEP EEG
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Introduction: The topography of quantitative EEG during rapid-eye movement (REM) sleep is a tool to discriminate Alzheimer patients from controls (Petit et al. 1992) but less is known on the effects of normal aging on the topography of REM sleep. The aim of this study is to compare the topography of REM sleep EEG in young and older participants.

Methods: Forty-six young (20–30 y.o.), 30 middle-aged (40–60 y.o.) and 16 elderly (60–70 y.o.) subjects underwent a polysomnographic sleep recording. Power spectral analysis of the REM sleep EEG was performed on prefrontal, frontal, central, parietal and occipital derivations. Absolute power in the delta, theta, alpha and beta frequency ranges was computed from 60 seconds of artifact-free REM sleep EEG selected in all REM periods except the first. An EEG slowing ratio [delta + theta] / [alpha + beta] was also calculated. ANOVAs 3groups*5derivations were performed.

Results: Compared to young subjects, both middle-aged and elderly subjects showed lower REM delta power for all derivations but this effect was less prominent in the prefrontal area. The elderly subjects displayed lower theta power than young subjects for all derivations, except prefrontal. Elderly subjects also presented lower power in alpha and beta but only for the occipital derivation. Compared to young subjects, middle-aged and older subjects showed a smaller slowing ratio and this effect was predominant in central and parietal regions.

Conclusion: The age-related decrease in REM sleep EEG power was limited to delta in middle-aged subjects but encompassed all frequencies in the elderly. These effects were more prominent in posterior areas. Contrary to the REM EEG slowing reported in Alzheimer patients, normal aging was associated with a faster REM sleep EEG ratio, supporting the notion that REM sleep slowing in dementia does not reflect “accelerated” aging. Research should evaluate links between age-related changes in REM sleep EEG and cognition.

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DEPRESSION AS A MEDIATOR OF THE RELATIONSHIP BETWEEN BURDEN AND SLEEP IN DEMENTIA FAMILY CAREGIVERS
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Introduction: Caring for a family member with dementia poses special challenges. People with dementia require increasing levels of supervision and personal care. Many family caregivers experience high levels of stress and negative effects on their health as a result of overwhelming caregiving task. Existing research evidence supports that burden on caregivers may cause their depression and sleep problem, and caregivers’ depression is highly correlated with their sleep. Yet, limited evidence is available regarding the role that depression may play in the relationship between burden and sleep. The study aimed to examine the mediating effect of depression on the association between caregivers’ burden and sleep.

Methods: This study used a cross-sectional design. Participants were recruited from the Alzheimer’s Association Western New York Chapter at Buffalo. Caregivers’ sleep are measured by Actigraph (wore for 7 days) and Pittsburgh Sleep Quality Index (PSQI). Other measures include burden (Caregiver Burden Inventory) and depression (Center for Epidemiologic Studies Depression). Descriptive statistics and path analysis were used for data analysis.

Results: Forty-five family caregivers participated in this study. The results of path analysis indicated that depression mediated the relationship between caregiver burden and subjective sleep. By adding depression in the association between caregiver burden and sleep, the direct effect of caregiver burden on sleep switched from significant to non-significant. This model showed a near complete mediating effect of depression on the association between caregiver burden and sleep. Similar results were remained after removing the sleep items from the depression scale. However, depression did not mediate the relationship between caregiver burden and objective sleep.
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Conclusion: In the context of family caregiving in dementia, the development of depressive symptoms may explain why caregivers with a higher level of perceived burden experienced increased sleep problems. Our findings suggested that providing treatments for caregivers’ depression may improve their sleep.

0085

EFFECTS OF LONG-TERM CALORIC RESTRICTION ON CIRCADIAN RHYTHMS AND SURVIVAL OF AGED RATS

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Introduction: Aging involves changes in physiological functions. Long-term caloric restriction (LTCR) can prevent or delay age-related deteriorations and diseases. Here we assessed the effects of LTCR on circadian rhythms of aged rats.

Methods: 26 male rats were submitted to a 40% caloric restriction from 8 to 21 months old (O-CR rats) while 13 control rats (O-AL) were fed ad libitum. Average weight was then 605 g and 1185 g, respectively. A group of 8 months old rats (M-AL rats) served as age controls. Telemetry probes for rest-activity, body temperature and heart rate were implanted and recordings took place for the next 6 days. Analyses were performed on the last 24 hours, with ANOVAs on means of 4-hour bins, alpha = 0.05. Following the recordings, the rats were submitted to an experimental myocardial infarction and survival rate was calculated.

Results: O-AL rats were significantly less active than O-CR rats and the latter were not different from M-AL rats. Only M-AL rats exhibited a circadian pattern of the rest-activity cycle. Heart rate was significantly faster in O-AL rats than O-CR and M-AL rats. Again, only M-AL rats showed a circadian pattern of heart rate. Body temperature was significantly higher in O-AL than O-CR rats, particularly during the dark (active) period. Values of M-AL rats were in between and the amplitude of the temperature circadian rhythms was higher in M-AL rats. 90% of the M-AL and O-CR rats survived the myocardial infarction while only 10% of the O-AL did.

Conclusion: The present results show that LTCR may favorably impact the effects of aging on activity levels, heart rate and body temperature. However, it does not appear to protect the loss of circadian rhythmicity. The neural mechanisms involved remains to be identified. LTCR also increased survival to a myocardial infarction.

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0086

DECREASED BIP CONTRIBUTES TO AGE-ASSOCIATED CHANGES IN WAKE ACTIVE NEURONS AND SLEEP/WAKE BEHAVIOR

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Introduction: Sleep/wake quality changes across aging. Many individuals experience increased nighttime awakenings and have difficulty staying awake during the day. This is likely attributed to age related wake-active neuronal dysfunction. Expression of BiP/GRP78, an ER molecular chaperone, decreases over age leading to accumulation of misfolded proteins and an increase in apoptotic factors. Low levels of BiP are correlated with impaired waking in aged mice. We hypothesized that transgenic mice with reduced BiP (+/-) would display wakefulness impairments at earlier ages than wild-type (WT) mice.

Methods: Analysis of EEG-recorded sleep/wake and power density over the frequency spectrum was completed for wild type and BiP heterozygous mice across 24 hours at 3, 12 and 18 months. Immunohistochemistry and neurostereology was used to determine orexin neuron numbers in 12 month old wildtype and heterozygous mice.

Results: The BiP heterozygous mice display premature aging of sleep/wake behavior. BiP heterozygotes have decreased wake bout duration at 12 months, although wild-types don’t display this until 18 months. Spectral analyses indicate that there was a significant decrease in the power (5–6 Hz) in heterozygous mice during waking in the first 3 hours of the dark phase (p < 0.05) at 12 months compared to WT. This is accompanied by a significant decrease in numbers of orexin neuron (p < 0.01) compared to WT at 12 months, a phenotype characteristic of aging, in the heterozygous mice.

Conclusion: Age related chaperone dysregulation diminishes maintenance of wakefulness.

Support (If Any): P01 AG017628

0087

SLEEP Fragmentation-INDUCED ER Stress is ASSOCIATED WITH DIFFERENTIAL SPATIAL MEMORY DEFICITS IN YOUNG AND AGED MICE

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Introduction: Sleep fragmentation is a prevalent concern among the elderly, yet little is understood about how fragmentation affects the aging brain. We have shown previously that endoplasmic reticulum (ER) stress is induced in mouse cortex following sleep deprivation, and that this induction varies with aging. The present study addresses whether sleep fragmentation, a more physiological concern, induces age-dependent effects in wake-active area locus coeruleus (LC) and whether these effects are associated with cognitive changes.

Methods: EEG recordings from 3-month-(young) and 12-month-old (aged) mice were collected over the 12-hour sleep phase during baseline and fragmented conditions. Fragmentation was induced by a rotating bar spanning the diameter of a circular chamber. Following fragmentation (or undisturbed conditions), one cohort of mice was perfused and brains were extracted for immunohistochemical analysis of ER stress markers in LC. Another cohort was tested for their ability to recognize a displaced object using visual cues.

Results: At baseline, aged mice had fragmented sleep (p < 0.001), and also showed increased basal levels of ER stress marker CHOP (p < 0.001). Following 12-hour sleep fragmentation, young but not aged mice had robust induction of upstream marker p-PERK (p < 0.01) and CHOP (p < 0.05) expression. In correlation, young but not aged undisturbed mice were able to recognize a displaced object (p < 0.05), and this ability was lost in young mice following fragmentation.

Conclusion: By 12 months of age, mouse sleep is fragmented, basal ER stress is increased in LC, and spatial memory is impaired. Furthermore, fragmentation causes ER stress and memory impairments in young but not aged mice. This indicates that baseline fragmentation in aged mice may induce protein dyshomeostasis that contributes to memory impairments in aging, consistent with data on sleep loss and aging in human subjects.

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0088

NAPPING AND AGE ASSOCIATION WITH PERCEIVED ADEQUATE SLEEP

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Introduction: Older adults nap more than younger adults, although the relationship between napping and nightly sleep remains unclear. We
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0089 THE EFFECT OF LIFE SATISFACTION ON SLEEP ONSET LATENCY DURING MIDLIFE
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Introduction: Poor sleep quality during midlife has been linked with poor subjective well-being. Insomnia symptoms also impact subjective well-being during midlife. Though the link between sleep quality and subjective well-being during midlife is well documented, there is a dearth of research on the link between life satisfaction and sleep onset latency (SOL).

Methods: Data was collected from 3,950 adults as part of the Midlife in the United States II (MIDUS-II) study. A 6-item life satisfaction survey was used to code participants as having low, medium, and high levels of satisfaction, and a subjective measure of minutes it takes to fall asleep was used to measure SOL. The sample was 55% female and ranged in age from 17 to 74 (M = 55.43; SD = 12.45).

Results: A one-way analysis of variance showed the impact of satisfaction on SOL was significant [F(2,3947) = 76.59, p < 0.001]. Bonferroni post hoc tests for significance demonstrated that each group was significantly different from one another: low satisfaction (M = 57.94; SD = 5.86), medium satisfaction (M = 59.52; SD = 1.16), and high satisfaction (M = 24.78; SD = 0.60). These results suggest that low life satisfaction may delay sleep onset during midlife.

Conclusion: Respondents with higher life satisfaction reported shorter sleep onset latency. Sleep onset delay among those with low life satisfaction could be the result of worry and anxiety, as reported elsewhere. These findings support the idea that life satisfaction is interlinked with many measures of sleep and sleep quality, suggesting that improving one of these variables might result in improving the other. For example, by decreasing sleep onset latency with the help of pharmacological agents or cognitive behavioral therapy for insomnia we might ameliorate the impact of depressive symptoms.

Support (If Any): Social Sciences Research Institute and Office of the Vice President for Research at the Pennsylvania State University.

0090 GOOD SLEEP IN OLDER WOMEN HAS SIMILAR POLYSOMNOGRAPHICAL CHARACTERISTICS AS POOR SLEEP IN YOUNGER WOMEN
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Introduction: Women complain more of sleep than do men, but little is known about the relation to the macro- and microstructure of sleep and how age affect this relation. This was the topic of the present study.

Methods: Ambulatory polysomnographical (PSG) recordings were obtained in a representative sample of 400 non-pregnant women (oversampling of snorers) and analysed through automatic analysis and manually verified. Sleep quality ratings (poor, rather poor, average, good, very good sleep) at awakening after recording and age (cutoff 50.1 years) were related to PSG-derived data using ANOVA (300 participants after exclusions).

Results: Significant association between sleep quality ratings (good vs poor) and age and PSG measures were obtained for sleep efficiency (91 ± 2 vs 83 ± 2% for young participants and 85 ± 2 vs 72 ± 2% for older participants), WASO, Changes to Stage wake, and Stage changes/h). Stage 1% and increased with poor sleep (no age effect). Number of sleep spindles increased with poor sleep in young subjects only, while K-complexes and spectral data (delta, theta, beta power in NREM or REM) were not related to sleep quality. Also total sleep time increased with good sleep and young age (418 vs 373 min for young participants and 386 vs 328 min for older participants. For most PSG variables Good sleep in the older group corresponded to poor sleep in the younger group.

Conclusion: Reported sleep quality is clearly related to PSG indicators of sleep continuity in a large, representative group of women, but age will change the PSG values characterizing good and poor sleep.

Support (If Any): The Swedish Research Council for Health, Working Life and Welfare

0091 THE EFFECT OF AGE ON OBJECTIVE SLEEPINESS DURING CHRONIC SLEEP RESTRICTION
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Introduction: Sleep loss increases subjective and objective measures of sleepiness and negatively affects many aspects of neurobehavioral performance. There is evidence that healthy older adults tolerate acute sleep deprivation better than young adults, but whether this is true for chronic sleep restriction (CSR) is not known. To explore this, we assessed the effects CSR combined with circadian disruption on measures of sleepiness in healthy older and young adults.

Methods: 12 healthy young (18–27; 6f) and 12 older adults (55–70; 6f) participated in a 39-day inpatient study. The study consisted of 3 baseline days (time-in-bed (TIB) 10 h/24 h), followed by 3 weeks of CSR-in a forced desynchrony protocol (6.5 h TIB/28 h, equivalent to 5.6 h/24 h). Objective sleepiness was assessed by the number of lapses...
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on a psychomotor vigilance task (PVT) and by the number of epochs of sleep in the EEG during the scheduled wake episodes. Mixed-Model ANOVA was used for statistics.

**Results:** The number of PVT lapses and the number accidental sleep epochs during scheduled wake increased across the 3 weeks of CSR, and were significantly higher during the CSR segment compared to baseline (p < 0.01). There was a significant effect of age, such that both the number of lapses (p = 0.026) and the number of accidental sleep epochs (p = 0.030) were lower in older subjects.

**Conclusion:** In both age groups objective sleepiness increased across the 3 weeks of CSR. As has been shown with acute sleep deprivation, older subjects had fewer inadvertent epochs of sleep and fewer PVT lapses during CSR, suggesting that healthy older individuals may be better at resisting sleepiness.

**Support (If Any):** The study was supported by NIH grant P01AG099795 and was conducted at the Brigham and Women's Hospital Center for Clinical Investigation, part of Harvard Catalyst (Harvard Clinical and Translational Science Center) supported by NIH Award UL1 TR001102 and financial contributions from the Brigham and Women's Hospital and from Harvard University and its affiliated academic health care centers. KMZ was supported by a fellowship from the Finnish Cultural Foundation.

0092

SLEEPINESS AND FATIGUE DIFFERENCES BETWEEN AVERAGE AND LONG SLEEPING OLDER ADULTS

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**Introduction:** Previous research has found that long sleep is associated with a myriad of negative outcomes. These studies have been epidemiological, with large samples but without validated measures of sleep-related outcomes. Few studies have examined subjective sleepiness and fatigue levels in the context of long sleep among older adults. The present study examined differences between average and long sleeping older adults on measures of sleepiness and fatigue. We hypothesized that both sleepiness and fatigue would be higher among the long-sleeping compared with the average-sleeping older adults.

**Methods:** Participants were 41 older adults (31 female; mean age 65.0, range 60–77). Exclusion criteria included sleep medication use, excessive napping, severe medical disorders, > 30 mins TIB intentionally awake, TIB < 6 hrs, 7.25–8 hrs, or > 9.25 hrs, and OSA (AHI > 15) as assessed by ambulatory peripheral arterial tonometry. Participants completed two weeks of sleep diaries and actigraphy and were classified as average sleepers (median 2-week TIB: 6–7.25 h, N = 22) or long sleepers (median 2-week TIB: 8–9.25 h, N = 19). Participants then completed the Epworth Sleepiness Scale (ESS) and Multidimensional Fatigue Symptom Inventory Short Form (MFSI-SF).

**Results:** On the ESS, average sleepers indicated greater sleepiness (6.2 ± 3.4) than long sleepers (3.7 ± 2.8), p < 0.02, d = 0.80. There were no significant group differences on the MFSI-SF, with average sleepers reporting similar levels of fatigue (14.95 ± 11.7) as long sleepers (12.26 ± 13.3), p = 0.46.

**Conclusion:** Lower levels of sleepiness among long sleepers is inconsistent with previous research. That we found a difference in sleepiness, but not in fatigue suggests that this may not simply be due to measurement effects. Since all participants were healthy, longer sleep time may leave these long sleepers better rested. Future research should include larger sample sizes and objective measures of sleepiness to clarify the differences between these groups.

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0093

SLEEP IS ASSOCIATED WITH DUAL-TASK WALKING AMONG COMMUNITY DWELLING OLDER ADULTS

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**Introduction:** Sleep problems are highly prevalent in older adults and are associated with increased mortality and morbidity and greater physical and mental functional limitations. Dual-task (DT) interference during walking is widely recognized as a functional mobility concern among older adults, and is an important public health problem due to its association with increased risks for falls and cognitive decline. We aimed to examine associations between objective sleep/wake measures and indices of motor (gait) and cognitive function in a DT walking test, hypothesizing that reduced sleep and increased wake during the nighttime sleep period are associated with increased motor and cognitive functional limitations in DT testing.

**Method:** Thirty-six (21 women) independently functioning community dwelling older adults (Mean age 71.3 ± 5.8, Montreal Cognitive Assessment mean score 24.0 ± 2.7) participated. Sleep/wake measures were assessed based on seven-day wrist actigraphy monitoring, to include sleep (SMIN, SPER) and wake (WMIN, WPER) minutes and percentages, sleep efficiency (SE) and number of wake episodes (WE). Measures of gait (walking distance) and verbal fluency (number of words generated) during 1-min periods were assessed separately as motor and cognitive single-tasks (ST) respectively, and combined as DT. Relative dual-task cost (DTC) was computed using the formula [(ST-DT)/(ST)]*100 for motor and cognitive tasks, so that higher scores reflect higher DTC (i.e., lower functional ability). Bivariate correlations were performed to assess relationships between sleep and DT measures.

**Results:** Cognitive DTC was negatively correlated with SMIN (r = −0.43), SPER (r = −0.62) and SE (r = −0.63, all p < 0.001), and positively correlated with WMIN (r = 0.62, p < 0.001) and WE (r = 0.45, p < 0.05). Motor DTC was not related to any of the sleep/wake measures.

**Conclusions:** Reduced sleep and increased wake during the nighttime sleep episode were associated with lower ability to efficiently divide attention between two tasks, as expressed in compromised cognitive function. Experimental and longitudinal studies are needed to assess the direction of these associations.

0094

LIGHT TO OPTIMIZE VISION AND MINIMIZE ALERTNESS IN OLDER ADULTS

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**Introduction:** Nocturia reduces sleep quality and is associated with an increased risk of falls and fractures among older adults. To offset the risk of falling during nocturnal toileting, many individuals turn the lights on, which may exacerbate difficulties re-initiating sleep. The current study manipulated the lighting environment in an attempt to optimize vision while minimizing alertness.

**Methods:** Twenty-one healthy older adults (65 [range = 55–82] years, 55% female, 75% White) completed a three-week crossover protocol. On three separate occasions, following a week of at-home activity monitoring, participants came to the lab three hours prior to their habit-
ual bedtime. Participants remained in ~150 lux broad spectrum white light until their bedtime. After a two-hour sleep opportunity, researchers awakened subjects for 13-min into one of three lighting conditions: dim white light (< 0.5 lux), white light (~28.0 lux) and orange light (~28.0 lux). Low contrast visual acuity was assessed with standard ET-DRS charts, subjective sleepiness with the Stanford Sleepiness Scale, and sleep onset latency after the 13-min awakening was determined using polysomnography.

**Results:** Within subjects, visual acuity was significantly better in both orange (39.4 ± 37.0 correct answers; p < 0.001) and white (39.2 ± 40.0 correct answers; p < 0.001) light as compared to dim white light (20.5 ± 20.0 correct answers). There was no difference in subjective sleepiness (F = 0.18, p = 0.84) or sleep onset latency (F = 0.08, p = 0.93) after the awakening across lighting conditions.

**Conclusion:** Compared to dim white light, orange or white light of 28 lux in illuminance can improve visual acuity without influencing alertness. These findings suggest that light of an illuminance similar to what is emitted from a desk lamp (either long wavelength or broad spectrum) is sufficient to improve vision of older adults at night without further disrupting sleep.

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**FACTOR STRUCTURE OF SLEEP ACTIGRAPHY MEASURES**

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**Introduction:** It has been shown that actigraphy can be used to reliably and validly evaluate sleep disturbances among older adults, 50% of whom have chronic sleep disturbances. However, little is known about the interrelationship of the various sleep parameters measured by an actigraph. The purpose of this research was to determine the factor structure of this sleep measure.

**Methods:** Data were obtained from 62 older adults over 60 years of age (male: 24%; mean age: 70 years). Sleep variables were measured by an actigraph worn on the non-dominant wrist for 7 days. Exploratory factor analysis was used to explore the factor structure among the actigraph sleep variables. Principal components method was used to extract factors; eigenvalues over Kaiser’s criterion of > 1 and scree plot were used to determine factor numbers; and the Varimax method was used to rotate factor loading.

**Results:** Results showed that sleep variables fit a three-factor solution: sleep fragmentation (eigenvalue of 3.7), difficulties for falling asleep and maintaining sleep (eigenvalue of 2.2), and sleep time (eigenvalue of 1.9), explaining total 86% of total variance. The value of Kaiser-Meyer-Olkin Measure test was 0.55, and the result of Barlett’s Test of Sphericity was significant (p = 0.000), which indicated acceptable sample adequacy.

**Conclusion:** The sleep parameters from actigraph had a clear and stable factor structure, indicating that the actigraph is capable of identifying distinct aspects of sleep disturbances among older adults.
TRANSGENIC MICE CARRYING THE MOUSE HOMOLOG OF THE PRION PROTEIN MUTATION ASSOCIATED WITH FATAL FAMILIAL INSOMNIA (FFI) DEVELOP SEVERE SLEEP ABNORMALITIES

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Introduction: Investigation of inherited prion disease biology requires animal models with the essential features of the corresponding human disorder. To this purpose, we developed transgenic (Tg) mice, referred to as Tg(FFI), expressing the mouse homolog of the prion protein (PrP) mutation associated with fatal familial insomnia (FFI). We then investigated sleep patterns, and EEG features of Tg(FFI) mice.

Methods: Adult male mice were anesthetized and instrumented for chronic EEG recording according to standard techniques. Cages were kept in sound-attenuated rooms at a constant temperature (26 ± 1 °C), with a 12/12-hour light-dark cycle. Gross body activity was detected using an infrared sensor. EEG signals and gross body activity were recorded for 24 h. Two mice of different genotypes were always randomly matched and recorded simultaneously. Postacquisition determination of vigilance states was done according to standard criteria. EEG recordings were also band pass filtered, and NREM sleep spindles were visually identified.

Results: Sleep spindle density and slow wave activity during NREM sleep were significantly reduced in Tg(FFI) mice (n = 9) compared to non-Tg controls (n = 8). Tg(FFI) mice also exhibited a profound disruption of sleep continuity and organization. They showed a higher number of transitions between the different behavioral states than non-Tg mice. In addition, in Tg(FFI) mice approximately one fourth of REM sleep episodes started directly from wakefulness. REM sleep amount and EEG theta activity during REM sleep were also significantly decreased in Tg(FFI) mice. Circadian organization of sleep and motor activity was lost in Tg(FFI) mice. Bursts of high voltage polyphasic complexes were detected in the EEG of Tg(FFI) mice.

Conclusion: Like in FFI patients, circadian organization, architecture, EEG features and amount of sleep are deranged in Tg(FFI) mice. We propose that these mice represent a useful model for investigating the pathophysiology of sleep alterations in FFI.

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SLEEP IS NECESSARY FOR NEUROPROTECTION FROM ISCHEMIC STROKE INDUCED BY REMOTE PRE-CONDITIONING

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Introduction: Neuroprotection from stroke can be facilitated by intermittent exposure to mild, non-harmful ischemia prior to stroke. This phenomenon termed pre-conditioning has been widely studied at the level of the brain. Here, we developed a model of peripheral (remote) pre-conditioning (rPC). We were also interested in the residual effects of rPC on sleep and if this sleep was necessary for rPC-induced neuroprotection from occlusion of the middle cerebral artery.

Methods: We first employed four, different regimens of hind limb ligation in male mice (n = 6/treatment) under anesthesia. Only regimens of interval-based ligation consisting of 10 min of ligation immediately followed by 10 min of release for 2x or 3x reduced the extent of infarcted tissue present in the fore- and midbrain compared to a one-time ligation lasting 10 or 30 min.

Results: A recording of sleep two days after an interval-based regimen of rPC revealed a ~35% increase in NREM sleep coupled with a ~85% increase in slow wave activity relative to baseline that was namely found during the light-phase. There was no change in sleep in anesthetized, control mice. We then employed a protocol of induced wakefulness that accounts for sleep rebound to determine if this additional 2.5 h of recovery sleep after rPC was necessary for rPC-induced neuroprotection from stroke. Preventing mice from having this recovery sleep reduced the neuroprotective benefits of rPC; the extent of infarcted tissue increased by ~30% relative to undisturbed, rPC-treated mice. In Conclusion: The relationship between remote pre-conditioning, sleep, and stroke outcome is of high translational value; remote pre-conditioning may be a novel therapeutic strategy outside the CNS to improve sleep quality in the general population and stroke outcome in high-risk stroke populations.

CHRONIC INTERMITTENT SHORT SLEEP: DELAYED RECOVERY AND DEGENERATION OF WAKE NEURONS

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Introduction: Chronic intermittent sleep loss (CISL) is pervasive in modern 24/7 societies. The effects of sleep loss on brain function and health are largely considered reversible. However, we recently determined that mice exposed to three consecutive days of short sleep lose 1/3 of locus coeruleus neurons (LCn). In this series of studies, we determined whether mice over time adapt to chronic sleep loss or injury to LCn progresses. To determine whether the effect of sleep loss is specific to LCn we also examined orexinergic neurons and a sleep-active group, melanin concentrating hormone (MCH) neurons.

Methods: Adult male mice were randomized to rested conditions or exposed to three consecutive days of 8 hr sleep loss across the lights-on period followed by 4 recovery days; this sleep loss pattern was repeated for 4 consecutive weeks. Subsets of mice in both groups were provided 4 weeks of recovery. Sleep/wake activity and LC, orexin and MCH counts using unbiased optical fractionator stereology were obtained.

Results: Four consecutive weeks of intermittent sleep loss (CISL-4wk) resulted in a further reduction in LCn and in orexin neurons but not in MCH neurons. Specifically, CISL-4wk resulted in a 50% reduction in LCn (p < 0.0001) and in orexinergic neurons (p < 0.01). The 4 wk recovery opportunity did not normalize cell counts for either group. MCH neuron counts were unaffected by CISL. Total time spent in each behavioral state across 24 hrs did not differ across groups (N.S., n = 8/group), but mice exposed to 1 CISL showed less diurnal variation in Dark:Light wake, CISL, 1.59 ± 0.12 vs. rested, 2.21 ± 0.10, p < 0.01. Body weights and corticosterone levels did not differ across groups.

Conclusion: Our findings substantiate irreversible injury to wake-active neurons and lasting effects on sleep/wake activity. The work has implications for the individuals with CISL or sleep disorders with chronic sleep disruption.

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ASSOCIATION BETWEEN CORTICAL THICKNESS AND OBSTRUCTIVE SLEEP APNEA: A PRELIMINARY STUDY

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Introduction: Obstructive sleep apnea (OSA) has been linked with cognitive impairment or brain structural changes, due to its association with hypoxemia and arousal. However, there is a lack of consistent report on whether OSA contributes to cortical thinning. The current study was aimed to investigate the association between OSA and cortical thickness in the general population.

Methods: Fifty participants with moderate-severe OSA (mean age = 63.30 ± 4.36, 51% male) and 50 age- and sex matched healthy participants (mean age = 63.30 ± 4.38, 51% male) were randomly selected from a population-based Korean Genome and Epidemiology Study (KoGES). Each participant underwent acquisitions of structural T1-weighted magnetic resonance imaging (MRI) scans using a 1.5 Tesla scanner, and all data were averaged to produce high-resolution, high-contrast data sets. Cortical thickness was measured by reconstructing representations of the gray/white matter boundaries and was quantified by calculating the distance between those boundary surfaces at each point, resulting in a continuous estimate across the cortical mantle. Group analysis for cortical thickness was then performed between OSA and control groups, with age and gender as covariates. All MRI data analyses were performed using the FreeSurfer software package.

Results: Results from the general linear model (GLM) analysis showed that OSA was associated with regional atrophy in the superior temporal (604 mm²), the lateral occipital (301 mm²), the precentral (107.26 mm²), the caudal middle frontal (36 mm²), the rostral middle frontal (120 mm²), and the superior parietal regions (119 mm²) in the left hemisphere. Right precuneus (191.91 mm²), the right postcentral (235 mm²), right pericalcarine (350 mm²), right postcentral (225 mm²), and right precentral (225 mm²) were significantly associated with OSA. However, these results were not statistically significant after correction for multiple comparisons.

Conclusion: Findings from the current preliminary study did not support previous findings that OSA is associated with cortical thickness. Further studies with greater sample size may clarify whether there exists a relationship between sleep apnea and cortical atrophy in the non-clinical aging population.

NEUROPATHOLOGICAL HALLMARKS OF ALZHEIMER’S DISEASE ARE MORE COMMON IN PATIENTS WITH MODERATE-SEVERE OBSTRUCTIVE SLEEP APNEA

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Introduction: Typically diagnosed in midlife, obstructive sleep apnea (OSA) is characterized by repeated cessation of breathing during sleep, causing blood-oxygen desaturations and arousals. Alzheimer’s disease (AD) is a neurodegenerative dementia that is common in old age. OSA is prevalent in patients with AD; middle-aged persons with OSA have an increased risk of developing dementia in old age, yet no causal link has been established. The present study investigated how frequently the neuropathological features of AD are seen in moderate-severe OSA.

Methods: Autopsy brain tissue was obtained from 34 Icelandic patients previously diagnosed with mild-to-severe OSA (oxygen desaturation index (ODI): 1.9–92.2 events/hr). Formalin-fixed tissue from the hippocampus, embedded in paraffin, was sectioned at 20 microns. Immunohistochemistry was performed for glial fibrillary acidic protein (anti-GFAP) to show astrocytes, and for cluster of differentiation molecule 11b (anti-CD11b) to show microglia. Labelled cells in the hilus were counted with image analysis software (CellSens, Olympus). Statistical comparisons used 2-tailed student t-tests.

Results: 12 patients had mild OSA (ODI less than 15; mean ODI 7.3 ± 3.1) and 22 had moderate-severe OSA (ODI more than 15; mean ODI 35.5 ± 20.4). The groups did not differ significantly in age at death (mean 62.2 vs 69.7 years; p = 0.057), BMI (mean 28.1 vs 30.4; p = 0.341) or number of astrocytes (mean 360.4 vs 357.7; p = 0.925). However, patients with mild OSA had fewer microglia than those with moderate-severe OSA (mean 134.4 vs 175.6; p = 0.022). When stratified by reported CPAP use, 15 moderate-severe patients who used CPAP had a similar number of microglia to patients with mild OSA (mean 161.2 vs 134.4; p = 0.223) whereas the 7 moderate-severe patients who had not regularly used CPAP had higher numbers of microglia (206.5 vs 134.4; p = 0.005).

Conclusion: Patients with moderate-severe OSA have more microglial cells in the hilus, indicative of hippocampal injury. This microgliosis is attenuated when regular CPAP therapy is reported.
of moderate-severe patients. Both plaques and tangles were present in 17% of mild OSA patients and 59% of moderate-severe patients. Moderate-severe patients had significantly more tangles (mean stage: 1.7 vs 0.9; \( p = 0.029 \)), and a significantly higher plaque burden (mean stage: 1.5 vs 0.4; \( p = 0.031 \)).

**Conclusions:** Patients with moderate-severe OSA are more likely to have a greater burden of tangles and plaques, suggesting that moderate-severe OSA contributes to AD-like neuropathological changes.

## 0102
**HYPOCRETIN PREVENTS APNEA-INDUCED DEGENERATION OF HIPPOCampAL NEURONS BY FACILITATING GABAERGIC INHIBITION**

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**Introduction:** Previous studies demonstrated that hypocretin (Hcrt) can function as a neuroprotective agent by promoting the survival of cortical and hypothalamic neurons during periods of ischemia and hypoxia. Recently, we reported that Hcrt also prevents the apnea-induced degeneration of hippocampal CA1 neurons. In the present study, we investigated the neuronal mechanism that mediates the neuroprotective actions of Hcrt in the hippocampus.

**Methods:** Four groups of adult alpha chloralose-anesthetized rats were employed. In three groups, two hours of recurrent apnea was induced by ventilatory arrest. Group 1 rats were apneic and otherwise untreated. Group 2 rats were administered Hcrt-1 (60 ug/kg, i.v.) 15 min before the initiation of apnea. Group 3 rats were administered bicuculline, a GABAA antagonist (1 mg/kg, i.v.), 15 min prior to the injection of Hcrt-1 (60 ug/kg, i.v.); 15 min later, apnea was initiated. Group 4 rats were untreated and normoxic. After experimentation, the hippocampus was immunostained with the poly (ADP-ribose) polymerase-1 (PARP-1) antibody to detect DNA strand breaks and activation of a caspace-independent pathway of programmed cell death, i.e., neurodegeneration.

**Results:** Apneic, untreated rats (Group 1) exhibited abundant PARP-1-positive CA1 neurons. In apneic, Hcrt-1-treated rats (Group 2), only weak traces of PARP-1 immunoreactivity were present in a few CA1 neurons. Apneic rats that were treated with bicuculline and Hcrt-1 (Group 3) exhibited many labeled CA1 neurons with similar immunoreactive labeling intensity in apneic, untreated rats. PARP-1-positive CA1 neurons were not observed in CA1 neurons of control normoxic rats (Group 4).

**Conclusion:** We conclude that Hcrt-1 prevents the apnea-induced degeneration of CA1 neurons by activating GABAA receptors on these cells. These findings corroborate the Survival Theory of the Functioning of the Hypocretinergic System, presented by Chase in 2013, by demonstrating that hypocretin facilitates survival-related cellular processes in addition to promoting survival-related behaviors.

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## 0103
**PRELIMINARY CHARACTERIZATION OF SLEEP-WAKE BEHAVIOR AND LOCOMOTOR ACTIVITY IN THE VMAT2-DEFICIENT MOUSE MODEL OF PARKINSON’S DISEASE**

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**Introduction:** In addition to debilitating motor symptoms, patients with Parkinson’s disease (PD) suffer non-motor symptoms such as sleep disturbances (fragmented nocturnal sleep, excessive daytime sleepiness, REM sleep during daytime naps, excessive phasic muscle activity during sleep, and/or absence of REM sleep atonia). Mice with reduction in vesicular monoamine transporter 2 (VMAT2-deficient, VMAT2LO) exhibit progressive loss of striatal dopamine, L-DOPA-responsive motor deficits, alpha-synucleinopathy, and nigral dopaminergic cell loss. VMAT2LO mice also display reduced latency to rest behavior after an arousing stimulus. To determine whether this rodent model of PD exhibits Parkinsonian sleep disturbances, we examined locomotor and EEG-EMG characteristics.

**Methods:** We measured habituated locomotor activity for 48 h (open field infrared beam breaks) in VMAT2LO and wildtype controls (n = 7 per group). Mice were then instrumented and tethered in standard fashion to measure EEG-EMG, which was scored visually in 10 sec epochs using Somnologica. Following recovery and baseline recording, mice were challenged with a 4 h sleep deprivation (SD). A smaller cohort (n = 6 VMAT2LO, n = 3 WT) underwent murine multiple sleep latency test (MMSLT).

**Results:** VMAT2LO mice showed no difference in baseline distance traveled, center time, or horizontal movement, but showed a nonsignificant trend toward depressed vertical rearing. EEG/EMG of VMAT2LO mice exhibited increased phasic EMG during sleep. VMAT2LO mice exhibited more overall sleep-wake transitions and longer bouts of rest phase REM sleep than WT mice. Following a 4 h SD, VMAT2LO and WT mice similarly recovered sleep amounts, but VMAT2LO mice again showed more sleep-wake transitions.

**Conclusion:** Preliminary studies suggest abnormal phasic EMG during sleep, prolonged REM sleep duration, and sleep-wake fragmentation in VMAT2LO mice. VMAT2LO mice may provide a valid model for future descriptive and therapeutic studies of sleep disturbances associated with PD.
**0104**

**IDENTIFICATION OF A WAKE-PROMOTING GABAERGIC POPULATION IN THE LATERAL HYPOTHALAMUS**

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**Introduction:** A role for the lateral hypothalamic (LH) in promoting wakefulness has long been suggested. However, identification of a wake-promoting cell group in this region has proven elusive. While LH orexin neurons strongly influence wake bout length, these neurons are not required for normal amounts of daily wake. Additionally, MCH neuronal activity is linked with REM sleep, but not wake, regulation. We thus sought to identify other LH cell types that may promote wakefulness. One LH cell type that has received little attention, and is coexpressive with orexin and MCH neurons, are GABAergic vesicular GABA transporter containing (VGAT+) neurons.

**Methods:** We activated LH VGAT+ neurons using the excitatory DREADD (hM3Dq). hM3Dq was delivered to the LH of Vgat-IRES-cre mice via stereotaxic injection of an adeno-associated viral (AAV) vector that expressed hM3Dq in a cre-dependent manner (AAV-FLEX-hM3Dq-mCherry). In a parallel experiment, injections of a conditional anterograde tracer (AAV-STOP-hrGFP) were placed into the LH of Vgat-IRES-cre mice and the brains were analyzed for terminal projections.

**Results:** Mice expressing hM3Dq in LH VGAT+ neurons were near continuously awake for 4 hours following injection of the hM3Dq ligand, clozapine-N-oxide (CNO; 98.74 ± 0.67% vs. 37.46 ± 1.13% following saline, n = 8, p < 0.0001, paired t-test) and correspondingly displayed a peak in the 8–12 Hz range of the EEG power spectrum. Activation of VGAT+ neurons in neighboring regions, such as the zona incerta, was without effect on wakefulness. In addition, conditional anterograde tracing from LH VGAT+ neurons revealed projections to several established sleep and arousal nodes, including the ventrolateral preoptic area, ventral periaqueductal gray, locus coeruleus and tuberomammillary nucleus.

**Conclusion:** LH VGAT+ neurons can potently drive wakefulness and project to other sleep-wake nuclei. LH VGAT+ neurons likely comprise a hitherto undefined wake-promoting node.

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**0105**

**OPTOGENETIC ACTIVATION OF HYPOTHALAMIC DOPAMINE A11 NEURONS RESCUES CATAPLEXY IN NARCOLEPTIC MICE**

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**Introduction:** Cataplexy, a defining symptom of narcolepsy, is a dissociative state in which brain arousal and motor activity are involuntarily decoupled. Multiple lines of evidence indicate that dysregulation of dopamine system function contributes to narcolepsy. We recently showed that A11 dopamine cells function to couple arousal state with motor activity during natural behavior. Here, we aimed to determine if activation of A11 dopamine neurons could reinstate motor activity during cataplexy.

**Methods:** To precisely control the neuronal activity of the A11 dopamine neurons, we bilaterally infused 200 nL of an adeno-associated viral vector (AAV) containing a light-sensitive opsin (AAV-EF1α-DIO-ChETα-eYFP) into the A11 region of narcoleptic mice containing cre-recombinase in dopaminergic neurons (i.e., OXKO/TH-cre mice). Animals were instrumented for EEG and EMG recordings. Neurons were stimulated with short blue light pulses (5 ms) at 20 Hz independent of behavioral state, or at the onset of cataplexy. Only animals that had histological verification of ChETα/eYFP expression in the A11 region were used for analysis.

**Results:** To generate narcoleptic mice with cre-recombinase in dopamine cells, we crossed hypocretin knockout mice with those expressing cre-recombinase in tyrosine hydroxylase positive cells. We found that double transgenic and hypocretin knockout mice exhibited similar amounts of cataplexy (unpaired t-test; n = 4; p = 0.5813). Semi-chronic activation (i.e., laser on 10 ms and off 90 ms) of A11 dopamine cells decreased overall cataplexy amounts by 51 ± 0.1% (n = 4; p < 0.05) during the 3 h stimulation period. We also found that individual cataplexy attacks were rapidly terminated when A11 dopamine cells were optically stimulated during discrete cataplexy episodes. Specifically, we found that A11 activation terminated cataplexy within 5 ± 2 s (n = 4; p < 0.05) after optical stimulation.

**Conclusion:** Our findings show that A11 neurons function to couple arousal and motor behaviors, and that optical activation of this dopamine circuit rescues cataplexy in narcoleptic mice.

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**0106**

**TARGETED ACTIVATION OF THE SUBCOERULEUS PROMOTES REM SLEEP AND PREVENTS NREM SLEEP**

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**Introduction:** The subcoeruleus (SubC) region in the brainstem is hypothesized to generate REM sleep. Chemical stimulation of the SubC can produce REM-like sleep and motor atonia, whereas, SubC lesions disturb REM sleep and prevent motor atonia. Here, we aimed to determine if targeted and reversible activation of SubC neurons would trigger REM sleep episodes in freely behaving mice.

**Methods:** We infused 400 nL of an AAV harboring a modified muscarinic G-protein coupled receptor (AAV-HSYN-hm3D(Gq)-mCherry) into the left/right SubC regions in wild-type mice. Administration of clozapine-N-oxide (CNO; 5 mg/kg) was used to activate SubC neurons expressing hM3D(Gq) receptors. Sleep/wake data was analyzed for 3 hours following CNO administration.

**Results:** We found CNO-induced activation of SubC neurons promoted sharp increases in overall amounts of REM sleep. Specifically, SubC stimulation increased the number of REM sleep episodes by 467% (saline vs CNO; n = 9, paired t-test; p < 0.05). Remarkably, SubC activation triggered REM sleep episodes that rapidly punctuated periods of wakefulness. CNO-induced REM sleep episodes are indistinguishable from “natural” REM sleep episodes. Muscle tone and length of REM sleep periods were similar during baseline and CNO-induced conditions. However, one difference between CNO-induced and natural REM sleep was the intensification of theta activity during REM sleep and wakefulness (p < 0.05). One unexpected finding was SubC activation completely blocked NREM sleep expression during the 3 h recording period (saline vs CNO; p < 0.05).

**Conclusion:** Our results support the hypothesis that the SubC promotes REM sleep. Indeed, SubC activation is capable of triggering REM sleep episodes that intrude directly into wakefulness. Importantly, we show that SubC stimulation prevents NREM sleep expression, suggesting SubC neurons not only drive REM sleep, but also function to inactivate the neuro-circuitry underlying NREM sleep.
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0107 ALTERED REGIONAL BRAIN ACTIVITY IN PATIENTS WITH PSYCHOPHYSIOLOGICAL INSOMNIA
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Introduction: Psychophysiological insomnia is known to be learned insomnia related with sleep-related anxiety. Conditioning of sleep situations with insomnia (or arousal) plays a major role in the pathophysiology. In current study, we aimed to investigate neural correlates of learning (conditioning) in patients with psychophysiological insomnia using sleep-related stimuli.

Methods: Ten patients diagnosed as psychophysiological insomnia (INS: 44.4 ± 4.8 y, 7 females) on ICSD-2 and 20 healthy good sleepers (GS: 36.6 ± 2.5 y, 16 females) underwent brain fMRI while viewing blocks of sleep-related pictures and matched control pictures. A whole-brain analysis was used for comparing neural activity to sleep related stimuli among two groups.

Results: Compared to GS group, INS group showed increased activation to sleep related pictures (vs. control picture) in right visual association cortex (BA18, Talairach coordinate x = 22, y = −78, z = −7), bilateral posterior cingulate (BA29,30, Talairach coordinate x = 9, y = −43, z = 14), right hippocampus (Talairach coordinate x = 23, y = −16, z = −13), right inferior temporal (BA29,30, Talairach coordinate x = 38, y = −16, z = −19), cerebellum (Talairach coordinate x = 3, y = −80, z = −7), and midbrain (Talairach coordinate x = 0, y = −21, z = −11) (all, uncorrected p < 0.001), whereas GS group showed increased activation in left inferior frontal (BA44, Talairach coordinate x = −40, y = 1, z = 23, uncorrected p < 0.001).

Conclusion: The current results revealed differential brain regional activations in psychophysiological insomnia patients from those in good sleepers to sleep related pictures. Especially, brain regions with increased responses in our results were associated with arousal, emotion or intrinsic control networks.

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0108 PUBERTAL OVERWEIGHT PROGRAMS LIFE-TIME SLEEP DISTURBANCES IN MICE BY REDUCING THE SEROTONERGIC TONE IN THE BRAIN
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Introduction: Obese individuals often show sleep disturbances, such as excessive daytime sleepiness and poor sleep quality. Obesity is a major health threat and its incidence is rapidly rising, especially in young individuals. Since puberty is a period when brain functions undergo dynamic remodeling, it was of interest to examine the impact of pubertal overweight on sleep-wake behavior during adulthood.

Methods: We generated a peripubertal diet-induced obesity (ppDIO) model by exposing male C57BL/6N mice to a high-fat/high-carbohydrate diet (HFD) for six weeks (postnatal weeks 4 to 10); control mice were maintained on standard laboratory diet. To monitor sleep-wake behaviors, mice were implanted with EEG and EMG electrodes at different ages (2.5, 3 and 12 months).

Results: HFD exposure during puberty significantly increased body weight and time spent asleep during the active period. Cessation of HFD exposure resulted in acute increases of wakefulness and body weight loss in 3-mo ppDIO mice. In contrast, ppDIO mice aged 12-mo exhibited an increase in sleep time and body weight. To understand the mechanisms underlying these changes in sleep-wake behavior and body weight regulation, we analyzed neurotransmitter and neuropeptide levels in the lateral hypothalamus (LH), a brain area where cues for ingestive and sleep-wake behaviors converge. We found that increased LH dopamine contents paralleled the increased time spent awake in 3-mo ppDIO mice. However, dopamine contents returned to normal levels in ppDIO mice at 12-mo of age. By contrast, LH serotonin contents were decreased during HFD exposure and in ppDIO mice aged 12-mo. However, orexin and MCH expression was differentially regulated in 2.5-mo and 12-mo old ppDIO mice, suggesting that reduced serotonin contributed to increased sleepiness and body weight during HFD exposure and again, when ppDIO mice were 12-mo old.

Conclusion: These results suggest that ppDIO programs excessive sleepiness and increased bodyweights through reduced serotoninergic inputs to the LH during aging.

Support (If Any): European Union (FP7 SWITCHBOX Project)

0109 CHOLINERGIC NEURONS IN THE PEDUNCULOPONTINE TEGMENTUM MODULATE BLOOD PRESSURE AND RENAL SYMPATHOE XCITATION IN AN EXPERIMENTAL MODEL OF INTermittent HYPOXIA
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Introduction: Sleep apnea syndrome confers a significant risk for developing hypertension. The pedunculopontine tegmentum (PPT) of the rostral pons may be implicated. Known functions of the PPT include regulation of wakefulness, rapid eye movement sleep, and respiration. We tested the hypothesis that PPT neurons are involved in blood pressure regulation.

Methods: DL-homocysteic acid (DLH 4 mM, 10 nl) was microinjected into the PPT of anesthetized Sprague-Dawley rats (N = 6) to identify sites eliciting increases in renal sympathetic nerve activity (RSNA) and mean arterial pressure (MAP); the micropipette position was fixed once a response was observed. Rats received alternating cycles of room air (RA) and hypoxia (10% oxygen) via tracheostomy for the following inspired gas episodes: 5-min baseline [RA], 5-min stimulus [hypoxia], and 5-min recovery [RA]; this sequence was repeated 3 times (45-min). Then, carbachol (1 mM, 10 nl) was microinjected to inactivate cholinergic neurons, followed by DLH (5-min later); rats again underwent the 45-min inspired gas protocol. We examined responses across each inspired gas episode (using data from the last 30-sec of each; data are mean ± SD).

Results: DLH microinjections into the PPT elicited increases in RSNA and MAP by 35.0 ± 9.0% and 10.1 ± 5.0% from baseline, respectively. Each bout of hypoxia was associated with RSNA bursts followed by peak MAP elevations within 5.5 ± 1.2 sec. These sympathoexcitatory responses increased in magnitude with each successive hypoxia exposure. After microinjecting carbachol, however, DLH did not elicit
the sympathoexcitatory response, and there were no statistically significant increases in RSNA or MAP with the subsequent hypoxia exposures.

**Conclusion:** Our observations suggest that cholinergic neurons in the PPT regulate sympathetic responses to intermittent hypoxia. Because the PPT regulates sleep-wake behaviors, research into the role of PPT neurons in the descending control of the cardiovascular system is important to achieve a mechanistic understanding of cardiovascular risk factors with sleep disorders.

**Support (If Any):** National Institute of Nursing Research (K99NR014369).

### 0110 EFFECTS OF CYCLICAL INTERMITTENT HYPOXIA ON THE BLOOD BRAIN BARRIER

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**Introduction:** Associations between obstructive sleep apnea, specifically cyclical intermittent hypoxia (CIH), and cognitive impairment are reported. Physiological effects of CIH on the Blood Brain Barrier (BBB) may be one mechanism of cognitive impairment. We propose that different CIH severities in a mouse model differentially affect angiogenesis and transporter levels at the BBB.

**Methods:** We exposed C57BL/6 male mice, 4 months old, to one of four conditions for 12 hours per day for 2 weeks: (1) sham of continuous air, FiO2 = 0.21, (2) moderate CIH, FiO2 0.21 to 0.125 (CIH12.5), (3) severe CIH, FiO2 0.21 to 0.10 (CIH10), and (4) very severe CIH, FiO2 0.21 to 0.05 (CIH5). We use immunohistochemistry to stain hippocampal brain tissue for CD31 and GLUT1. Neurostereology using CD31 was used to quantify the length of blood vessels, a measure of angiogenesis. GLUT1 expression in blood vessels at the BBB was quantitated using Immunohistochemistry Quantification (IQ) algorithms.

**Results:** We show that there is significantly more angiogenesis in the CIH5 condition compared to all other conditions (p < 0.05), as well as strong evidence for a linear dose response to CIH severity (p = 0.002). Using IQ we identified a total of 564,714 vessels and quantified GLUT1 expression to be significantly increased at the CIH5 compared to the other conditions (p < 0.05), but no significant dose response increase in GLUT1 within the other CIH conditions. Thus, only very severe CIH levels increased expression of this transporter.

**Conclusion:** Increasing severity of CIH induces angiogenesis in the BBB in a linear response. However, GLUT1 increased only at very severe CIH. Thus, homeostatic mechanisms are likely to be activated during moderate and severe CIH, but at severe CIH there may be a breakdown in homeostasis.

**Support (If Any):** Supported by the JSPS (#23659869 and #25670789).

### 0111 ANTAGONISTIC JAW MUSCLE RESPONSES TO CORTICOBULBAR TRACT STIMULATION DURING REM SLEEP IN GUINEA PIGS

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**Introduction:** Rhythmic jaw muscle activities often occur during REM sleep in experimental animals. However, little is known about the responsiveness of jaw premotor system to facilitatory inputs during REM sleep. This study aimed to investigate the response characteristics of jaw-opening (digastric) and -closing (masseter) muscles to electrical micro-stimulations to corticobulbar tracts during REM sleep in guinea pigs.

**Methods:** In ten male Hartley guinea pigs, the electrodes for electroencephalographic (EEG), electro-occulographic, electromyographic (EMG; dorsal neck, digastric and masseter muscles) and electrocardiographic electrodes were first implanted for chronic sleep recordings. Subsequently, a glass-coated metal electrode was placed into the corticobulbar tract where the electrical micro-stimulation can induce jaw muscle responses. In the recording sessions, short- and long-train repetitive electrical micro-stimulations were given to the corticobulbar tract under freely moving conditions. EMG responses to the stimulation were analyzed and compared among wakefulness, NREM sleep and REM sleep.

**Results:** Short-latency oligo-synaptic responses of the digastic muscle were induced by short-train stimulations for the three behavioral states. The response rate and the EMG amplitude of the responses were significantly lower during REM sleep than the other two states while the response latency did not differ among the three states. Long-train stimulations induced rhythmic digastic activations during wakefulness and NREM sleep; most of them were followed by rhythmic masseter contractions after stimulation. During REM sleep, however, only digastic muscle was rhythmically activated while stimuli were given. Stimulus-induced rhythmic digastic activations were less frequently scored during REM sleep than wakefulness and NREM sleep.

**Conclusion:** During REM sleep, trigeminal premotoneurons and masticatory rhythm generators can be responsive to corticobulbar stimulation although motoneurons are inhibited.

**Support (If Any):** Supported by the JSPS (#23659869 and #25670789).

### 0112 MATERNAL SLEEP DEPRIVATION-INDUCED COGNITIVE DEFICITS WERE IMPROVED BY INHIBITION OF MICROGLIAL ACTIVATION IN YOUNG OFFSPRING RATS

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**Introduction:** During pregnancy, maternal sleep complaints are emerging health concerns as they are associated with several harmful consequences to their children. But few researches evaluated the effects of microglia on offspring with maternal sleep deprivation (MSD). In this study, it was investigated the effect of MSD on cognition, neurodevelopment and inflammation in prepuberty offspring rats.

**Methods:** Sleep deprivation was performed using modified small-platform method. Pregnant Wistar rats received sleep deprivation for 72 h on gestational day (GD) 4, 9, and 18, respectively. The male prepuberty offspring (21 days old) were used in the experiments. Cognitive function was examined by Morris Water Maze for 7 days. Hippocampal neurogenesis (BrdU+/DCX+ cells) was estimated by immunohistochemistry (IHC). Inflammatory cytokines were determined by Real
A. Basic Sleep Science

Time PCR and IHC. The microglial state was confirmed by ELISA and IHC. The prepuberty male offspring with MSD were given the intraperitoneal injections with minocycline (50 mg/kg) for 5 days to inhibit microglial activation.

Results: MSD impaired hippocampus-dependent spatial learning and memory in the Morris Water Maze task, and decreased the number of BrdU+/DCX+ cells in prepuberty offspring, especially in the late MSD young rats (sleep deprivation on GD18). The pro-inflammatory cytokines (IL-1β, IL-6 and TNFα) increased and anti-inflammatory cytokine (IL-10) decreased and the Iba1+ microglia activated in late MSD offspring. After injected minocycline, the classical microglial activation (M1 phenotype) was inhibited, and promoted the alternative microglial activation (M2 phenotype). The cognition and neurogenesis were improved after minocycline administration.

Conclusion: MSD-induced microglial activation is involved in impaired of neurogenesis and cognitive function in the prepuberty offspring.

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0113 EEG CROSS-FREQUENCY COUPLING DURING SLEEP AND WAKEFULNESS DISTINGUISHES MILD TRAUMATIC BRAIN INJURY IN MOUSE AND HUMAN SUBJECTS

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Introduction: Chronic mild traumatic brain injury (mTBI) is associated with persistent sleep-wake disturbances in both human subjects and animal models. EEG cross-frequency coupling (CFC) reflects coordination between neural circuits, an important component of optimal sleep and wakefulness. We sought to identify a CFC-based quantitative EEG metric during sleep and wakefulness sensitive to mTBI, first, by using a mouse model of mTBI, and next, by applying our findings to a human population with chronic mTBI.

Methods: Mice were randomized to receive mTBI or sham surgery (n = 6 per group) using lateral fluid percussion injury. Amplified polysomnographic EEG/EMG recordings were obtained 2 weeks post-injury and scored for behavioral state across 24 hours of continuous recording (NREM, REM and wakefulness). EEG amplitudes were computed for each frequency band (delta, theta, alpha, beta and gamma frequencies) using the square root of EEG power obtained by short-term Fourier transform (STFT) using a 2 second sliding window. Ratios between amplitudes of each pair of frequency bands were calculated for every second, and were averaged over the awake and NREM sleep periods to obtain a single index value. For the human studies, polysomnography from subjects obtained for clinical purposes were scored according to AASM guidelines (n = 10 mTBI, n = 10 controls). EEG from electrode C3 was used to compute a similar ratio of the EEG amplitudes for each frequency band. Statistical analyses were performed in MATLAB using Student’s t-tests.

Results: Mice with mTBI showed significantly higher EEG CFC amplitudes based on the ratio of median EEG amplitude for delta:theta (1–5 Hz: 6.5–10 Hz) in both awake and NREM sleep states, compared to sham injured mice. Human subjects with mTBI showed significantly higher EEG CFC amplitudes based on the ratio of median EEG amplitude for theta:gamma (6 Hz: 40 Hz) in both awake/drowsy and stage N2 sleep states, compared to control subjects. These results suggest that in both mouse and human subjects, amplitude couplings between slower and faster frequency bands appear to be a sensitive marker for chronic mTBI.

Conclusion: EEG amplitude CFC during wake and NREM sleep states is a sensitive marker for chronic mTBI in a mouse model and in human subjects. These results identify potentially useful sleep-relevant physiologic markers of mTBI. Further work should interrogate these markers in response to treatment and their predictive utility in recovery of function.

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0114 THE ROLE OF HYPOCRETIN IN POST-TRAUMATIC BRAIN INJURY (TBI) SLEEP DISTURBANCES

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Introduction: Disorders of sleep and wakefulness have been reported in up to 73% individuals who have experienced traumatic brain injury (TBI). Specifically, increased sleep need and excessive daytime sleepiness is often reported post-TBI. At present, the etiology of post-TBI sleep disturbances is not well understood, and behavioral and pharmacological therapies have limited efficacy. Here, we investigate the effects of TBI on sleep-wake behavior and on hypocretin and melanin-concentrating hormone (MCH), two neuropeptides important for regulating sleep and wakefulness.

Methods: Adult male C57BL/6 mice (n = 6–10/group) were implanted with EEG recording electrodes and baseline recordings were obtained. After baseline recordings, TBI was induced using controlled cortical impact (CCI). EEG recordings were obtained from the same animals at 7 and 15 days post-surgery. A separate set of animals (n = 6–8/group) underwent sham or TBI surgery and were sacrificed 7 or 15 days later. Brains from these animals were used for immunohistochemistry to determine the number of hypocretin or MCH-producing neurons in the hypothalamus.

Results: At 15 days post-surgery, wakefulness was decreased and NREM sleep was increased during the dark period in moderately injured animals. There were no differences between groups in REM sleep time, nor were there any differences between groups in sleep behavior during the light period. There was a main effect of injury severity on hypocretin-producing neurons, such that more severe injury resulted in fewer hypocretin-producing neurons. There were no significant differences among groups in MCH-producing neurons.

Conclusion: Moderate TBI reduces wakefulness and increases NREM sleep during the dark period. Moderate TBI also decreases the number of hypocretin-producing neurons, which may be one mechanism underlying observed changes in sleep after TBI.

Support (If Any): Funding was provided by the Department of Anesthesiology & Pain Medicine, University of Washington, Seattle, WA.

0115 HYPERACTIVITY AND MALE-SPECIFIC SLEEP DEFICITS IN THE 16P11.2 DELETION MOUSE MODEL OF AUTISM

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Introduction: Sleep problems are extremely prevalent in several neurodevelopmental disorders, including autism spectrum disorders (ASDs) and attention deficit-hyperactivity disorder (ADHD). Evidence...
from genome-wide association studies suggests that chromosomal copy number variations (CNVs) are significantly more likely in both ASDs and ADHD. In particular, CNVs in chromosomal region 16p11.2 profoundly increase the risk for these male-enhanced neurodevelopmental disorders. We hypothesized that 16p11.2 hemideletion mice (16p11.2 del/+ ) may exhibit sex-specific sleep and activity deficits, and thus may serve as an appropriate genetic model for a common human CNV strongly associated with ASDs and ADHD.

Methods: Activity patterns were assessed in male and female 16p11.2 del/+ and control mice across the 12-hour light/dark cycle for 2 weeks via infrared home cage beam breaks. After 2 weeks, lighting conditions were switched to 24 hour continuous darkness for 2 additional weeks in order to assess intrinsic circadian rhythms. In separate experiments, male and female 16p11.2 del/+ and control mice were implanted with EEG/EMG electrodes. Sleep was scored during 24 hour baseline conditions and also over the 18 hour recovery period following 6 hours of sleep deprivation by gentle handling.

Results: Both male and female 16p11.2 del/+ mice exhibit robust home cage hyperactivity in comparison to controls. This is particularly pronounced during the early third of the dark/active period (p < 0.0001 in males; p < 0.01 in females). Additionally, 16p11.2 del/+ male, but not female, mice exhibit significantly more wake and significantly less NREM sleep over the 24 hour day. There are no differences in circadian period between 16p11.2 del/+ and control animals.

Conclusion: 16p11.2 del/+ mice exhibit hyperactivity and male-specific sleep deficits. These findings are analogous to behaviors observed in human ADHD and ASD patients, suggesting that the 16p11.2 del/+ mouse model may be an appropriate genetic model for studying human neurodevelopmental disorders.

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0116 DAYTIME SLEEPINESS IS ASSOCIATED WITH ALTERED THALAMOCORTICAL CONNECTIVITY

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Introduction: The thalamus plays a critical role in alertness, attention, and the transfer of neural information, as well as regulation of sleep states and wakefulness. While evidence suggests that total sleep deprivation disrupts thalamocortical functional connectivity, in turn contributing to deficits in alertness, vigilance, and information processing; it is unclear whether such altered connectivity is associated with daytime sleepiness under non-sleep deprived conditions. We hypothesized that greater daytime sleepiness would be associated with lower thalamocortical resting state functional connectivity.

Methods: Sixty healthy adults (30 male, 30 female; M age: 30.4 years), completed the Epworth Sleepiness Scale (ESS) and underwent a six minute resting state functional connectivity neuroimaging scan at 3T. Regions of interest for the thalamus (bilaterally) and parcellated regions of the cortex (defined by the Automated Anatomical Labeling Atlas) were interrogated using the CONN toolbox in SPM12. Specifically, we examined the functional connectivity between the thalamus and other regions of the cortex (p < 0.05, FDR corrected for height and cluster threshold).

Results: Higher levels of sleepiness were associated with significant anticorrelated activity between the right thalamus and widespread cortical regions, most prominently including the ventral prefrontal cortex, sensory, motor, auditory, and visual processing regions. Sleepiness levels were only associated with four small clusters of cortical sensory and motor regions that were anticorrelated with the left thalamus.

Conclusion: These findings suggest that differences in daytime sleepiness are associated with altered thalamocortical connectivity during rested wakefulness. This pattern of reduced functional connectivity may reflect the disengagement of sensory and motor processing, resulting in the reduced alertness that is present among individuals with high levels of chronic sleepiness. Future work may examine whether these patterns of connectivity are affected by alertness promoting agents or other treatments that experimentally reduce sleepiness.

Support (If Any): W81XWH-09-1-0730

0117 CONNEXIN36 KNOCKOUT MICE SHOW REDUCTION IN ACOUSTICALLY GENERATED CORTICAL GAMMA

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Introduction: Gap junction proteins such as connexins form electrical synapses between neurons. Among several subtypes of connexins (Cx), Cx36 is of particular interest as its expression is restricted to neurons. Cx36 is highly expressed in parvalbumin-expressing GABAergic interneurons and unlike other connexins, forms only homotypic channels. Thus, in Cx36 knockout (Cx36KO) mice, which lack Cx36 expression, functions subserved by these channels will be compromised. In vivo experiments have shown that cortical oscillations at the gamma range (30–40 Hz) are specifically reduced in Cx36 knockout mice (Buhl et al., 2003). Here using Cx36 gene knockout model mice we examined the importance of Cx36 in acoustically generated cortical gamma, and explore the impact of sleep deprivation on Cx36 expression.

Methods: Frontal EEG/EMG recordings were performed on both Cx36KO mice, and wild-type (WT) controls to assess their response to an auditory steady state paradigm (ASSR). Here, using a cage mounted speaker, mice were exposed to a 500 ms train of audible clicks (90 dB), presented at a defined frequency (20–60 Hz). These stimuli were repeated 100X, and the resulting EEG activity was averaged to provide the evoked response. Additionally, we examined total cortical protein levels of Cx36 in WT mice to determine the effects of 6 hr of sleep deprivation on channel expression.

Results: Our ASSR findings show that Cx36KO mice (n = 8), compared to WT (n = 7) have an impaired ability to entrain cortical activity specifically in the low gamma frequency range (30–40 Hz). Further, we have found that in WT mice cortical expression of Cx36 is increased following 6 hr of sleep deprivation.

Conclusion: These findings suggest that Cx36 is essential for evoked cortical gamma activity, confirming earlier findings. Our somewhat surprising observation that cortical Cx36 expression is actually increased following sleep deprivation may suggest a compensatory role of Cx36 expression to help maintain gamma activity, which is strongly linked to cognition.

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**0118**

**ELECTROENCEPHALOGRAPHIC SIGNATURES OF CIRCUIT-SPECIFIC ACTIVATION IN THE CEREBRAL CORTEX**

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**Introduction:** Slow wave activity (SWA) in the cerebral cortical electroencephalogram (EEG) varies locally in proportion to the use of cortical circuits during prior wake. Whether SWA varies in relation to higher EEG frequencies associated with information processing, such as beta (15–35 Hz) and gamma (80–90 Hz) during prior wake is uncertain. We measured the effects of intensive activation of the vibrissal sensorimotor circuit of mice on local and distal SWA, beta and gamma activities during wake.

**Methods:** EEG was monitored unilaterally, with cerebellar reference, from the frontal and somatosensory barrel cortices of mice. Barrel cortex receives whisker sensory input. A sensory stimulation (SS) protocol consisted of six back-to-back sessions of alternating 30 min SS/30 min spontaneous sleep/wake cycling (Rec), beginning at ZT4 and ending at ZT10. Mice were subjected to either continuous stimulation of the whiskers during SD (STIM; n = 12) or whisker trimming before SS and continuous stimulation of the hindlimbs and dorsum during SD (NOSTIM; n = 11). Data were analyzed as percentage change from wake in the 24-hr baseline immediately prior to SD onset.

**Results:** STIM/NO-STIM was significant for beta activity in barrel cortex (F(1.17 = 5.64, P = 0.030) but not frontal cortex. Beta activity was elevated of STIM mice compared to NOSTIM mice. Main effect of session on beta, gamma and SWA (P < 0.015 all channels, all frequencies) and significant interaction of session and time-within-session (P < 0.001 all channels, all frequencies) demonstrated effects of homeostatic sleep pressure non-selectively across EEG channels. Across and within sessions beta and SWA activities increased, while gamma decreased, in both channels. These time effects on beta were attenuated in STIM mice non-selectively across channels (session X time-within-session X STIM interaction P < 0.01).

**Conclusion:** Beta activity measures circuit-specific activation. Gamma and SWA activities in wake change in opposite fashion as a function of homeostatic sleep pressure independently of circuit activation.

**Support (If Any):** R01NS078498

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**0119**

**CHANGES IN PHOSPHORYLATED mTOR AND PSD-95 PROTEIN EXPRESSION ACROSS SLEEP DEPRIVATION AND RECOVERY IN MICE**

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**Introduction:** Phosphorylated mammalian target of rapamycin (p-mTOR) mediates the synthesis of proteins critical for synaptic potentiation and experience-dependent plasticity, such as post synaptic density 95 kDa (PSD-95). Sleep deprivation (SD) has been shown to disrupt protein synthesis-dependent forms of plasticity and downregulate p-mTOR and PSD-95 in the hippocampus, but changes after the immediate SD period are not well described. Here we investigated the time-course of p-mTOR and PSD-95 protein expression in cortex and hippocampus following 5 hours of SD + 1 or 2 hours of additional SD or sleep recovery (SR).

**Methods:** Adult male C57BL/6J mice were sleep deprived for 5 h by gentle handling, after which time they were sleep deprived for an additional 1–2 hours (SD+1h/2h SD), or allowed to sleep for 1–2 hours (SD+1h/2h SR). Experimental animals and homecage controls were sacrificed for cortical and hippocampal protein extraction and Western blot protein quantification analysis, allowing for the comparison of protein expression changes associated with extended sleep deprivation and sleep recovery.

**Results:** We confirmed previous results, showing downregulated hippocampal p-mTOR expression in SD+1h SD animals compared to controls. Additionally, we found that 1 h SR was sufficient to bring p-mTOR expression levels back to control levels. In contrast to hippocampus, cortical p-mTOR protein levels actually trended slightly higher in both the SD+1h SD and SR conditions. Cortical PSD-95 protein expression was found to be downregulated in the SD+1h SD conditions, as compared to upregulated levels in the SR conditions.

**Conclusion:** The time-course expression of p-mTOR and PSD-95 protein during SD and SR highlights a differential role of sleep in plasticity-related protein translation throughout different brain areas. Future studies should investigate the effects of varying amounts of SD and SR on protein targets along the mTOR pathway involved in cortical and hippocampal synaptic plasticity.

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**0120**

**INTRINSIC MEMBRANE PROPERTIES AND CHOLINERGIC MODULATION OF BASAL FOREBRAIN VGLUT2-POSITIVE NEURONS**

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**Introduction:** Basal forebrain (BF) wake-active neurons play an important role in cortical activation, attention and cortical plasticity. Among the three major types of BF cortically-projecting neurons (cholinergic, GABAergic and glutamatergic), glutamatergic neurons are the least understood due to difficulties in identification. Here, we take the advantage of a novel transgenic mouse model [vesicular glutamate transporter 2 (vGluT2)-tdTomato mice] expressing a red fluorescent protein in the major group of BF glutamatergic neurons to characterize for the first time the intrinsic membrane properties and neurotransmitter modulation of identified BF glutamatergic neurons.

**Methods:** vGluT2-cre mice were crossed with cre-tdTomato mice to generate vGluT2-tdTomato mice. Whole-cell patch clamp recordings were performed on coronal slices from young (13–22 d) vGluT2-tdTomato mice. vGluT2 neurons were identified prior to recording based on their expression of tdTomato (red fluorescence). Drugs were bath-applied.

**Results:** Unlike BF cholinergic neurons, BF vGluT2 neurons were small-medium-sized (14.5 ± 1.4 μm, n = 9), had a small afterhyperpolarization (~14.0 ± 1.5 mV) and a high maximum firing frequency (37.6 ± 4.8 Hz), but did not display an A-type current. Unlike most large-sized (> 20 μm) BF GABAAergic neurons, vGluT2 were silent at rest. vGluT2 neurons had a time-dependent depolarizing sag (80.7 ± 2.8%) due to a small H-current, which distinguishes them from small-sized (< 20 μm) GABAAergic neurons. The vGluT2 neurons were later categorized into two groups: medium-sized (larger than 15 μm, n = 3) and small-sized (< 15 μm, n = 6). The medium-sized vGluT2 neurons showed repetitive bursts of action potentials when depolarized, and were hyperpolarized by 50 μM carbachol in the presence of tetrodotoxin (~18.6 ± 6.4 mV, n = 2), while the small-sized vGluT2 neurons exhibited tonic firing while depolarized.

**Conclusion:** BF glutamatergic neurons have distinct intrinsic membrane properties from BF cholinergic and GABAergic neurons. Unlike BF GABAergic neurons, cholinergic inputs have a hyperpolarizing effect which may facilitate burst firing during wakefulness and REM sleep.
Support (If Any): VA Merit, NIMH R01 MH039683, NHLBI HL095491.

0121

BASEL FOREBRAIN PURINERGIC P2 RECEPTOR MECHANISMS OF SLEEP-WAKE REGULATION
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Introduction: Adenosine triphosphate (ATP) serves as the cellular energy source of all organisms and is an important glio- and neurotransmitter in the brain. In vivo, extracellular ATP activates purinergic P2 receptors (P2Rs), and/or inhibitory adenosine receptors via degradation to adenosine by ectonucleotidases. While the effect of adenosine in basal forebrain (BF) in sleep homeostasis has been extensively investigated, little is known about the effect of P2Rs. Thus, we investigate the effect of selective activation of BF P2Rs on wakefulness and on the excitability of BF neurons.

Methods: Reverse microdialysis was used to infuse drugs into BF in freely-moving adult male mice. The sleep-wake states were recorded with electroencephalography and electromyography. Whole-cell patch clamp was performed on coronal slices from GAD67-GFP knock-in mice (13–22 d). Cholinergic neurons were GFP-negative and identified by their distinctive intrinsic membrane properties. GABAergic neurons were GFP-positive and categorized after recording based on their intrinsic membrane properties. Drugs were bath-applied.

Results: A 2-h infusion of 1 mM ATP-γ-S (non-hydrolysable ATP analog) into BF during the light period (ZT3-ZT5) increased wake time by ~17% compared to ZT1-ZT3 on the same day (no change on baseline day; n = 3). In tetrodotoxin, ATP-γ-S (100 μM) depolarized BF cholinergic (20.7 ± 4.2 mV, n = 5) and two groups of putative cortically-projecting GABAergic neurons (large Ih: 12.1 ± 1.4 mV, n = 5; small Ih: 18.3 ± 2.6 mV, n = 6). An ionotropic-P2XR antagonist, 30 μM PPADS, blocked 80–90% of the ATP-γ-S-induced response in cholinergic neurons (n = 5) and the GABAergic neurons with large Ih (n = 4), and reduced it by ~30% in GABAergic neurons with large Ih (n = 6).

Conclusion: Our data suggest that application of a P2R agonist to the BF increases wakefulness in vivo and excites BF cholinergic and GABAergic neurons in vitro. Therefore, investigation of BF P2Rs’ role in promoting wakefulness may contribute to the discovery of novel therapeutic agents to promote alertness.

Support (If Any): VA Merit Review

0122

ROLE FOR NUCLEUS PONTIS ORALIS (PNO) IN THE NEURAL NETWORK OF REM SLEEP-CONTROL
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Introduction: The PnO has long been identified as part of a REM sleep-control network based on the action of a variety of drugs, acting through different receptors, to induce significant increases in REM sleep following direct injection into PnO. How mechanisms in PnO interact with these drugs and other putative nodes in the neural network of REM sleep-control is largely unknown.

Methods: Here we address the problem by mapping the network in rat utilizing triple-label immunohistochemistry and neuronal tract-tracing to identify connectivity, neurotransmitter and receptor proteins. This is determined at high resolution utilizing fluorescence scanning confocal microscopy. Functional aspects are studied with behavioral pharmacology using intracerebral injection into PnO.

Results: Utilizing retrograde transport of cholera toxin B ejected into the sublaterodorsal nucleus (SLD), a sub-population of GABAergic neurons labeled with GAD67 were observed to project to SLD and coexpress a variety of receptors including: muscarinic m2 and m4; adenosinergic A1; and melanin concentrating hormone MCH-1R. Agonist ligands at these receptors induce REM sleep following injection into PnO. Utilizing antibodies to vesicular acetylcholine transporter (VACHT), cholinergic boutons in PnO were observed to express GABAa receptor gamma2 subunit apposed by GAD67 labeled varicosities. In addition, immunoreactivity for all receptors mediating the action of pituitary adenylate cyclase-activating polypeptide (PACAP) and vasoactive intestinal polypeptide (VIP) were found colocalized to cholinergic boutons. GABAa receptor antagonists and agonists of PACAP and VIP injected into PnO result in an atropine sensitive induction of REM sleep.

Conclusion: Based on these data and more, we hypothesize the presence of two network nodes in PnO in the control of REM sleep. One, in the control of REM-off activity of GABAergic neurons in PnO projecting to SLD influencing REM-on activity in the latter nucleus. And, a second node in the control of acetylcholine release in PnO resulting in selectively high levels during REM sleep.

Support (If Any): VA Merit Review

0123

OPTOGENETICALLY-EVOKED RESPONSES IN NEURONAL NITRIC OXIDE SYNTHASE-POSITIVE CELLS OF THE CEREBRAL CORTEX
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Introduction: A putative sleep-active population of interneurons, defined as such by the expression of Fos in the brains of animals euthanized after protracted deep sleep and identified neurochemically by the expression of neuronal nitric oxide synthase (nNOS), may be a local regulator of slow wave activity in the cerebral cortex.

Methods: Using a germ line Cre/loxP strategy, we targeted the nNOS population of interneurons to express the light-activated cation channel Channelrhodopsin2 and the histological marker tdTomato. We applied optogenetic stimuli (10-msec blue light pulses at 1 Hz) to the cerebral cortex of awake transgene-expressing (n = 10) and negative control (n = 11) mice. We also applied optogenetic stimuli to the cerebral cortex of anesthetized transgene-expressing (n = 4) and transgene negative control (n = 5) mice. We measured event-triggered electrophysiological potentials (n > 500 per animal) at the site of stimulation to generate averaged evoked potential curves.

Results: Evoked responses to stimulation occurred in anesthetized (F(49,147) = 5.97, P < 0.001) and awake, behaving (F(109,796) = 3.81, P < 0.001) transgene-expressing mice, but not in non-expressor controls in anesthetized (F(49,196) = 1.06, P = 0.375) or awake (F(109,796) = 0.75, P = 0.993) conditions. The evoked response was a positive deflection of the electrical potential lasting approximately 200 msec and peaking at 80 msec. This evoked response in unanesthetized transgene-expressing mice varied as a function of EEG background state (F(1,11) = 3.75, P = 0.041): the magnitude was maximal when the electroencephalogram (EEG) was in a negative polarization state and abolished when the EEG was in a positive polarization state at stimulus onset.

Conclusion: nNOS cell-driven potentials are phenomenologically similar to slow waves. The polarization state of the EEG is a manifest-
tation of slow wave oscillations in the activity of underlying pyramidal neurons between the relatively depolarized up state and the relatively hyperpolarized down state. The data demonstrate responsiveness of the cortex to nNOS cells only when it is in the depolarized up state.

**Support (If Any):** NINDS RO1NS078498 and RO3NS082973.

**0124**

**VGLUT2-TDTOMATO TRANSGENIC MICE AS A MODEL SYSTEM FOR INVESTIGATION OF BASAL FOREBRAIN GLUTAMATERGIC NEURONS**

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**Introduction:** The basal forebrain (BF) plays a crucial role in cortical attention, activation, and sleep-wake behavior. Glutamatergic neurons are the least well understood of the three major BF neurotransmitter classes, due to difficulties in identification. Thus, here, we establish a novel transgenic mouse model which expresses a red fluorescent protein (tdTomato) in BF glutamate neurons, allowing online identification and combinatorial approaches with other transgenic mouse lines or viral vectors utilizing green/yellow fluorescent proteins.

**Methods:** Vesicular glutamate transporter, subtype 2 (vGluT2)-tdTomato mice were generated by crossing vGluT2-Cre Recombinase mice with a Cre-reporter strain expressing tdTomato. Immunohistochemical staining was performed against choline acetyltransferase, to confirm that tdTomato was not ectopically expressed in cholinergic BF neurons; and calbindin, to identify putative cortically-projecting neurons. Crossing with GAD67-GFP knock-in mice is underway to test for co-localization in GABAergic neurons. To investigate BF vGluT2 projections, floxed adeno-associated viral vectors (AAV) expressing ChR2-EYFP (Enhanced Yellow Fluorescent Protein) were unilaterally injected into BF.

**Results:** The distribution of tdTomato<sup>+</sup> neurons in the BF of vGluT2-tdTomato mice was markedly different from that of GABAergic (GFP<sup>+</sup>) neurons in GAD67-GFP knock-in mice and resembled that of BF vGluT2<sup>+</sup> neurons identified by in situ hybridization in rats. tdTomato was not expressed in cholinergic neurons (N = 2, 1172 neurons analyzed). 26.1 ± 4.5% of BF vGluT2-Tomato neurons contained calbindin (N = 2). Efferent projections were identified in frontal cortex and midline thalamus as well as fibers apposed to BF cholinergic and PV neurons.

**Conclusion:** BF vGluT2 neurons may play a role in modulation of cortical activation through their direct cortical projections and interactions with BF cholinergic and parvalbumin neurons. Validation of this mouse model is a critical first step prior to studying their role in sleep-wake behavior, using in vivo optogenetic or pharmacogenetic approaches and will facilitate study of their properties using in vitro intracellular recordings.

**Support (If Any):** Department of Veterans Affairs NIMH R01 MH039683 and NHLBI P01 HL095491

**0126**

**RECIPROCAL PROJECTIONS BETWEEN CORTEX AND BASAL FOREBRAIN - AN IN VITRO ELECTROPHYSIOLOGICAL STUDY**

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**Introduction:** The basal forebrain (BF) is an essential wake-promoting region that contains a heterogeneous population of neurons. BF cholinergic neurons fire in association with wakefulness and REM sleep, and they promote cortical activation. These neurons also receive a robust glutamatergic input, which might contribute to their behavioral state-dependent activity. The cortex is heavy innervated by the BF and provides reciprocal glutamatergic inputs back to the BF. Here we used a ChR2-assisted-circuit-mapping approach to identify BF neurons targeted by the medial prefrontal cortex (mPFC).

**Methods:** We used ChAT-IRES-cre, Vgat-IRES-Cre and Vglut2-IRES-cre mice that express Cre recombinase respectively in cholinergic, GABAergic or glutamatergic BF neurons. We placed two microelectrode arrays targeted by the medial prefrontal cortex (mPFC) in each mouse. We injected an AAV-FLEX-hrGFP into the BF of each type of cre-expressing mouse line to label cholinergic, GABAergic or glutamatergic BF neurons. We also injected AAV-CaMKIIa-hChR2(H134R)-mCherry into the mPFC to express ChR2 in glutamatergic cortical neurons. We performed whole-cell recordings in BF slices and targeted MCPO/SI neurons that expressed GFP. We photostimulated ChR2 expressing axons/terminals using blue-light (473 nm) pulses.

**Results:** Photostimulation of cortical axons/terminals expressing ChR2-mCherry evoked short latency (shorter than 6 ms) excitatory post synaptic currents (EPSCs) in GABAergic and glutamatergic...
VI. Neurobiology

A. Basic Sleep Science

0127

A NOVEL THETA-GAMMA COUPLING DURING RAPID EYE MOVEMENT SLEEP IN RATS
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Introduction: Defining interactions among brain oscillations in different frequency bands is important for understanding complex behaviors such as learning and memory. Oscillations in the theta and gamma frequency range (5–12 Hz and 30–120 Hz, respectively) occur concomitantly during wakefulness and rapid eye movement (REM) sleep. Variations in these oscillations, as well as alternations in their coupling, may reflect changes in information processing. The aim of this study was to explore the characteristics of cortical theta and gamma oscillations, as well as their coupling, in rats undergoing 20-hr polysomnography.

Methods: Electrodes were implanted to record the frontal and parietal electroencephalogram (EEG) and nuchal muscle electromyogram in rats (N = 8). For each REM period we determined the variation of EEG-banded power across sleep-wake states revealed a pattern of coupled theta-gamma activity associated with REM sleep. This phenomenon may represent a unique fingerprint of REM sleep that correlates with behaviors. Future studies will determine whether these REM-related theta-gamma interactions are associated with performance on cognitive tasks, such as navigation and memory, in rats.

Support (If Any): NHLBI (HL095491) and NINDS (NS061863)

0128

HYPOCRETIN AND NOREPINEPHRINE INTERACTIONS IN ZEBRAFISH LARVAE
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Introduction: The hypothalamic neuropeptide hypocretin is a major regulator of wakefulness in vertebrates, including the diurnal teleost zebrafish. The neurotransmitter noradrenaline, supplied to the central nervous system by efferent projections of the locus coeruleus, has been shown to promote arousal in many vertebrate model systems.

Methods: Here we employ a pharmacological approach and high-throughput behavioral experiments to investigate interactions between hypocretin and noradrenaline in larval zebrafish.

Results: We previously showed that overexpression of hypocretin using a heat-shock inducible system (HS-Hcrt) induces an insomnia-like state. Conversely, we find that the alpha-adrenergic antagonist prazosin increases sleep during both day and night. When HS-Hcrt larvae are subjected to heat shock, we find that the majority of the insomnia phenotype is inhibited by prazosin.

Conclusion: These, as well as other pharmacological studies, suggest that noradrenaline is a major mediator of the hypocretin system in larval zebrafish, similar to what has been shown in mammals. Thus zebrafish could provide a useful diurnal vertebrate system for investigating interactions between arousal promoting centers in the brain.

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0129

GABAERGIC NEURONS IN THE VENTROLATERAL PERIAQUEDUCTAL GREY SUPPRESS RAPID EYE MOVEMENT (REM) SLEEP IN MICE
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Introduction: Previous studies have established the role of the ventrolateral periaqueductal grey/lateral pontine tegmentum (vlPAG/LPT) in suppressing rapid eye movement (REM) sleep. Because cytotoxic lesions and pharmacological inhibition of the vlPAG/LPT produced an increase in REM sleep, we hypothesized that GABAergic neurons in the vlPAG/LPT are critical for REM sleep suppression. To test this hypothesis, we herein selectively activated and silenced vlPAG/LPT GABAergic neurons using Designer Receptors Exclusively Activated by Designer Drugs (DREADDs), a pharmacogenetic method, and studied changes in REM sleep in mice.

Methods: Adult male Vgat-Cre mice [transgenic mice expressing CRE recombinase (Cre) specifically in GABA neurons (containing vesicular GABA transporter, Vgat)] were stereotaxically injected with Cre-dependent adeno-associated viral vectors (AAVs) containing the stimulatory (hM3Dq) or inhibitory (hM4Di) DREADD into the vlPAG/LPT bilaterally. These mice were then implanted with telemetry transmitters to record electroencephalogram and electromyogram. Four weeks after the surgical procedure, all mice were intraperitoneally (IP) injected with saline (vehicle) or clozapine-N-oxide (CNO, ligand for DREADDs; 0.3 mg/kg) on 2 occasions (10 am and 7 pm) and post-injection recordings were carried out for 24 h. Three days after the final
This research was funded by the Canadian Institute of Health Research Council of Canada (NSERC), and the CIHR Sleep and Biological Rhythms Toronto Training Program.

0130

PHARMACOGENETIC ACTIVATION OF THE AMYGDALA PROMOTES CATAPLEXY IN NARCOLEPTIC MICE
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Introduction: Narcolepsy is a sleep disorder caused by loss of orexin (hypocretin) neurons in the hypothalamus. Cataplexy is a particularly debilitating symptom of narcolepsy characterized by abrupt, involuntary loss of muscle tone during wakefulness. The neural circuits mediating cataplexy are poorly understood. Cataplexy is often triggered by strong positive emotions, and the amygdala is hypothesized to play a role in its onset. The goal of this study is to establish whether the amygdala mediates cataplexy by determining how reversible activation of this region impacts cataplexy in narcoleptic mice.

Methods: The central nucleus of the amygdala (CeA) of five orexin knockout mice, a mouse model of narcolepsy, was bilaterally injected with 200 nL of a recombinant adeno-associated viral (rAAV) vector containing a Designer Receptor Exclusively Activated by Designer Drugs (DREADD) (rAAV/hSyn-hM3Dq-mCherry). Neurons expressing this DREADD are activated by clozapine-N-oxide (CNO, 2.5–5 mg/kg). Electroencephalogram, electromyogram, and video data were collected overnight following intraperitoneal CNO or saline (control) injections to evaluate changes in sleep/wake architecture and cataplexy.

Results: We found that CNO-induced activation of CeA neurons increased the amount of time orexin knockout mice spent in cataplexy (p < 0.05) but not wakefulness. CeA activation triggered more cataplexy episodes (p < 0.05), but did not change the average duration of individual attacks. Importantly, CNO-induced cataplexy attacks were indistinguishable from episodes occurring during control conditions. Specifically, we found levels of muscle atonia, theta activity (4–8 Hz; total spectral power), and cataplexy duration were identical under both saline and CNO conditions, suggesting CNO-induced CeA activation produces cataplexy attacks that resemble spontaneous cataplexy events.

Conclusion: Our results are important because they suggest that the amygdala, and particularly the CeA, is an integral part of the neuro-circuitry underlying emotionally-induced cataplexy in narcolepsy. Understanding how orexin cell loss impacts normal amygdala function is an important next step in dissecting mechanisms of cataplexy.

Support (If Any): This research was funded by the Canadian Institutes of Health Research (CIHR), the Natural Sciences and Engineering Research Council of Canada (NSERC), and the CIHR Sleep and Biological Rhythms Toronto Training Program.
NEURAL TRANSLIN IS REQUIRED FOR SLEEP-METABOLISM INTERACTIONS
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Introduction: Neural regulation of sleep, appetite and energy homeostasis is essential to an animal’s survival under stringent evolutionary pressure. Dysregulation of sleep is strongly linked to metabolic disease such as obesity and diabetes. Fruit flies, like mammals, modulate sleep-wake cycles in accordance with their nutritional needs, providing the opportunity to characterize the neural basis for metabolic regulation of sleep.

Methods: A neuron-specific RNA interference screen isolated translinden (trsn), an mRNA/DNA binding-protein, that is highly conserved among species was isolated. Neural specific trsn knock-down results in flies that fail to suppress sleep during starvation but have normal energy stores, indicating that trsn is required for modification of sleep in accordance with metabolic state.

Results: Current work seeks to characterize the cellular and neuroanatomical function of trsn to determine how sleep and metabolic state are integrated. trsn knock-down and trsn null flies display normal feeding behavior suggesting trsn is not required for the induction of hunger dependent behaviors. Tissue specific knock-down experiments reveal that trsn functions in peptidergic neurons that innervate the Insulin Producing Cells. Insulin levels are constitutively upregulated in trsn mutants and mutation of specific insulin like peptides rescue the sleep phenotype of trsn mutant flies, suggesting trsn regulates insulin signaling to modulate sleep during starvation.

Conclusion: Taken together, these experiments indicate trsn is a novel integrator of sleep and metabolic state.

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0133
GABAERGIC REGULATION OF THE CENTROMEDIAN THALAMUS AND CONTROL OF CORTICAL ACTIVATION IN THE MOUSE
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Introduction: Vegetative and minimally conscious states (VS/MCS) are devastating neurological conditions with limited therapeutic options. Improved function has been observed in some VS/MCS patients following application of drugs affecting the basal ganglia or electrical stimulation of the centromedian thalamus (CM). In particular, the paradoxical arousing effect of the hypnotic, zolpidem, may be due to its facilitation of GABA-A receptors containing α1 subunits on basal ganglia outputs which target CM (Schiff, 2010). Here we test this model in the mouse using optogenetic techniques.

Methods: We used optogenetic techniques to test the effect of stimulation or inhibition of CM & SNr on the cortical EEG. We used anatomical tracing to confirm the connection between SNr and CM in the mouse and immunohistochemistry to test if the subset of SNr neurons containing parvalbumin (PV) express GABA-A receptors containing α1 subunits. In vitro optogenetic experiments tested the effect of the GABAB receptor agonist baclofen on the SNr PV→CM pathway.

Results: Excitation of CM enhanced cortical gamma-band power, particularly in frontal regions. Conversely, inhibition of CM suppressed the 40 Hz auditory steady-state response. Tracing experiments revealed a major input to CM from SNr parvalbumin (PV) neurons. Furthermore, SNr PV neurons stained for the α1 GABA-A receptor subunit. Notably, bilateral stimulation of SNr PV neurons elicited an EEG peak at ~8 Hz, reminiscent of that observed in zolpidem-responsive VS/MCS patients, and thus may be an EEG biomarker of responsive patients. The GABA-B receptor agonist, baclofen, inhibited the GABAergic inputs to CM in vitro.

Conclusion: Our data in the mouse support the Schiff 2010 mesocircuit model that increased activity of basal ganglia inputs to CM causes impairments in the generation of EEG activity required for conscious states. Use of an in vitro optogenetic approach may be beneficial in identifying novel therapeutic agents which downregulate the SNr→CM pathway.

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0134
MELATONIN IS REQUIRED FOR THE CIRCADIAN REGULATION OF SLEEP
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Introduction: Sleep is regulated by homeostatic and circadian processes, but the molecules underlying the circadian process are unclear. Melatonin is a good candidate because the circadian clock regulates its production and it can induce sleep in some contexts. However the efficacy of exogenous melatonin in promoting sleep is controversial and the function of endogenous melatonin is unknown. Determining the role of endogenous melatonin in sleep has been difficult because it is produced at night in both nocturnal and diurnal animals, and because mouse strains commonly used for genetic studies produce little or no melatonin. To clarify the role of endogenous melatonin in regulating sleep and circadian rhythms in a diurnal vertebrate, we generated zebrafish that lack melatonin due to mutation of arylalkylamine N-acetyltransferase 2 (aanat2).

Methods: We compared the sleep/wake behavior of aanat2 mutant zebrafish larvae to their wild-type siblings using a high-throughput videotracking assay.

Results: Under standard light/dark conditions, aanat2 mutants have defects in the initiation and maintenance of sleep at night, but have normal daytime sleep/wake behaviors, indicating that endogenous melatonin is required to promote sleep at night. In free-running conditions, the circadian regulation of sleep is abolished in aanat2 mutants, indicating that melatonin is required for the circadian regulation of sleep. In contrast to claims that melatonin affects sleep indirectly via the circadian system, the aanat2 mutant phenotype persists in animals that lack entrained circadian rhythms, suggesting that melatonin directly engages the sleep/wake regulatory system. While it has been claimed that melatonin is required for circadian rhythms, we found that molecular and behavioral circadian rhythms are normal in aanat2 mutants. Finally, we provide evidence that melatonin promotes sleep in part by stimulating adenosine signaling, thus potentially linking homeostatic and circadian regulation of sleep.

Conclusion: Our results suggest that melatonin mediates the circadian process of the two-process model of sleep regulation.

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0135
ANTERIOR INSULA REGULATES PATTERNS OF SLEEP AND WAKEFULNESS
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Introduction: The brainstem, hypothalamus, and cortex interact to generate sleep and its behavioral and electrophysiological properties. The role of specific cortical regions in sleep-regulating circuits is unclear. The anterior insula has strong reciprocal connectivity with wake and sleep-promoting brainstem regions, and dysfunction of this region has been implicated in sleep disorders like insomnia. We hypothesized that the anterior insula regulates patterns of sleep and wakefulness.

Methods: To test this hypothesis, we lesioned the anterior insula in rats and measured sleep-wake patterns with electroencephalography (EEG), electromyography (EMG), and video recordings. We also examined chronic activity patterns using infrared sensors.

Results: Compared to control animals, anterior insula lesion animals had less wakefulness and more rapid eye movement (REM) sleep and non-REM (NREM) sleep. Insula lesion animals were unable to sustain wakefulness, especially during the active dark period. Insula lesion animals also had more transitions from NREM to REM sleep, especially during the inactive light period. Chronic infrared monitoring revealed that insula lesion animals also had disturbed fractal patterns of activity but intact circadian rhythms.

Conclusion: These results suggest that the anterior insula regulates sleep and activity patterns. Projections to brainstem sleep and wake-promoting regions may allow the insula to regulate wakefulness, NREM, and REM sleep and sustain normal patterns of activity throughout the day. Dysfunction of the anterior insula may underlie changes in sleep/wake patterns in neurological and psychiatric disorders.

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0136
DISCOVERY OF A NEUROPEPTIDE SIGNALING PATHWAY THAT REGULATES SLEEP/WAKE BEHAVIOR IN ZEBRAFISH
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Introduction: The discovery of the neuropeptide hypocretin’s role in regulating sleep was a major breakthrough in sleep research and underscored the potential of genetic approaches to discover new sleep regulators. However, few molecular regulators of sleep have been discovered since.

Methods: To identify genes that regulate vertebrate sleep, we performed an inducible genetic overexpression screen using a high-throughput larval zebrafish locomotor activity assay.

Results: We found that overexpression of neuregulin U (Nmu) dramatically increased locomotor activity and decreased sleep during both the day and night. To identify the signaling pathways that mediate this phenotype, we mutated the zebrafish orthologs of the two mammalian Nmu receptors. We found that Nmur2, which is primarily expressed in the central nervous system, and not Nmur1, which is expressed at lower abundance in the CNS, is required for Nmu-induced arousal. Previous studies hypothesized that Nmu promotes behaviors associated with stress via the hypothalamic-pituitary-adrenal (HPA) axis, which is initiated by hypothalamic corticotropin-releasing hormone (CRH) signaling and ultimately stimulates adrenal production of glucocorticoids. We found that the Nmu overexpression phenotype persists in zebrafish glucocorticoid receptor mutant larvae, suggesting that the HPA axis is not required for Nmu-induced arousal. Instead, we found that Nmu overexpression activates CRH-expressing neurons in the rostral brainstem. These cells may be analogous to mammalian brainstem CRH neurons in the locus coeruleus and parabrachial nucleus, which play an important role in sleep/wake regulation.

Conclusion: Taken together, our data identify a role for Nmu in regulating sleep/wake behaviors and suggest that the relevant effectors are arousal systems in the brainstem rather than the classical HPA axis in the periphery.

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0137
GLUTAMATERGIC INPUT TO OREXIN NEURONS IS DECREASED AFTER MILD TRAUMATIC BRAIN INJURY AND RESTORED BY DIETARY THERAPY
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Introduction: Traumatic brain injury (TBI) causes difficulty in maintaining wakefulness, in part explained by decreased activity/levels of orexin. Dietary supplementation with branched chain amino acids (BCAA; precursors to de novo glutamate synthesis in brain) restores wakefulness and orexin activity in mice with TBI. One possible mechanism to explain decreased orexin activity/levels following TBI is decreased excitatory inputs. We hypothesized that TBI would decrease pre-synaptic glutamate levels within terminals contacting orexin neurons, and that dietary BCAA therapy would restore glutamate in these terminals.

Methods: Mice were randomized to receive no TBI, mild TBI, or mild TBI plus dietary BCAA therapy for 1 week (n = 8 per group) using lateral fluid percussion injury. Brain tissue was processed for electron microscopy first by orexin pre-embed immunolabeling, followed by glutamate post-embed immunogold labeling. Thirty images of pre-synaptic terminals synapsing onto three types of orexin-labeled postsynaptic structures (i.e. dendrites, cell bodies and dendritic spines) were collected from each animal. Synapses were subdivided into asymmetrical (excitatory) or symmetrical (inhibitory) contacts. Glutamate particles within pre-synaptic terminals were counted and analyzed using one-way ANOVA followed by Bonferroni post-hoc comparisons.

Results: The density of glutamate labeling within terminals making asymmetrical synaptic contact onto orexin-labeled dendrites was significantly decreased following TBI, compared to naïve mice and TBI mice receiving BCAA therapy. Furthermore, TBI mice showed a significantly increased terminal area for asymmetrical synaptic contacts onto orexin-labeled cell bodies compared to naïve mice; however, this effect was not restored by BCAA therapy.

Conclusion: TBI decreases the density of glutamate immunogold labeling within nerve terminals making an excitatory synaptic contact onto orexin neurons, and this is restored by dietary BCAA supplementation. Increased nerve terminal area within synapses contacting orexin in cell bodies may reflect irreversible swelling ofafferent projections after TBI. These results suggest a possible mechanism by which TBI compromises orexin neuron function and causes sleep-wake disturbances, and highlight a potential therapy that enhances glutamatergic input to orexin neurons.

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0138
CGRP NEURONS IN THE EXTERNAL LATERAL PARABRACHIAL NUCLEUS REGULATE HYPERCAPNIA-INDUCED AROUSALS
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Introduction: We have reported that glutamatergic signaling in the lateral parabrachial area that includes both the lateral crescent and external lateral PB (PBl) regulates cortical arousals to hypercapnia [J Neurosci, 2013]. The majority of the PBl neurons express calcitonin gene-related peptide (CGRP), and are possibly a necessary relay for the hypercapnic signal to cause arousal.

Methods: We conducted optogenetic inhibition of CGRP PBl neurons selectively in CGRP-CreER mice (n = 5) and tested their arousal responses to 10% CO2. On one side of the brain, we injected an adenovirus containing the gene for Archaerhodopsin TP009 T in a Cre-inducible FLEX cassette (AAV-FLEX-ArchT-GFP), that expressed ArchT in CGRP+ PBl cells. On the other side we deleted the CGRP neurons by injecting a Cre dependent virus expressing the diphtheria toxin subunit A (AAV-FLEX-DTA). Mice were also instrumented for sleep recording and glass fiber. To model cyclic hypercapnia as seen during sleep apnea, we investigated EEG arousals to 10% CO2 given for 30 s every 300 s. We compared the cortical arousals to 10% CO2 in these mice, with and without the 593 nm laser light that hyperpolarize the CGRP-PBl.

Results: Without laser, mice showed normal responses to CO2 (arousal latency 16.8 ± 0.6 sec), and woke-up on every CO2 trial (0% failure to arouse). With 593 nm laser-ON, the arousal latency increased five-fold.
(74.4 ± 6.9 sec) and in 43.7 ± 5.2% of the trials mice did not wake up to CO2 stimulus. ArchT-induced inhibition of CGRP-PBel had no effect on sleep and wake percentages, and on their responses to acoustic stimuli.

**Conclusion:** These results suggest that CGRP-PBel neurons mediate cortical EEG arousals to hypercapnia, by projecting to the lateral hypothalamus, basal forebrain, and central nucleus of amygdala. Current studies are underway to dissect the role of these targets of the CGRP-PBel neurons in CO2 arousal.

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**0139**

**DIET/ENERGY BALANCE AFFECT WAKEFULNESS INDEPENDENT OF BODY WEIGHT**

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**Introduction:** Obesity is strongly associated with sleep/wake disturbances, even in individuals without obstructive sleep apnea or narcolepsy. In rodent models of adiposity, sleep/wake abnormalities can be rescued by diet-induced weight loss. Therefore, it was posited that sleep/wake alterations are secondary to increased body weight. However, an alternate explanation is that diet and/or energy balance drives sleep abnormalities, potentially independent of body weight. To test this, we implemented a novel feeding paradigm that generates mice of equal body weight, but opposing energetic states.

**Methods:** Adult mice were randomized to receive either regular chow (RC; 13.5% kcal from fat) or high fat diet (HFD; 45% kcal from fat) for eight weeks. Subsets of mice from each group were then fed the opposite diet, causing newly-fed HFD mice to gain weight and RC-fed mice to lose weight. One week post-diet switch, the two groups of mice were of equal body weight. Sleep/wake behavior was assessed at baseline (Week 0), pre-diet switch (Week 8), and post-diet switch (Week 9).

**Results:** Consistent with previous studies, chronic HFD-feeding increases both total sleep time (p < 0.05, t-test) and sleep and wake fragmentation (p < 0.0001, t-test). We found that one week of HFD significantly decreases total wake time (p = 0.05, one-way ANOVA with Holm-Sidak’s correction) and worsens wake fragmentation in the dark phase (p < 0.001, two-way ANOVA, H-S), while acute RC improves total wake time and wake consolidation. In comparing groups in our ‘diet switch’ paradigm, we found that RC-fed mice spend more time awake than HFD-fed mice (p < 0.05, t-test) despite having similar body weight and caloric intake at this time point.

**Conclusion:** Our study provides evidence that acute dietary alterations are sufficient to drive sleep/wake behavioral changes. Further, adiposity is not necessary to induce these wake impairments.

**0140**

**DRONABINOL, A CANNABINOID RECEPTOR AGONIST, MODIFIES SLEEP ARCHITECTURE IN CONSCIOUS SPRAGUE-DAWLEY RATS**

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**Introduction:** Untreated obstructive sleep apnea (OSA) is associated with cardiovascular and metabolic diseases. Treatments for OSA are limited, and there are currently no pharmacological treatments. In anesthetized rats, dronabinol attenuates reflex apnea via activation of cannabinoid (CB) receptors located on vagal afferents, and reflex apnea attenuation is blocked by systemic pre-treatment with cannabinoid type 1 (CB₁) and/or type 2 (CB₂) receptor antagonists. Here, we examine the effects on sleep architecture of dronabinol, alone and in combination with selective antagonists.

**Methods:** Adult male Sprague-Dawley rats were anesthetized and implanted with bilateral stainless steel screws into the frontal/parietal bones of the skull for EEG recording and bilateral wire electrodes into the nuchal muscles for EMG recording. The EEG/EMG leads were soldered to a miniature connector and fixed to the skull. Rats were allowed to recover from surgery for one week. Each animal was recorded by polysomnography on multiple occasions (10:00 to 16:00) separated by at least 3 days. The study was a fully nested, repeated measures crossover design, such that each rat received each of 8 intraperitoneal injections one time: vehicle alone (DMSO/potato oil in PBS); vehicle and CB₁ antagonist (am 251, 5 mg/kg); vehicle and CB₂ antagonist (am 630, 5 mg/kg); vehicle and CB₁/CB₂ antagonist (5 mg/kg); dronabinol alone (10 mg/kg); dronabinol and CB₁ antagonist; dronabinol and CB₂ antagonist; dronabinol and CB₁/CB₂ antagonist.

**Results:** Dronabinol decreased the percent time spent in REM sleep (2.7 ± 2.9% [mean ± SD]) compared to vehicle controls (5.4 ± 4.3%). Cannabinoid receptor antagonists did not reverse this effect (antagonist main effect p = 0.09). Interestingly, CB₁/CB₂ receptor antagonist combination increased percent time spent awake (48 ± 11%) compared to vehicle controls (40 ± 12%).

**Conclusion:** Dronabinol decreased time spent in REM sleep, and CB receptor antagonists did not reverse dronabinol’s effect on REM sleep, suggesting dronabinol’s effects are independent of CB receptor activation. Biologically active doses of CB₁ and CB₂ receptor antagonists were tested, given that their combination increased wakefulness.

**Support (If Any):** National Institutes of Health (1UM1HL112856)

**0141**

**SLEEP DIFFERENCES AND NALOXONE INTERACTION IN HEALTHY PARTICIPANTS**

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**Introduction:** Poor sleep has a well-documented negative impact on clinical pain. These effects are mirrored in the laboratory, with shortened sleep duration/poorer sleep quality amplifying sensitivity to quantitative sensory testing methods. One explanation for the differences in pain perception could be differential functioning of endogenous pain-regulatory systems between those who get more vs. less sleep per night. Of note, recent evidence in non-human animals suggests that naloxone may be a micro-glia inhibitor, which may also impact the sleep-pain relationship. We examined the association between self-reported sleep duration and response to capsaicin pain under both saline and naloxone conditions.

**Methods:** Naloxone (0.1 mg/kg), an opioid antagonist, was employed to probe endogenous opioid function and examine its effect on pain report. Thirty-two healthy individuals (20 with < 6.5 hours, 12 with ≥ 6.5 hours per night; average age, M = 25.4, SD = 5.2) participated. A 10% topical capsaicin cream was applied to the dorsum of the non-dominant hand and a thermode was applied, maintaining a constant temperature of 40°Celsius for 90 minutes. Pain ratings were obtained every five minutes, using a 0–100 scale.

**Results:** Capsaicin pain ratings typically increase for 20 to 25 minutes and then plateau; therefore, analyses focused on ratings in the last hour. There were no sex or age differences between sleep groups, and no differences in psychological characteristics (i.e., pain catastrophizing, reactivity; p’s > 0.05). Analyses revealed a main effect of drug (p = 0.015), with responses during the naloxone session generally rated as less intense compared to the saline session. A drug by sleep interaction was also observed (p = 0.038), with participants who slept less re-
porting a significant pain increase in the naloxone condition compared to longer sleepers.

Conclusion: The findings of this study suggest differences in endogenous pain regulatory function based on sleep duration. Potential mechanisms for this finding will be discussed.

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0142
SYNERGISM BETWEEN A SEROTONIN 5HT2A RECEPTOR ANTAGONIST AND A SEROTONIN 5HT2C RECEPTOR AGONIST ON METHAMPHETAMINE-INDUCED SLEEP DISRUPTION IN RHESUS MONKEYS

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Introduction: Psychostimulants have pronounced effects upon sleep. Methamphetamine markedly disrupts sleep measures in monkeys, and these effects are attenuated by a selective 5HT2A antagonist. To further elucidate the serotonergic mechanisms involved in the sleep-disrupting effects of methamphetamine, we investigated the effects of the selective 5HT2C agonist, WAY 163909, administered alone and in combination with the 5HT2A receptor antagonist, M100907, on methamphetamine-induced sleep disruption in nonhuman primates.

Methods: Adult rhesus monkeys (Macaca mulatta; n = 5) consistently self-administered Meth (0.03 mg/kg/injection, i.v.) under a fixed-ratio 20 schedule of reinforcement for 1 week before the beginning of the treatments. In the first experiment, subjects received i.m. injections of WAY 163909 (0.03, 0.1, 0.3 or 1.0 mg/kg) or its vehicle at 6 pm (60 minutes prior to lights off). In a subsequent experiment, subjects were treated with either vehicle, M100907 (0.1 mg/kg), WAY 163909 (0.3 mg/kg) or a combination of these drugs in the same timeframe. Each treatment was given for 5 consecutive days, with a 1-week interval between different treatments. The order of the doses or drug treatments was randomized across subjects within an experiment. Daily self-administration sessions were maintained throughout the experiments. Sleep-like measures were evaluated with Actiwatch monitors a week before baseline sleep parameters and throughout the protocol.

Results: WAY 163909 dose-dependently attenuated the effects of methamphetamine on both sleep efficiency and latency to sleep onset, being significantly effective at the highest dose. Doses of M100907 and WAY 163909 that alone did not affect methamphetamine-induced sleep disruption significantly restored sleep measures (increased sleep efficiency and decreased sleep latency) when administered in combination.

Conclusion: Our data demonstrate a synergistic effect of 5HT2A and 5HT2C receptors on sleep impairment induced by methamphetamine. Because serotonin is involved in both sleep-wake behavior and drug addiction, our results provide important insights for the understanding of sleep in the context of methamphetamine abuse.

Support (If Any): USPHS grants DA010344, DA031246, and OD-P51OD11132, AFIP, CNPq.

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0143
ACTIGRAPHY-BASED SLEEP PARAMETERS DURING THE REINSTATEMENT OF METHAMPHETAMINE SELF-ADMINISTRATION IN RHESUS MONKEYS

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Introduction: Sleep impairment and drug addiction show a bidirectional relationship. Although several studies have addressed sleep in drug withdrawal, no study has evaluated sleep during drug relapse. We aimed to investigate the sleep patterns of nonhuman primates during extinction and drug-primed reinstatement of methamphetamine (Meth) self-administration (SA).

Methods: Adult rhesus monkeys (Macaca mulatta; n = 5) with an extended history of Meth SA self-administered Meth (0.01 mg/kg/injection, i.v.) under a fixed-ratio 20 schedule of reinforcement for 1 week. Saline infusions were then substituted for Meth and stimulus lights withheld until animals reached extinction criteria. Reinstatement effects were evaluated after i.v. non-contingent priming injections of Meth (0.03, 0.1 or 0.3 mg/kg). During reinstatement sessions, stimulus lights were reintroduced but saline continued to be substituted for Meth. Sleep-like measures were evaluated with Actiwatch monitors a week before baseline sleep parameters and throughout the protocol.

Results: Higher Meth intake predicted higher levels of sleep fragmentation during SA maintenance. Although Meth SA did not significantly affect sleep compared to baseline, sleep parameters were improved during extinction compared to SA maintenance (increased sleep fragmentation and decreased sleep efficiency). Priming injection of 0.1 mg/kg Meth, but not 0.03 or 0.3 mg/kg, induced significant reinstatement effects. These behavioral effects were accompanied by sleep outcomes, with increased sleep fragmentation and decreased sleep efficiency in the night following 0.1 mg/kg Meth-induced reinstatement.

Conclusion: Because sleep impairment during reinstatement was not dose-dependent, the direct pharmacological effects of the priming drug injection on sleep parameters cannot account for the results obtained. Rather, it appears that absence of both drug and drug-paired cues (extinction conditions) normalized sleep, while the reintroduction of the stimulus lights as drug-paired cues (effective reinstatement conditions) impaired sleep measures. Our data add to current literature showing that the relationship between sleep and addiction is influenced by the conditioned component of drug abuse.

Support (If Any): USPHS grants DA010344, DA031246, and OD-P51OD11132, AFIP, CNPq.

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0144
OPTOGENETIC INVESTIGATIONS IN MICE TO IDENTIFY THE CELLULAR MECHANISMS OF THE THALAMIC RETICULAR NUCLEUS CONTROL OF SPINDLES: IMPLICATIONS FOR SCHIZOPHRENIA

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Introduction: Spindles are EEG oscillations (12–15 Hz in humans, 8–15 Hz in rodents) occurring during NREM sleep. We here provide for the first time evidence of the importance of thalamic reticular nucleus (TRN) parvalbumin-containing GABA neurons (PV neurons) in control of spindles. Clinically this knowledge is important since spindles are abnormally reduced in schizophrenia (Sz) while PV cortical neurons are abnormal in Sz, and a GWAS study found the gene coding
for the CaV 3.3 channel responsible for spindles to be a risk gene for Sz. Evidence also suggests basal forebrain (BF) PV neurons may importantly control TRN PV neurons.

**Methods:** AAV-ChR2-EYFP (excitation) or AAV-ArchT-GFP (inhibition) were bilaterally injected into TRN or BF in PV-Cre mice. Optical stimulation (optical fibers) was used for stimulation/inhibition of TRN PV neurons or BF fibers in TRN to study spindle generation. Sleep-wake (EEG/EMG electrodes) and TRN single-units (microwire assembly) were recorded in freely moving mice. Auditory stimulation (40 Hz, 1 s) during TRN PV inhibition was compared with no inhibition. Mouse Ns ranged from 2 to 4 for the various experimental components.

**Results:** TRN resonance oscillation frequency was identified at the spindle frequency (~10 Hz). ChR2 excitation of TRN PV neurons produced spindles and increased (~30%) NREM sleep while decreasing wake. ArchT inhibition of TRN PV neurons blocked ongoing spontaneous trains of spindles for 4 s (p < 0.0001 compared with no ArchT). ArchT inhibition also increased wake (30%) while decreasing NREM sleep. ArchT inhibition of TRN PV neurons enhanced the cortical response to 40 Hz auditory stimulation. Immunohistological analysis showed a large BF PV neuronal projection to TRN PV neurons and companion electrophysiologic data indicated BF PV inhibitory control.

**Conclusion:** TRN PV neurons are important for spindle generation and NREM sleep. The BF PV projection to TRN is important in spindle regulation, inhibiting spindles during states of cortical activation. These mechanistic insights are ultimately important for pharmacological target development for Sz spindle deficit treatment.

**Support (If Any):** Dept. of Veterans Affairs (VA merit, RWM), MH039683 (RWM), HL095491

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**0145**

**OPTO-DIALYSIS: A NOVEL TECHNIQUE ALLOWING SIMULTANEOUS OPTOGENETIC STIMULATION AND IN VIVO MICRODIALYSIS REVEALS AN IMPORTANT ROLE OF BASAL FOREBRAIN NON-CHOLINERGIC NEURONS IN SLEEP-WAKE CONTROL**


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**Introduction:** Optogenetics is the premier tool for selective focal stimulation of specific neurotransmitter systems. However, the interpretation of optogenetic experiments requires an understanding of the effect of optical stimulation on neurotransmitter release adjacent to the stimulation and the effects on neighboring, ‘unstimulated’ neurons. Thus, here we report the development of an ‘opto-dialysis probe’ that is the first to couple selective optical stimulation with simultaneous in vivo microdialysis, allowing local measurement of neurotransmitter concentrations and application of pharmacological agents.

**Methods:** ChAT-ChR2-EYFP-BAC mice were outfitted with an optodialysis probe, aimed at the basal forebrain (BF) area, and EEG/EMG electrodes. The experiment consisted of a baseline day and an experimental day, where a 10-s stimulation paradigm was repeated every min for 2 h, using 10-ms laser pulses (473 nm) at selected frequencies (8/10 Hz). Microdialysis samples were collected every hour and analyzed by LC/MS-MS. To antagonize the muscarinic and/or nicotinic receptor-mediated input on BF GABAergic and glutamatergic neurons, atropine (50 µM) or atropine and mecamylamine (1 mM) were administered by reverse microdialysis during cholinergic stimulation.

**Results:** Using this novel tool we found that optical stimulation of BF cholinergic neurons increased wakefulness by 84 ± 9% (n = 6), increased the probability to wake, especially in the first 10 s after the start of stimulation (298 ± 74% increase in transitions from NREM sleep to wake; n = 6), and decreased NREM sleep to wake latency by ~12 s. Extracellular BF acetylcholine levels increased during stimulation, comparable to levels seen during sleep deprivation (81 ± 13% and 69 ± 13% increase from baseline respectively; n = 5). Surprisingly, the enhanced wakefulness caused by cholinergic stimulation is blocked by simultaneous reverse microdialysis of cholinergic receptor antagonists.

**Conclusion:** The wake-promoting effect of cholinergic stimulation is not primarily due to cholinergic actions in the cortex but rather to local release of acetylcholine in the BF and subsequent activation of cortically-projecting, non-cholinergic neurons.

**Support (If Any):** VA Merit Grant, NINDS R21 NS079866, NIMH R01 MH039683, Welch Foundation

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**0146**

**DO A1/C1 CATECHOLAMINERGIC NEURONS CONTRIBUTE TO SLEEP-RELATED INHIBITION OF GENIOGLOSSUS MUSCLE ACTIVITY?**

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**Introduction:** Withdrawal of excitation from brainstem catecholaminergic (CA) neurons has been suggested to mediate sleep-related atonia/hypotonia of upper airway muscles (Fenik et al., 2005). The A1/C1 neurons excite genioglossus (GG) muscle (Rukhadze et al., SFN-2014) in non-state dependent manner (Rukhadze et al., 2008). However, it is possible that the release of CA from A1/C1 terminals is modulated by sleep-related, presynaptic inhibitory mechanisms. To test this hypothesis, we used designer receptors exclusively activated by designer drugs (DREADD) technique to acutely inhibit A1/C1 neurons and assess their contribution to sleep-related inhibition of GG.

**Methods:** We used DBH-Cre mice in which Cre-recombinase is selectively expressed in CA neurons. The inhibitory DREADD (EFlaDIO-hM4Di-mCherry AAV10) was bilaterally injected into the A1/C1 regions. One week after the injections, mice were implanted for the chronic recording of the cortical electroencephalogram (EEG) and neck/GG electromyograms (EMGs). After habituation, animals were recorded 10 am–5 pm and received injections of either saline or the DREADD ligand, Clozapine-N-Oxide (CNO; 0.3 mg/kg, i.p.), at 12:00 pm. Sleep-wake states was scored in 10 s-long epochs as wakefulness, non-rapid-eye-movement (NREM) or rapid-eye-movement sleep and the mean of rectified GG and neck EMGs were quantified separately for each state in 3 hours after CNO/saline injections (n = 3 mice).

**Results:** After saline (control) injections, the magnitude of GG activity was 27.0 ± 16 during NREM sleep and 113 ± 38 during wakefulness (arbitrary units ± SE). After injections of CNO in the same animals, GG activity decreased to 22.0 ± 4.9 during NREM sleep and 95.3 ± 42 during wakefulness. The relative sleep-related inhibition of GG activity (ratio of NREM/wakefulness activity) was similar after saline (23.9%) and CNO (23.1%) injections.

**Conclusion:** Our results suggest that A1/C1 neurons may play a role in maintenance of GG tone during both wakefulness and NREM sleep. However, these results do not support the hypothesis that A1/C1 neurons contribute to sleep-related inhibition of GG activity.

**Support (If Any):** J. Christian Gillin, M.D. Research Grant, Sleep Research Society Foundation; R01 NS073613 and R01 HL116845
VII. Sleep and Arousal

0147 MEDULLARY A1/C1 CATECHOLAMINERGIC NEURONS DIRECTLY INNERVATE HYPOGLOSSAL MOTONEURONS
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Introduction: Genioglossus (GG) muscle activity is important for pharyngeal airway patency in Obstructive Sleep Apnea (OSA) patients. In recent studies we determined that acute inhibition of A1/C1 catecholaminergic (CA) neurons decreased GG muscle tone during sleep in behaving mice (Rukhadze, et al., SFN, 2014). In earlier anatomical studies (Rukhadze&Kubin, 2007) employing a conventional retrograde tracing technique, we found that A1/C1 cells project to the hypoglossal nucleus. However, spread of the tracer to surrounding regions of the XII nucleus limited our data interpretation. Therefore, in the present study, we used a conditional viral vector-based tracing method to identify A1/C1 CA input to XII mns.

Methods: We used transgenic mice, in which Cre-recombinase is selectively expressed in CA neurons under the tyrosine hydroxylase (TH) promoter. These mice received unilateral injections (10 nl) of an adeno-associated viral (AAV) vector coding for a Cre-dependent green fluorescent protein (GFP). Four weeks later, we double immunolabeled sections for GFP and TH to examine the injection site and distribution of A1/C1 CA fibers and terminal profiles in the XII nucleus.

Results: GFP-expressing TH-positive anterogradely labeled axons and terminals originating from A1/C1 neurons were largely restricted to ventral and lateral sub-divisions of the XII nucleus. The density of double-labeled fibers was relatively high in the central part of the ventral division of XII nucleus, which is where motoneurons that innervate GG muscle are located.

Conclusion: These finding suggest that CA A1/C1 neurons send direct projections to the hypoglossal motoneurons. These inputs may provide excitatory aminergic drive to GG motoneurons in a non-state-dependent manner.

Support (If Any): J. Christian Gillin, M.D. Research Grant, Sleep Research Society Foundation and R01 NS073613

0148 ACTIVATION OF THE SUPRAMAMILLARY NUCLEUS CAUSES PROLONGED WAKE WITHOUT SLEEP REBOUND
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Introduction: The ascending arousal system consists of a number of nuclei that produce wakeful behavior and cortical activation, predominately by the action of the upper brainstem parabrachial region, the posterior hypothalamus, and basal forebrain. We have recently shown that activation of the supramamillary (SuM) region of the hypothalamus results in prolonged wakefulness. Here we report the effects on rebound of sleep quantity and intensity (slow wave power) after this prolonged wakefulness.

Methods: Transgenic reporter mice (vesicular glutamate transporter 2 [vglut2]-cre) received microinjections of adeno-associated viral vectors containing an M3-muscarinic designer receptor exclusively activated by designer drugs (DREADD) into the SuM. We recorded sleep in these mice after habituation, then the injection of either vehicle or the DREADD agonist clozapine-N-oxide (CNO).

Results: Preliminary data showed that activation of the SuM produced uninterrupted wake for a mean of 8.9 hours (SD 0.11 hours) following injection of CNO, compared to a mean uninterrupted wake bout of 0.37 hours (SD 0.0079 hours) following a control injection of saline (paired t-test, p = 0.000014). However, the increased wake caused by activation of the SuM did not lead to a sleep rebound effect, measured by the average hourly accrual of sleep (mean [SD] 26.7 [13.8] min/hour after saline injection vs. 29.3 [16.7] min/hour after CNO, paired t-test, p = 0.75), or an increase in delta power (EEG fluctuations of 0.5–4.2 Hz, mean [SD] 2376 [893] after saline vs. 2391 [1013] after CNO) in non-rapid eye movement (NREM) sleep (paired t-test, p = 0.43).

Conclusion: Our preliminary findings suggest that the glutamate neurons in the SuM play an important role in wake-promotion. The lack of sleep rebound indicates that the SuM glutamate neurons may either suppress or bypass the homeostatic regulation of sleep, providing a model to study the circuits underlying sleep homeostasis.

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0149 DISTINCT MECHANISMS REGULATE THE EVOLUTION OF SLEEP LOSS IN MEXICAN CAVEFISH
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Introduction: Sleep is characterized by extended periods of quiescence and reduced responsiveness to sensory stimuli. Animals ranging from insects to mammals adapt to environments with limited food by suppressing sleep and enhancing their response to food cues, yet little is known about the genetic and evolutionary relationship between these processes. The blind Mexican cavefish, Astyanax mexicanus is a powerful model for elucidating the genetic mechanisms underlying behavioral evolution. A. mexicanus comprises an extant ancestral-type surface dwelling morph and at least five independently evolved cave populations.

Methods: The evolutionary convergence on sleep loss and changes in sensory responsiveness has been documented in cavefish. Further, cavefish have an increased number of lateral line sensory neuromasts likely to compensate for loss of vision, raising the possibility that enhanced sensory response underlies changes in sleep. To investigate the relationship between sensory processing and sleep, we ablated the sensory neuromasts and measured sleep in cave and surface fish.

Results: While neuromast ablation has no effect on sleep of surface fish, it significantly enhanced sleep in Pachón cavefish, suggesting that enhanced lateral line input underlies sleep loss in this population. Interestingly, no effect of lateral line ablation is observed in fish from the independently derived Molino cave, suggesting distinct mechanisms underlie the convergent evolution of sleep loss.

Conclusion: Enhanced sensory input or altered gating of sensory information, underlies sleep loss in Pachón population, while sleep loss in the Molino population is independent of changes in lateral line function. Current work seeks to localize the specific neuromast populations and genetic factors regulating sleep loss in Pachón cavefish. These findings highlight that distinct mechanisms can lead to the evolution of sleep loss in response to a changing environment.

Support (If Any): NSF IOS-125762
VII. Sleep and Arousal

0150
DIFFERENTIAL EFFECTS OF BEHAVIOUR AND GLOBAL AROUSAL ON CORTICAL NEURONAL ACTIVITY IN FREELY BEHAVING MICE
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Introduction: Global cortical neuronal firing rates vary with behavioral state and are modulated by preceding sleep/wake history. The origin and functional significance of differences in cortical firing patterns between waking and sleep states remains unclear. One possibility is that the higher firing rate during waking is state-dependent and merely a result of an elevated activation of arousal-promoting systems. Alternatively, cortical neuronal firing could be driven by specific behaviours rather than by global arousal or locomotor activity levels. To disentangle these possibilities, we investigated cortical multiunit neuronal activity (MUA) across a repertoire of spontaneous behavioural states ranging from sleep to active waking, including running on a wheel.

Methods: MUA was recorded from nine male C57BL/6J mice (3–4 mths, n = 4, 11–13 mths, n = 5) chronically implanted with 16 channel microwire arrays in deep cortical layers of the primary motor cortex. Recordings started at least 2–3 weeks post-surgery. Vigilance states were defined based on cortical EEG and nuchal EMG signals. For each animal, representative episodes of spontaneous waking, running wheel (RW) activity, NREM and REM sleep were selected during the dark period (LD 12:12). At least six recording channels showing robust MUA were included per animal (60 channels total, n = 9 animals).

Results: We found that cortical firing did not change uniformly across channels as a function of global state of arousal. Specifically, even within the same animal, some channels showed an increased MUA during RW activity vs. non-running waking while unexpectedly, in a greater number of channels it was reduced. Furthermore, across all animals, MUA firing rate in 38 channels (63%) was higher during non-running waking vs. running, while it was only lower in 16 recording channels (27%). RW-bouts were subdivided into 1-s epochs to determine periods of slow and fast running (relative to median running speed). Overall cortical firing rates were decreased by 19.5 ± 4.5% during fast running compared to non-running wakefulness. In most cases, neuronal firing was significantly lower during NREM and REM sleep vs. waking, but a substantial variability was apparent between individual channels, even in the same animal.

Conclusion: Overall these findings reveal that behaviour contributes significantly to cortical activity, independent of global levels of arousal. Future studies will seek to phenotype neurons which predictably change their firing during specific waking behaviours to investigate their activity patterns during subsequent sleep.

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0151
EFFECTS OF LIVING IN AN UNDERWATER HABITAT ON SLEEP PARAMETERS
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Introduction: The long-term effects of living in an underwater habitat on sleep parameters are currently unknown. We assessed the sleep of individuals conducting a 31-day stay in the Aquarius underwater research habitat 4.5 km offshore of Key Largo, Florida.

Method: Sleep data was collected using standardized electronic sleep diaries and actigraphy. Participants lived in the underwater habitat for either 15 nights (n = 6) or 30 nights (n = 3).

Results: Nine individuals participated (mean age 35 ± 12.32, 22.22% F). Diary results revealed a large effect size of sleep location on sleep onset latency (SOL; d = 0.91), such that SOL was higher while underwater (X = 17.39 min ± 8.81 min) compared to surface levels (X = 10.00 min ± 7.36 min). A large effect size of sleep location on sleep efficiency (SE) was also found (d = 0.85), with SE being lower underwater (X = 91.47% ± 4.65%) compared to surface levels (X = 94.00% ± 1.27%). Actigraphy data showed low levels of total sleep time (TST; X = 360.12 min ± 53.86 min) and low SOL (X = 4.38 min ± 1.00 min) for the duration of the mission regardless of location. Post-mission Insomnia Severity Index (ISI) results suggest that all individuals were non-insomniacs (X = 4.13, range = 1–8).

Conclusions: These results suggest that in normal healthy individuals, minimal sleep disruption (+7.5 min SOL; −2.5% SE) occurs in an underwater habitat (63 ft below the surface) for durations up to 30 days. Sleep deprivation throughout the duration of the mission may have minimized the potential impact of living at depth on sleep.

0152
UNDERLYING MECHANISMS OF SUBJECTIVE AND OBJECTIVE EXCESSIVE DAYTIME SLEEPINESS
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Introduction: Several studies have shown that objective and subjective measures of excessive daytime sleepiness (EDS) are weakly associated, which precluded a good understanding of the underlying mechanisms of EDS. Pro-inflammatory cytokines such as interleukin-6 (IL-6) are suggested to be fatigue-inducing, while activation of the HPA axis supresses sleepiness. Our aim was to assess the mechanisms that underlie both subjective and objective EDS based on IL-6 and cortisol levels.

Methods: We studied 103 research subjects (74 men; 50.48 ± 9.39 years) who underwent in-lab polysomnography for 4 consecutive nights and serial 24-hour plasma measures of IL-6 and cortisol obtained during the 4th day. Objective sleepiness was assessed with the Multiple Sleep Latency Test (MSLT: 6 naps on the 4th day) and defined by mean MSLT value ≤ 8 min. Subjective EDS was assessed with the Epworth Sleepiness Scale (ESS) and defined by ESS > 10. Depressive symptoms were assessed with the Beck Depression Inventory-II (BDI-II). Twenty-four-hour plasma IL-6 and cortisol level were analyzed using MANOVA, controlling for age, sex, gender, AHI, BMI, and BDI-II score.

Results: Subjects with objective EDS had elevated mean 24-h IL-6 secretion, particularly during the 18:00–6:00 period (p = 0.02), as compared to subjects without objective EDS. Subjects with subjective EDS had marginally decreased 24-h cortisol levels as compared to subjects without subjective EDS (p = 0.15). In fact, mean cortisol levels were lower and IL-6 secretion highest in subjects with subjective EDS coupled with a complaint of subjective EDS, as compared to those without EDS or with either subjective or objective EDS only.

Conclusion: These data indicate that the underlying mechanisms of subjective vs objective EDS differ, which may explain the weak association of these two seemingly similar variables and suggest that possibly they reflect two different CNS functions.

Support (If Any): R01 HL64415
HEMISPHERIC ASYMMETRY IN VIGILANCE AND AROUSAL DURING SLOW-WAVE SLEEP IN ASSOCIATION WITH THE FIRST-NIGHT EFFECT IN HUMAN
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Introduction: Marine mammals and migrating birds show a half-awake-half-asleep state by interhemispheric asymmetry in sleep when complete sleeping is challenging; they can sleep deeply in only one hemisphere of the brain, leaving the other less asleep. Here we found that an interhemispheric half-awake-half-asleep state occurs even in human sleep as a result of measuring vigilance for each hemisphere during the first night sleep (first-night effect: FNE) in which sleep does not deepen. We examined an evoked brain potential, the N3, as vigilance using an oddball paradigm by presenting tones to one brain hemisphere. If the FNE involves the interhemispheric half-awake-half-asleep state, the N3 to deviant stimuli should be larger in one hemisphere than the other on Day 1 with the FNE, and not on Day 2 without the FNE.

Methods: Two types of subthreshold auditory stimuli, deviant (10%, 2000 Hz) and standard (90%, 1000 Hz) tones, were presented to one brain hemisphere randomly while subjects were asleep, which was determined polysomnographically.

Results: The result showed that deviant tones presented to the left hemisphere induced not only significantly larger N3, but also arousals more often than those to the right, specifically during slow-wave sleep stage on Day 1. The hemispheric asymmetry in vigilance was vanished on Day 2.

Conclusion: Our results suggest that the human brain involves an interhemispheric half-awake-half-asleep under the FNE in which humans may have to keep some degree of alertness in a new environment.

PSYCHOPHYSIOLOGICAL STRESS REACTIVITY IN INDIVIDUALS WITH DIFFERENT STRESS-RELATED SLEEP VULNERABILITY
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Introduction: Sleep vulnerability to stress, as measured by the Ford Insomnia Response to Stress Test (FIRST), has been proposed to be a predisposing factor for insomnia. Previous studies have shown that the score on the FIRST are associated with arousal related subjective measures, such as rating scales for emotional valance, neuroticism and extraversion. However, its association with psychophysiological stress reactivity has not been established. The current study aims whether sleep vulnerability is also associated with stress reactivity as measured by objective psychophysiological measures.

Methods: 21 normal young adults were recruited and were divided into two groups (high vs low vulnerability) based on their scores on the FIRST (cut-off = 19). All participants underwent two different stress task, speech stress and cognitive challenge with the PASAT. The ANS reactions, includes skin conductance, peripheral temperature, and heart rate, were recorded throughout the experimental procedure, including 3-minutes baseline, two periods of stress challenges (3 minutes), and 6 minutes of rest were inserted after arousal stimulations.

Results: High vulnerable individuals showed higher skin conductance response (23.23 ± 9.14 vs. 17.91 ± 7.80) and heart rate (104.15 ± 20.37 vs. 99.01 ± 15.94) than low vulnerable individuals while undergoing the stress tasks; however, the difference between the two groups only approached significant level (SCR: F = 1.96, p = 0.177; HR: F = 3.319, p = 0.085). Low vulnerable group (0.06 ± 0.036 vs. 0.035 ± 0.024.) shows the trend of better recovery from stress on finger temperature (p = 0.082).

Conclusion: The results show that high sleep vulnerability individuals have the tendency to show higher stress reactivity and longer recovery time than low vulnerability population. Future study required more subjects to determine the psychobiological mechanisms of sleep vulnerability.

FLIPPING THE SLEEP SWITCH ON OR OFF (PROCESS O) ALLOWS THE RECUPERATIVE EFFECTS OF BRIEF NAPS AND EXTENDED SLEEP FOLLOWING NOCTURNAL AWAKENINGS
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Introduction: A novel sleep process, Process O (onset/offset of sleep), has been proposed to account for the significant recuperative effects of brief naps (10 minutes of sleep) since little, if any, dissipation of homeostatic drive (Process S) would occur in that brief light sleep period. It is suggested to operate similar to Process S but have less strength and much shorter time constant. It was seen as operating on the ‘sleep switch’ such that when it is ‘flipped’ to sleep during the day there is a rapid dissipation of a limited but significant amount of wakeful inhibition accumulated by Process O. It is hypothesized here that Process O should also have a symmetrical effect such that when a brief awakening interrupts nocturnal sleep it should rapidly dissipate the inhibition to continued sleep and allow extended sleep when sleep resumes. PSG recordings of normal sleep generally show longer sustained bouts of sleep following awakenings late in the sleep period than would be predicted by a largely dissipated Process S. It has been suggested that Process C, the circadian effect with maximum circadian sleepiness at the end of the normal sleep period helps to sustain sleep. The circadian effect can be removed in a forced de-synchrony routine by examining the ends of forced sleep periods (last 3 hours) not falling in the maximum circadian sleepiness phase.

Methods: Analysis of these periods was carried out in twenty normal good sleepers undergoing forced de-synchrony routine.

Results: We found generally longer sleep bouts after awakenings than would be predicted by Process S alone.

Conclusion: These results were consistent with the predictions of Process O that ‘flipping the switch’ to the opposite state for only a brief time dissipates the inhibition to the previous state and helps to maintain the previous state, once it resumes.

Support (If Any): Flinders University Research Grant
CORTICAL RHYTHM MODULATIONS BY REPEATED SLEEP RESTRICTION AND RECOVERY
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Introduction: This study investigated the effects of repeated sleep restriction and recovery on cortical oscillations, which represent fundamental characteristic of brain activity and facilitate the coordination of local and long-range brain networks in response to cognitive demands.

Methods: Continuous electroencephalograms (EEG) were first recorded during a 24-h baseline period with 8 h of sleep opportunity (1:2 sleep-to-wakefulness ratio). This was followed by 4 cycles, each including 3 24-h periods of sleep restricted to 4 h (1:5 ratio) and 24-h where recovery sleep was permitted. EEGs (channels F3, F4, C3, C4, O3, O4) were recorded continuously during the 3rd 24-h period of each cycle and the 24-h recovery period at the end of cycle 4. Forty-five adult subjects were randomly assigned to the control and sleep restricted groups. A sub-cohort of six subjects from each group (a total of 12 subjects) were included in this preliminary analysis of cortical oscillations. EEGs were sampled at 200 samples/s and low-pass filtered during acquisition with a 60 Hz cutoff. They were decomposed using a time-domain method, with a 10-s sliding analysis window, to identify dominant brain oscillations. Characteristic oscillation frequencies were estimated from their auto-correlation function. Mean (over each time window) oscillation amplitudes were also estimated.

Results: Non-significant frequency fluctuations were estimated throughout the recordings for all identified oscillations. Significant decreases in frequency, for oscillations in the range 1–30 Hz, were measured during transition periods from wakefulness to sleep (p < 0.001) but not during sleep restriction, where frequency fluctuations were similar to those during other periods of wakefulness (p ≥ 0.1). Mean oscillation amplitudes, averaged over all EEG channels, fluctuated substantially during baseline and normal sleep-wakefulness periods. In the sleep restricted group, the amplitude variability at the end of the 1st and 2nd cycles was statistically identical to that of the baseline period (p ≥ 0.3), but significantly lower at the end of the 3rd and 4th cycles (p < 0.01), and during the last recovery period (p < 0.05).

Conclusion: These initial results suggest potentially cumulative effects of repeated sleep restriction on brain oscillations that may not be reversible during recovery, at least in the short run.

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THE EFFECTS OF SEASONALITY ON SLEEP AT THE POLAR LATITUDES
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Introduction: At the polar latitudes, there are drastic changes in natural light levels between seasons. Light exposure has an influence on the circadian system, which can have a significant influence on sleep. Disruptions in the circadian system and sleep have been reported to be associated with cardiac disease, obesity and diabetes among others. Because of this, our aim was to determine if sleep and sleep times were affected when exposed to ~5.5 hours (winter solstice) versus ~12 hours of natural light (spring equinox), while participants lived in a real world setting at 61° latitude.

Methods: We conducted a within-subjects outpatient study (one week during the solstice and one week during the equinox). Eight participants (30.8 ± 5.6 yrs; 4 women) lived in their homes and had their sleep recorded with sleep diaries and portable sleep monitors (measured individual sleep stages).

Results: During extended periods of natural darkness (winter solstice) participants had significantly later wake times (p < 0.0125), when compared to during the spring equinox. Additionally, participants went to bed later on the weekend when compared to the weekdays during the solstice and the equinox (p < 0.0125). There was a nonsignificant trend for participants awakening earlier during weekdays when compared to weekends during both the equinox and solstice. There were no significant changes in sleep stages between the days of the week or seasons, however participants fell asleep significantly faster during the equinox (7-day average; p < 0.0125).

Conclusion: Even in real world situations with artificial light, the shifts in natural light throughout the seasons seemed to have an impact on sleep timing. Taken together, these results suggest that even with the impact of artificial light, the seasonal changes of natural light impact sleep, which might have impacts on the underlying physiology, health and disease.

APNEA FREQUENCY PEAKS IN ASSOCIATION WITH REM-ONSET IN ZUCKER RATS
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Introduction: Pontogeniculooccipital (PGO) waves are phasic brainstem events that increase in frequency just prior to and during REM. It has also been suggested that PGO waves may disturb respiratory rhythm. To test this hypothesis, we examined the probability distribution of spontaneous apneas during NREM sleep to REM sleep transitions in rodents.

Methods: Adult male Zucker lean rats (N = 8) were instrumented for chronic polysomnography with EEG and nuchal EMG electrodes. Respiration was recorded by single chamber plethysmography. After adaptation to the apparatus, each animal was recorded from 12:00 to 08:00 the following day. A MATLAB script was developed to extract the latencies of apnea events (pauses ≥ 2 s in duration) that occurred within 300 seconds preceding or following a NREM to REM state transition.

Results: As expected, apnea frequency during NREM sleep (9.46 ± 1.49 apneas/h) was significantly (p < 0.05) lower than the frequency during REM sleep (27.3 ± 4.3/h). However, these frequencies were not uniform around NREM to REM transitions. In particular, the pooled histogram demonstrated increasing apnea frequency beginning 100 seconds before REM onset; a sharp peak of 86.6 apneas/h 10–20 seconds before REM onset; an elevated frequency (32.7/h) during the first 30 seconds of REM sleep; and diminishing thereafter. However, apnea frequency diminished sharply as REM sleep progressed beyond this point. The observed distribution of apnea about NREM to REM transitions differed significantly from one constant frequency during NREM to a higher frequency during REM sleep.

Conclusion: Our observations demonstrate an increase in apnea frequency during NREM sleep just prior to REM onset and a falloff of apnea frequency as REM sleep progresses. These patterns are consistent with the previously described pattern of PGO wave activity during NREM to REM transitions, further supporting a potential impact of PGO waves on breathing pattern during sleep.
**A. Basic Sleep Science**

**0159**

**EFFECTS OF INTERMITTENT HYPOXIA (IH) ON GLUCOSE METABOLISM AND IN VIVO CALCIUM SIGNALING IN HEPATOCYTES**

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**Introduction:** Sleep-disordered breathing is associated with altered glucose metabolism. Studies using animal models have shown that IH induces fasting hyperglycemia. Hepatic glucose output primarily determines fasting glucose levels and is modulated by calcium-dependent and -independent pathways. Murine hepatic calcium signaling is altered by in vivo IH exposure. The current study sought to characterize the calcium pathways that may be involved in alterations of intracellular calcium concentration ([Ca\(^{2+}\)]\(_i\)) and glucose output levels in murine hepatocytes.

**Methods:** Adult male C57BL/6J mice were exposed to IH or intermittent air (IA) for 7 days. Hepatocytes were isolated from both groups of animals and [Ca\(^{2+}\)]\(_i\) was assessed using Fura-2 AM and fluorescence microscopy imaging in cells perfused with normal and calcium-free extracellular solution. To quantify glucose output, the isolated hepatocytes were incubated in control media overnight and then maintained in glucose-free media with or without calcium for four hours, after which the media was sampled to measure basal glucose production.

**Results:** Fasting blood glucose levels were higher in mice exposed to IH compared to IA. [Ca\(^{2+}\)]\(_i\) was higher in hepatocytes isolated from mice exposed to IH. Switching to calcium-free solution showed a trend toward greater decrease from baseline in mice exposed to IH. Basal total glucose output from isolated hepatocytes increased with IH compared to IA (569.50 ± 33.53 vs. 400.25 ± 20.95 µg glucose/mg protein, p = 0.02) and decreased in calcium-free media with both IH and IA (315.30 ± 51.64 vs. 231.55 ± 13.47 µg glucose/mg protein).

**Conclusions:** Intermittent hypoxia in vivo increases intracellular calcium signaling in hepatocytes, with extracellular calcium appearing to contribute to this alteration. Extracellular calcium also contributes to the increased glucose output induced by IH in vivo. These findings provide a potential mechanism that may explain fasting hyperglycemia observed in murine models of IH and suggest a putative causal pathway for alterations in glucose metabolism with sleep-disordered breathing.

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**0160**

**SLEEP DISTURBANCE IS ASSOCIATED WITH INCREASED RISK FOR HIGH GLUCOSE LEVELS**

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**Introduction:** Sleep disturbance has been linked to metabolic disorders in the adult. Little is known how sleep disorders affects metabolic function in school-aged children. This study examined the association between sleep disturbances and blood glucose levels in a sample of Chinese children.

**Method:** As part of the China Jintan cohort project, 1101 school aged children participated in this study. Both fasting plasma glucose levels and sleep patterns were assessed when children were 11–13 years old. The Chinese version of the Child Sleep Habits Questionnaire (CSHQ) was used to assess parent-reported child’s sleep with high scores indicating more severe sleep problems. A total of 729 children with available data on fasting plasma glucose and sleep was included for the current study. Fasting plasma glucose was dichotomized into two levels (< 5.5 mmol/L as normal, ≥ 5.6 mmol/L as Pre-diabetes/diabetes), and one-way ANOVA was used to compare the CSHQ subscale scores between the two groups.

**Result:** Mean age at sleep assessment was 11.05 years old (SD = 0.88), 53% were males. Mean blood glucose levels were 5.13 mmol/L (SD = 0.54). The CSHQ subscale scores of impaired group were higher compared with normal blood glucose group. Compared with children in normal-glucose group, children in impaired-glucose group had a significant increase of 2.14 for total sleep score (p = 0.034), 0.51 for sleep anxiety score (p = 0.016), and 0.63 for sleep parasomnia score (p = 0.041).

**Conclusion:** Our findings suggest that sleep disturbance is associated with increased fasting glucose levels, which is associated with a higher risk for the later development of type 2 diabetes. Further research is warranted to examine the long-term impact of childhood sleep problem on glucose homeostasis.

**0161**

**INTERACTION BETWEEN REPRODUCTIVE HORMONES AND SLEEP IN MIDLIFE WOMEN**

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**Introduction:** As women approach menopause, worsening sleep quality has been hypothesized to be due to the changing hormonal milieu, characterized by increasing follicle stimulating hormone (FSH) and fluctuating and declining estradiol levels, along with erratic menstrual cycle-related hormonal changes. Here, we aimed to assess the interaction between polysomnographic (PSG) sleep measures and concurrent reproductive hormone levels in a sample of midlife women.

**Methods:** Thirty-three perimenopausal women aged 43–52 y had in-lab PSG recordings during the preovulatory follicular phase (FP) of their menstrual cycle. Serum samples were collected and analyzed for estradiol, progesterone and FSH. PSG and hormones were also assessed on one night in the postovulatory luteal phase (LP) of the menstrual cycle in a sub-sample of fourteen women.

**Results:** In the FP, FSH was positively associated with PSG measures of wake after sleep onset, number of awakenings and arousals and negatively associated with sleep efficiency (all p’s < 0.05) independent of age, body mass index and presence of objective hot flashes. No associations were found between FSH and the duration of any sleep stage. When progesterone levels were raised (9.0 ± 5.6 ng.ml-1) in the LP compared to the FP, women (n = 14) had more awakenings (FP: 16.3 ± 5.7; LP: 21.6 ± 4.1; p = 0.003) and arousals (FP: 44.9 ± 16.5; LP: 58.3 ± 17.4; p = 0.020), and more sleep stage shifts (FP: 0.29 ± 0.06; LP: 0.33 ± 0.05; p = 0.048). There were no differences in the percentage of time spent in N1, N2, N3 and rapid-eye-movement sleep between the FP and LP.

**Conclusion:** Higher levels of FSH are strongly associated with PSG-derived measures of wakefulness in perimenopausal women who still have menstrual cycles. Also, women had poorer sleep in the LP compared to the FP of their menstrual cycle. Our results indicate an interaction between the hypothalamic-pituitary-ovarian axis and sleep-wake regulatory systems in midlife women.

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0162  
**GENDER EFFECT FOUND IN THE ASSOCIATION BETWEEN OVERNIGHT BREATHING RATE VARIATION AND REPORTED SLEEP QUALITY SCORES**  
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**Introduction:** The relationship between objective sleep parameters, derived from polysomnography (PSG), and subjective sleep quality has been researched thoroughly in the past. Yet, correlations between other objective measures, such as respiratory parameters, and subjective sleep quality have not been analyzed. We expect that a stable sleep, seen in, for example, a low breathing rate variation overnight, is indicative for a good sleep quality rating.  

**Methods:** Data from the SIESTA project was used, consisting of 165 healthy participants (age 51.8 ± 19.4 years; 88 females). Participants spent two consecutive nights in a sleep laboratory, where a complete PSG was assessed. From the PSG two parameters were derived: mean breathing rate (BR) and mean standard deviation of breathing rates (SDBR). In addition, participants filled out every morning the self-rating questionnaire for sleep and awakening quality (SSA). Spearman’s rho correlation analyses were conducted to analyze the association between the SSA score and the two respiratory parameters.  

**Results:** Positive correlations were found between SDBR and the total SSA score (night 1: \(r = 0.179, p = 0.024\); night 2: \(r = 0.213, p = 0.007\)). However, the correlation coefficient was not high, implicating that the association is weak. A gender effect was observed in both nights, as significant correlations were found between SDBR and total score on SSA for females (night 1: \(r = 0.263, p = 0.014\); night 2: \(r = 0.300, p = 0.005\)), but this was not the case for males.  

**Conclusion:** The association between breathing rate variation and the SSA score was more profound for females. However, these correlations were not as high as we expected. If future research can find a strong relationship between other objective sleep parameters and subjective sleep quality ratings, this would mean that predictions can be made about how someone has slept.  

0163  
**CALCULATING UPPER AIRWAY NEURAL RESPONSE FROM AIRFLOW MEASUREMENTS AT ATMOSPHERIC PRESSURE**  
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**Introduction:** We hypothesized that spontaneous variability of \(V_{\text{max}}\) at atmospheric pressure would reflect a spectrum of passive and active states, which can be used to estimate passive and active \(P_{\text{crit}}\) and the upper airway neuromuscular response (\(\Delta P_{\text{crit}}\)).  

**Methods:** In 7 subjects, active and passive standard \(P_{\text{crit}}\) were measured and compared to calculated \(P_{\text{crit}}\). The latter was derived from breath-by-breath \(V_{\text{max}}\) measurements at atmospheric pressure in ~70 flow limited breaths during a 5–10 min period of sleep. The mean \(P_{\text{crit}}\) (-\(R_{u} \times V_{\text{max}}\)) was calculated from breaths in the 5\(^{\text{th}}\) and 95\(^{\text{th}}\) percentiles of \(V_{\text{max}}\) to define the calculated passive and active \(P_{\text{crit}}\) respectively. \(R_{u}\) from previously published population mean (22.9 cm H\(_{2}\)O/L/s) was used for both the passive and active condition. The \(\Delta P_{\text{crit}}\) was computed to determine the upper airway neural response.  

**Results:** For the group, no differences between standard and calculated passive, active and \(\Delta P_{\text{crit}}\) were observed.  

**Conclusion:** Capitalizing on spontaneous variability of \(V_{\text{max}}\) at atmospheric pressure, we demonstrated that active \(P_{\text{crit}}\) and \(\Delta P_{\text{crit}}\) neural responses can be characterized from flow measurements at atmospheric pressure during baseline sleep studies.  

0164  
**SLOW WAVE SLEEP IN A DAYTIME NAP DIFFERED IN INDIVIDUALS WITH/WITHOUT EXERCISE BEHAVIOURS AND SHORT SLEEP DURATION**  
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**Introduction:** Previous research showed that exercise and sleep restriction could lead to an increase in slow wave sleep (SWS) in nocturnal sleep. SWS has been found to relate to enhanced cognitive abilities, e.g. memory, as well as restoration of bodily functions after exercise. While we recently found that exercise habits interacted with short sleep duration (SSD) in predicting cognitive functions, we here investigated whether exercise experience interacted with habitual sleep duration in affecting individuals’ sleep physiology during a daytime nap.  

**Methods:** Participants included 48 university students (aged 17–25, 39.6% male). Participants reported exercise experience and sleep-wake behaviours throughout the 7-day experimental protocol and came to a laboratory to have 90-minute polysomnography-monitored nap at about 2:30–4 pm on the 6th day. Based on their self-report measure, 47.9% of participants were classified as Exercisers (> 150 minutes of moderate-intensity or > 75 minutes of vigorous-intensity exercise per week) and less than an average of 6.5 hours of sleep throughout the protocol was classified as SSD (52.2% exercisers, 32% sedentary adults).  

**Results:** No significant group differences for gender, age, body mass index was found (\(ps > 0.05\)). A 2x2 factorial design, with two between subject factors (exercise and sleep duration), revealed a significant interaction effect between exercise and sleep duration on SWS, \(F(1,47) = 7.21, p = 0.010\). Exercisers without SSD were found to have significantly fewer SWS than exercisers with SSD (mean difference = −11.045, \(p = 0.018\)) and sedentary adults without SSD (mean difference = −12.487, \(p = 0.004\)).  

**Conclusion:** This was the first study reporting the sleep physiology during a daytime nap among exercisers with/without habitual SSD. Exercisers’ SWS during daytime napping was found to depend on habitual sleep duration. It might be possible that exercisers without SSD had sufficient SWS at night, and therefore had fewer SWS during the daytime nap, than both exercisers with SSD and sedentary adults without SSD. The lack of significant results in the comparison between sedentary adults with SSD with the other three groups may be due to small sample size.  

0165  
**STATES OF REDUCED BRAIN AROUSAL AGGRAVATE OPIOID-INDUCED RESPIRATORY DEPRESSION IN RATS**  
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**Introduction:** Drugs acting on \(\mu\)-opioid receptors (MOR) are widely used in pain management or as drugs of abuse, but present unwanted side-effects, such as sedation and life-threatening cardio-respiratory depression. Although mortality and morbidity related to MOR drugs are major health issues, our understanding of opioid-induced respiratory depression is limited because their mechanisms of action on physiological and brain functions are unclear. For instance, major breathing disorders can occur during sleep, but it is unknown whether respiratory depression by MOR drugs is more severe in states of reduced arousal such as sleep, especially considering that these drugs also have potent sedative properties. We aim to determine whether respiratory depression by MOR drugs is aggravated in states of reduced arousal, such
as sleep, sedation or anesthesia. We evaluated the impact of systemic administration of a clinically-relevant MOR drug on cardio-respiratory and brain functions in states of reduced arousal either naturally-occurring during sleep or induced by anesthetics.

Methods: By combining electrophysiological, respiratory and cardiac recordings in freely-behaving and anesthetized adult rats, we compared the cardio-respiratory and electrocortical responses to systemic injections of saline or the MOR agonist fentanyl (0.1 μg/kg).

Results: We first found that fentanyl induced a sedative state characterized by reduction of high (β2: 20–30 Hz) electrocortical frequencies and increased low (δ1: 2–4 Hz) frequencies (P = 0.02, n = 8). Fentanyl also reduced the time spent awake (P = 0.001) and eliminated REM sleep. Fentanyl initially increased respiratory variability (P = 0.006, n = 8) and then depressed respiratory rate (by 30–42%, P < 0.001). Further analysis of electrocortical and respiratory activities showed that respiratory depression was more severe when arousal was reduced (low β2 power) than when arousal was high (high β2 power) (P = 0.01, n = 8). We also exposed adult rats to different levels of ischemic anesthetia and identified that respiratory depression by fentanyl was more pronounced in deep anesthesia (isoflurane 2%) than in light anesthesia (1%) (P = 0.036, n = 5).

Conclusion: Our data show that respiratory depression by MOR analggesics was aggravated in states of reduced arousal such as sedation, sleep or anesthesia. A state-dependent effect of MOR analgesics is clinically-relevant because a dose deemed effective and safe in wakefulness may induce severe respiratory depression when the patient is asleep or under anesethesia.

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0166 SLEEP FACILITATION BY ARTIFICIAL CARBONATED BATHING OF 38°C AND 40°C; EEG, CORE, PROXIMAL, AND DISTAL TEMPERATURE EVALUATIONS  

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Introduction: Bathing, especially with hot spring with various mineral compositions, is known to facilitate/improve sleep by warming the body. Previous our study examined that Japanese hot spring bathing and artificial carbonated bathing more specifically affected body temperature and sleep. In this study, we evaluated the effects of usual (plain hot water of 40°C, PH40) and artificial carbonated bathing of 40°C (ACB40), 38°C (ACB38) on sleep using clinical thermometers and EEG.

Methods: Eight healthy men (average age 20.1 years) were included in the study. The subjects were divided into 3 groups and each group received the PH40 and ACB40, ACB38 (100 ppm, ph 4.7; Carbonic Nano; Crystal Giken CO., LTD) a week interval. Subjects soaked in the bath deep enough their chests touched the water at 22:00 for 15 min. From the time they finished bathing to the next morning, we measured their core body temperature (CT: rectum), distal skin temperature (DT: top side of the foot), proximal skin temperature (PT: lower part of the clavicle) and EEG using a single channel portable device (Moomin-kei SleepWell). Subjects were told to sleep from 24:00–7:00. This study was approved by the Akita University Ethics Committee.

Results: In EEG, the meaningful difference was not seen between 3 conditions. CT significantly increased in the order of ACB40, PH40 and ACB38 (p < 0.05) and declined in the same order during initial 40 minutes after bathing (p < 0.05), respectively. The early-morning minimum CTS were in the same order (p < 0.05). In the ACB38, DT significantly decreased and PT increased, therefore DPG remain smaller value than other 2 groups.

Conclusion: At ACB38, DPG became the small value, and there was little heat radiation of the temperature, therefore there were few night temperature drops. It is reported that parasympathetic system becomes dominant in the baths less than 39°C and sympathetic system becomes dominant in the baths more than 40°C. However, our result brought good sleep in ACB of 40°C. It would be one of the reasons that subjects were healthy young men without sleep problems.

0167 ENERGY METABOLISM DURING SLEEP ADJUSTED FOR SLEEP STAGE IN YOUNG ADULTS  

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Introduction: Metabolic rate during sleep is affected by time after sleep onset and different sleep stages reflecting different physiological process. Some, but not all, previous studies reported differences in sleeping metabolic rate (REM, stage 1,2 > SWS). Time course of sleeping metabolism free from the effect of sleep stages, which is unevenly distributed during the sleep, has never directly been addressed. The purpose of this study is to clarify both effects of sleep stages and sleeping time on sleeping metabolism (energy expenditure, RQ; respiration quotient, substrate oxidation).

Methods: Young subjects free from pathological condition participated in the study, in which polysomnography recording and indirect calorimetry in a metabolic chamber were performed. To get the whole picture of sleeping metabolic rate, we studied the time course of sleeping metabolic rate using semi-parametric regression approach, i.e. effect of sleep stage by parametrical and sleeping time course by non-parametrical analysis.

Results: Energy expenditure, RQ and carbohydrate oxidation were different among sleep stages. After controlling for sleep stage, energy expenditure decreased particularly during the first half but not during the second half of the sleep. RQ and carbohydrate oxidation decreased during the first half but increased during the second half of the sleep.

Conclusion: Energy expenditure, RQ and carbohydrate oxidation are affected by sleep stage and time after sleep onset.

0168 THE EFFECTS OF MACROPHAGE DEPLETION ON SLEEP  

Szentirmai É

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Introduction: The role of specific cellular elements in the interactions between the immune system and sleep is not completely understood. Macrophages have been implicated in the production of somnogenic substances in response to bacterial or viral challenge. In the present experiments we tested the hypothesis that intact macrophage function is also required for physiological sleep responses, such as recovery after sleep loss and sleep in cold environment. Clodronate-containing liposomes (CCL) were used to kill macrophages. During the first 24–48 h after treatment, CCL induces the release of bioactive substances from disintegrating macrophages while the number of functional macrophages gradually declines. Subsequently, a steady-state state develops when macrophage number stabilizes around 30% of the normal. We studied sleep during the first, dynamic phase after CCL treatment as
well as responses to sleep loss and cold during the macrophage-depleting, steady-state.

**Methods:** Male C57BL/6 mice, instrumented for sleep recording, received intraperitoneal (ip) injections of isotonic saline or CCL (0.2 ml/mouse) 10 minutes before dark onset. Sleep-wake activity and body temperature was measured to determine the acute effects of macrophage depletion. One week after CCL treatments, the effects of sleep deprivation by gentle handling and cold exposure (10°C) were measured.

**Results:** 1) Intraperitoneal injection of CCL elicited an immediate increase in non-rapid-eye movement sleep (NREMS) and body temperature as well as decreases in rapid-eye movement sleep (REMS), motor activity and EEG slow-wave activity. 2) Rebound sleep increases after sleep deprivation were significantly attenuated, by about 40%, in macrophage-depleted mice; there was no significant difference in the EEG SWA responses of the two groups. 3) In the cold, macrophage-depleted mice had significantly suppressed NREMS and increased wakefulness as compared to controls.

**Conclusion:** Intact macrophage function is required for normal sleep in cold environment as well as for recovery sleep responses after sleep loss.

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**0169**

**BROWN ADIPOSE TISSUE PLAYS A CENTRAL ROLE IN PROMOTING SLEEP IN SYSTEMIC INFLAMMATIONS**

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**Introduction:** Our previous work identified brown adipose tissue (BAT) as a source of peripheral sleep-inducing signals. The sleep-inducing property of BAT is conferred by the tissue-specific presence of uncoupling protein 1 (UCP-1). Since systemic inflammation greatly affects sleep and the function of BAT, we hypothesized that sleep responses to inflammation may be mediated by BAT-derived signals. To test this, we determined the effects of systemic inflammation on sleep and body temperature in UCP-1 KO and WT mice. Intraperitoneal (ip) injections of lipopolysaccharide (LPS), tumor necrosis factor alpha (TNF) and interleukin-1 beta (IL-1) were used as a model for acute, systemic inflammation.

**Methods:** Male WT and UCP-1 KO mice were instrumented for sleep and body temperature recordings. The animals were kept at 30°C. At dark onset, mice were injected ip with saline on the control day and with 0.3 or 1 ug TNF, 0.4 ug IL-1 or 100 ug/kg LPS on the experimental day. Sleep, body temperature and motor activity were recorded for 24 h after each treatment.

**Results:** In WT mice, NREMS increased by 85% after LPS and 45% after IL-1 injection for 12 h. Administration of TNF led to dose-dependent increases in NREMS. All sleep responses were completely abolished in UCP-1 KO animals. LPS, IL-1 and 1 ug TNF elicited biphasic changes in body temperature; after an initial hypothermia, temperature increased for 12 h in WT mice. In KOs, the hypothermic phases were abolished but increases in body temperature were not affected. LPS and both cytokines suppressed motor activity. There were no significant differences in the activity responses of WT and UCP-1 KO mice.

**Conclusion:** Present results indicate that BAT plays an essential role in generating sleep responses that accompany systemic inflammatory conditions. The febrile responses, however, are independent of the thermogenic activity of BAT.

**Support (If Any):** Faculty Seed Grants to LK and ES by Washington State University.

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**0170**

**THE RELATIONSHIP BETWEEN REM SLEEP AND THE CORTISOL AWAKENING RESPONSE (CAR) FOLLOWING STRESS EXPOSURE**

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**Introduction:** Research has shown sleep and stress to be inextricably linked, with daytime stress affecting the composition of subsequent sleep, and sleep affecting next-day stress reactivity. REM sleep may play a particularly important role in the processing of stressful experiences. One marker of the relationship between sleep and stress is the cortisol awakening response (CAR), a sharp increase in cortisol that occurs upon awakening from sleep. The CAR is a reliable biomarker of HPA activity and has high intra-individual reliability over time. Although previously experienced and perceived upcoming stress is known to influence the CAR, the relationship of sleep and specific sleep stages to the CAR remains unclear. We tested the hypothesis that REM sleep would be positively related to the magnitude of the CAR.

**Methods:** Participants arrived for the first session at ~4:00 pm and underwent a validated psychosocial stress task or a non-stressful control task, followed by an hour of saliva sampling in 15-minute increments. Participants returned at 10:00 pm for a night of polysomnograph-recorded sleep. The next morning, salivary sampling recommenced upon awakening and throughout the first hour of arousal, again in 15-minute intervals.

**Results:** As predicted, percentage of REM sleep positively correlated with salivary measures of next-day CAR (area under the curve with respect to increase; AUCi), but only when the previous day included exposure to the psychosocial stressor (r = 0.49, p = 0.038). Control participants did not demonstrate this relationship between REM sleep and CAR (r = 0.21, p = 0.41).

**Conclusion:** These results provide additional support for the findings connecting previous stress with subsequent morning CAR. We also found that the relationship between the CAR and sleep architecture may be moderated by an acute stressor. Specifically, following stress exposure, the amount of REM sleep may predict the degree to which a previously stressed individual is prepared for the next day, perhaps in anticipation of additional stressors.

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**0171**

**MECHANISM OF POST-EVENT TACHYCARDIA IN PATIENTS WITH OBSTRUCTIVE SLEEP APNEA**

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**Introduction:** Heart rate (HR) increases following obstructive events in patients with obstructive sleep apnea (OSA). We recently demonstrated that post-event tachycardia is largely due to sub-cortical reflexes and only partially due to cortical arousal. The nature of these reflexes remains unknown. HR is known to increase with increased minute ventilation (VE). We wished to determine the extent to which post-event tachycardia is related to post-event increase in VE.

**Methods:** 31 patients with severe OSA were placed on Continuous-Positive-Airway-Pressure (CPAP). CPAP was reduced during sleep to produce obstructive events. CPAP was increased after three obstructed breaths, terminating obstruction before it was terminated spontaneously. Breath-by-breath HR and VE were measured for the first two breaths after release of the obstruction in observations without arousal (B1, B2). To determine HR response to ventilatory stimulation in the
absence of obstruction or arousal, some dial-downs were preceded by hypercapnic and/or hypoxic breathing for 30 seconds, inducing a range of ventilatory stimulation during which breath-by-breath VE and αHR were determined. The HR response to ventilatory stimulation (αHR/VE) was calculated from these observations. In each patient the increase in HR in the first two post-event breaths was compared to the increase expected from the αHR/VE at the observed post-event VE levels.

**Results:** αHR/VE ranged 0 to 0.91 beats.L-1.m in different subjects (0.43 ± 0.28). The post-event changes in HR, relative to pre-dial-down HR, ranged −2.7 to 5.8 beats.min-1 in B1 (1.2 ± 2.2; p < 0.02) and −1.7 to 6.9 beats.min-1 in B2 (2.3 ± 2.4; p < 0.001). The difference between observed and expected αHR was −0.06 ± 2.02 min-1 for B1 and 0.55 ± 2.00 min-1 for B2. Neither value was significant.

**Conclusion:** Post-event tachycardia in OSA in the absence of cortical arousal can be entirely explained by the post-event increase in ventilation.

**Support (If Any):** Supported by Canadian Institutes of Health Research.

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0172

**CARDIAC ACTIVITY IN ADULTS WITH AUTISM BEFORE AND AFTER SLEEP**

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**Introduction:** Poor sleep is a frequent finding in autism and has been shown to interfere with daytime functioning in adults with autism (Limoges et al., 2013). Literature in typically developing individuals (TD) shows that sleep also influences the regulation of the autonomic nervous system so that the sympathovagal tone is normally higher in the morning compared to evening. Electrocardiographic (ECG) studies suggest the existence of a sympathetic-parasympathetic disequilibrium in autism (Ming et al., 2005). This research tested whether this observation is related to sleep or not.

**Methods:** 12 adults with ASD (20.8 ± 4.2 years) and 12 TD individuals (22.1 ± 4.0 years) were evaluated over two consecutive nights in a sleep laboratory using polysomnography. ECG samples were taken 5 minutes before and after sleep period. Spectral analysis of the heart rate variability was done using a commercial software and the following variables were extracted: total spectral power (TSP), absolute values of low (LFabs: sympathetic tone) and high (HFabs: parasympathetic tone) frequency spectral power. Analyses were performed using repeated measures ANOVA.

**Results:** Preliminary results show significant differences between evening and morning values in both groups, with higher morning values for TSP (p = 0.012), LFabs (p = 0.001) and HFnu (p = 0.004). No significant difference was found for the HFabs but HFnu was significantly lower in the morning (p = 0.007). No significant differences were found between the ASD and TD groups.

**Conclusion:** These results suggest that the effect of nocturnal sleep was similar in both groups with higher sympathetic activity in the morning. Interesting results show a higher parasympathetic influence on heart rate variability in the evening for TD and ASD participants. Further analyses will focus on ECG activity during sleep, for each of the sleep stages.

**Support (If Any):** Supported by the Canadian Institutes of Health Research and the “Fonds de la recherche du Québec en santé”.

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0173

**WHAT CAUSES THE DIFFERENCES IN CARDIAC ACTIVITY WITHIN AND BETWEEN SUBJECTS DURING SLEEP?**

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**Introduction:** It is known that cardiac activity varies across sleep stages. However, it has not been quantitatively investigated in what aspects the cardiac activity is influenced by within-/between-subject differences. The differences can be caused by many factors such as subject demographics, time and (cardiac) physiology. We hypothesize that these factors affect the cardiac activity during sleep. Therefore, we try to quantify these effects leading to cardiac variations within and between subjects, which can be potentially used to help separate sleep stages.

**Methods:** We considered overnight heartbeats, obtained from electrocardiographic signals, from 165 healthy adults (age 51.8 ± 19.4 years). Sleep stages were scored on 30-s epochs with polysomnography according to R&K rules. To investigate the abovementioned effects on cardiac activity, we applied multilevel models that consider structural variables at hierarchical levels. Two cardiac parameters were analyzed: mean heart rate (HR) and standard deviation of heartbeat intervals (SDNN). The models (with two levels: subject and time) included variables regarding effects from sleep stages (wake, REM, light and deep sleep), demographics (age, gender and body mass index), time of night and physiological differences within and between subjects.

**Results:** For both parameters, all the effects mentioned above were found to be significant (Wald Z-test, p < 0.05). Further, when excluding the variance caused by sleep stage, the variances explained by demographics, time, physiology within subjects and physiology between subjects respectively accounted for 3.4%, 4.0%, 12.4% and 80.2% of the total variance for HR, and 13.7%, 2.4%, 40.9% and 43.0% for SDNN.

**Conclusion:** Demographics, time and within-/between-subject physiological differences have significant effects on cardiac activity during sleep. The major effects come from the differences within and between subjects in physiology, accounting for > 80% of total variance (except sleep stage). Practically, for cardiac-based sleep staging, the main challenge is to reduce these within-/between-subject differences.

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0174

**AUTONOMIC CHANGES AFTER SLEEP RESTRICTION - EVIDENCE OF AN ALLOSTATIC MECHANISM**


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**Introduction:** Chronic sleep problems are commonly associated with mood difficulties, which are potentially linked to neurophysiological hyperarousal. It has been previously shown that total sleep deprivation interferes with autonomic function resulting in reduced vagal tone. However, research using partial sleep deprivation (PSD) protocols, which more closely approximate a real-world model of insomnia, is limited. Here we assessed the effects of repeated PSD on physiological and self-reported responses to emotional stimuli.

**Methods:** After a 2-min baseline, 22 participants (28% men, ages 25 ± 2.2) viewed validated neutral and sad film clips. Electrocardiography data used to derive heart rate (HR; beats/min) and heart rate vari-
ability (HRV), measured as the ratio of the low (0.04–0.15 Hz) to high (0.15–0.4 Hz) frequency (LH/HF) components of the HR spectrum, wherein HF reflects vagal tone, and the ratio indicates the balance between the sympathetic and parasympathetic arms of the autonomic system. Data collection occurred twice, following three nights of PSD (5 hrs/night) and 3 well-rested nights (WR; 8 hrs/night), in counterbalanced order.

Results: Irrespective of sleep condition, subjects reported feeling sadder during the “sad” compared with the “neutral” clips (p < 0.001). Baseline HR and HF did not vary with sleep condition, however compared to the WR condition, LF/HF was significantly reduced (p < 0.001) in PSD, indicative of a greater contribution of vagal tone to autonomic balance. A main effect of film clip on LF/HF was found only for sad film clips (p = 0.034). Follow-up tests showed that relative to baseline, HR and LF/HF significantly declined in the PSD-sad condition (p = 0.043, p = 0.005, respectively), but not in the other conditions.

Conclusion: Combined, these findings indicate that repeated PSD might initially invoke an adaptive autonomic response to the stress of reduced sleep by increasing baseline and emotion-induced vagal tone.

Support (If Any): Internal Faculty Fund Academic College Tel Aviv - Jaffa

0175 THE INFLUENCES OF FAMILY CONFLICT AND HERITABILITY ON DIURNAL SALIVARY CORTISOL LEVELS: MATERNAL TRANSMISSION, PUBERTAL EFFECT, AND GENE-ENVIRONMENT INTERACTION
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Introduction: It has been shown that diurnal cortisol profile is associated with various sleep disorders, including insomnia and OSA. The heritability and environmental determinants of diurnal cortisol profile especially on the modulation by family conflict and puberty needs further study. We aimed to investigate the associations between family conflict and cortisol levels in adults and adolescents, the heritability of the diurnal cortisol levels and potential gene-environment interaction.

Methods: A total of 205 adolescents (14.2 ± 2.8 years old, 51.7% females, and 57 with insomnia) and 244 adults (46.4 ± 4.1 years old, 52.8% females, and 69 with insomnia) were recruited from a community based family study. The family conflict subscale of the Family Environment Scale and serial salivary cortisol measurement were measured for all subjects.

Results: A lower secretion of cortisol awakening response with reference to ground (CARg) was found in adults and adolescents at late/ post puberty, but not in pre/early pubertal adolescents, who were experiencing high family conflict. Familial correlation analyses revealed significant correlations in nearly all diurnal cortisol levels (correlation coefficients range 0.16–0.31, p < 0.05) and CARg among mother-offspring pairs while father-offspring pairs did not show any correlations. There were mild to moderate heritabilities of salivary cortisol levels at each time point and CARg (h2 ranged from 0.18 to 0.42) but not cortisol awakening response with reference to increase (CARi) in the overall sample. There was a higher heritability of cortisol level at nearly each serial time point and a near-significant heritability in CARi in the high conflict families.

Conclusion: These findings suggested that diurnal cortisol profiles had a significant familial aggregation with predominant maternal influences and a potential gene-environment interaction. High family conflict is associated with lower total cortisol secretion upon awakening in adults and late/post pubertal adolescents but not in those at pre/early puberty.

Support (If Any): This study was part of the epidemiological study funded by Health and Health Services Research Fund (HHSSRF) grant (reference number 0809001) from Food and Health Bureau of Hong Kong SAR, China.

0176 ASSOCIATION BETWEEN SELF-REPORTED SLEEP CHARACTERISTICS AND LIVER ENZYME FLUCTUATIONS: THE HEXA STUDY
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Introduction: Though sleep disorders may predispose liver to significant inflammation or damage that could subsequently progress to a decline in liver function, epidemiological evidence is still insufficient in the general population. We investigated whether inadequate sleep duration and/or low sleep quality was associated with liver enzyme fluctuations, and whether usual sleep patterns could result in the asymptomatic elevated level of liver enzymes, aspartate-aminotransferase (AST) and alanine-aminotransferase (ALT) and gamma-glutamyltransferase (γ-GTP).

Methods: Based on the Health Examinees study, a total of 58,754 healthy middle-aged and elderly individuals were analyzed after excluding the participants who had been treated for liver diseases and other clinical conditions that could affect liver functions. Self-reported sleep duration and quality (i.e., difficulties falling asleep and tiredness even after sleeping) were assessed. By using multiple logistic regression models, odds ratios (ORs) and 95% confidence intervals (95% CIs) were estimated to evaluate the association between sleep duration and quality with elevated levels of liver enzymes, accounting for potential confounders.

Results: Inadequate sleep durations had significantly increased odds of elevated level of AST among both men (OR 1.26, 95% CI 1.01–1.58 for ≥ 10 hours/day) and women (OR 1.09, 95% CI 1.00–1.19 for < 6 hours/day and OR 1.07, 95% CI 1.02–1.13 for ≥ 10 hours/day) compared to normal sleep duration (6–7 hours/day). Women who usually slept < 6 hours were associated with a significant elevation in ALT level (OR 1.14, 95% CI 1.07–1.21). In terms of sleep quality, women who had always experienced difficulties falling asleep exhibited a significant elevation of γ-GTP (OR 1.71, 95% CI 1.45–2.02). Moreover, the odds of elevation in γ-GTP were significantly increased with the magnitude of tiredness even after sleeping among both men and women (p for trend < 0.05).

Conclusion: Our findings suggest that usual sleep problems experienced in daily life can be independently associated with liver enzyme elevations.

0177 PERIPHERAL INFLAMMATION CAUSES HYPERSONMIA WITHOUT ALTERING BODY TEMPERATURE IN MICE
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Introduction: Patients suffering from chronic inflammatory diseases often complain about poor quality sleep, including difficulty falling asleep and frequent awakenings during the night. Reciprocally, lack of restorative sleep is often associated with increased pain sensitivity and enhanced inflammation, potentially leading to a “vicious cycle”. We characterized sleep-wake behavior in two standard models of chronic inflammation in mice: intraplantar injection of Complete Freund’s Ad-
Rigid Red Blood Cell Membranes and Low Iron Result from Chronic Sleep Deficiency in Rats
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Introduction: The mammalian bone marrow and blood system is adapted to carrying out diverse, life-sustaining functions. Experimental sleep deficiency in otherwise healthy humans results in signs of an affected blood system, such as granulocytosis, iron deficiency, and a proinflammatory state. Insomnia is associated with anemia, and restless legs syndrome is associated with iron deficiency. The purpose of the present study was to investigate the extent to which red blood cells (RBCs) become more fragile due to sleep loss and the association of fragility with indices of iron.

Methods: Adult male Sprague-Dawley rats were chronically sleep restricted (SR, N = 5–7) for 72 days by disrupting their sleep (33% reduction) for six 10-day periods, separated by 2-day periods of sleep ad libitum according to a validated schedule. Ambulation controls (AC, N = 4–8) were produced by consolidating the ambulation requirements of sleep-restricted rats to allow for longer periods of uninterrupted sleep. Peripheral blood was tested for RBC mechanical and osmotic fragility. Decalcified bone marrow sections were stained with Prussian Blue for iron stores. Haptoglobin, which binds hemoglobin released by RBC lysis, was measured in heparinized plasma, as were plasma total iron binding capacity (TIBC), transferrin, and plasma osmolarity.

Results: RBC hemolysis in response to increased concentrations of hypotonic solution was normal in AC rats, while that for SR rats was shifted to the right, indicating rigid membranes. Plasma osmolarity was normal. Marrow iron stores were greatly reduced in SR rats compared with AC rats (0.07 vs 1.0% area). Haptoglobin exceeded to upper limit of assay detection (> 1200 µg/ml) in SR rats, compared with AC rats (733 ± 367 [SD] µg/ml; P < 0.01). Both TIBC and transferrin were increased in SR rats (TIBC, SR vs. AC: 139 vs. 61 µg/dl, P < 0.01; transferrin: 1931 vs. 1367 µg/ml, P < 0.001, respectively).

Conclusion: These results indicate that chronic sleep restriction decreases the deformability of RBCs, which is a sign of iron deficiency and decreased RBC lifespan. Iron deficiency is indicated by low iron stores and increased TIBC and transferrin. Dramatically increased haptoglobin rules out excessive hemolysis and usually reflects low numbers of RBCs and inflammatory processes. Changes to blood cell production and function are expected to contribute to signs and disease risk associated with sleep deficiency because RBCs circulate throughout the body, potentially affecting cell-cell signaling and functions in many organs and systems.

Support (If Any): The National Heart, Lung and Blood Institute

Heart Rate Variability Measures of Watchstanding in Simulated Naval Watch Schedules
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Introduction: Watch bills in Naval surface operations assign personnel to watches in rotating or fixed schedules to operate the ship around the clock. We simulated shipboard watch schedules in a laboratory and assigned continuous cognitive tasks during watch periods. Heart rate (HR) and HR variability (HRV) were measured as indices of physiologic state during simulated watchstanding.

Methods: N = 15 healthy, male subjects (ages 18–29) spent 5 consecutive days and nights in a laboratory. Subjects were assigned to one of four Naval watch schedules, each with 6 h of simulated watchstanding and 6.5 h opportunity to sleep daily on average. During simulated watches, subjects continuously performed cognitively challenging tasks. EKG was recorded throughout the study with Holter monitors. HR and low frequency (LF) and high frequency (HF) components of HRV were extracted in 5 min intervals. We compared these measures during watchstanding versus 30 min intervals immediately pre-watch and post-watch, controlling for time awake and time of day. For reference, we also compared these measures between scheduled wake and sleep periods. Statistical analyses employed mixed-effects ANOVA.

Results: HR was lower during simulated watches than immediately pre- and post-watch (F = 346, p < 0.001), and lower during sleep than during wakefulness (F = 7323, p < 0.001). HF and LF/HF ratio indicated greater vagal tone during watches than immediately pre- and post-watch (F = 34.4, p < 0.001), and even greater vagal tone during sleep (F = 1465, p < 0.001). LF, a speculative measure of sympathetic tone, was marginally increased during watches compared to 30 min pre-watch, and remained high 30 min post-watch (F = 6.2, p = 0.002). LF was substantially lower during other scheduled wakefulness and further decreased during sleep (F = 523, p < 0.001).

Conclusion: In this pilot study, HR and HRV indices differentiated sympathovagal balance during simulated watches from other wakefulness and from sleep. In particular, HR, HF and LF/HF ratio provided congruent evidence for increased vagal tone during watches compared to other waking periods. Using differences in HR and HRV measures between wakefulness and sleep as reference, this finding suggests that simulated watchstanding with continuous performance of cognitively challenging tasks was associated with physiologic symptoms that may indicate increased sleepiness—due to task load, reduced physical activity and/or sedentary posture.

Support (If Any): Naval Postgraduate School award N62271-13-M-1228
0180
WITHDRAWN

0181
SELECTIVE NON-IMAGE FORMING RESPONSES TO MILLISECOND FLASHES OF LIGHT
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Introduction: Light affects circadian timing, suppresses melatonin and modulates arousal. These non-image forming (NIF) responses to light are subserved by a network of retinal rods, cones and intrinsically photosensitive retinal ganglion cells that project to sub-cortical brain regions. To date, it remains unclear whether light-induced NIF responses use a common retino-sub-cortical pathway. Here, we compare the NIF impact of different patterns of ultra-short light flashes.

Methods: Twenty seven (26 ± 5.2 y.o) adults were empanelled in a 16-day protocol. Participants were exposed on the night of Day-15 to 60 minutes of ultra-short 2-msec flashes of different frequency (inter-stimulus intervals, ISI = 2.5–240 seconds). Circadian phase shift was calculated as the difference in salivary dim light melatonin onset between Day-15 and Day-16. Salivary melatonin concentration, prior to and after light exposure, was used to calculate melatonin suppression. Alertness and sleepiness were monitored on days 15 and 16 via the auditory psychomotor vigilance task and the Stanford Sleepiness Scale.

Results: Light-evoked changes in circadian phase shift followed a non-linear exponential decay function as ISI increased. A peak change (delay) in circadian timing of 1.5 h was observed after a 7.5-second ISI. Percent melatonin suppression, and changes in alertness and sleepiness fluctuated under the different conditions but did not vary systematically based upon ISI.

Conclusion: While the circadian system integrates ultra-short flashes of light over time in a non-linear fashion, the absence of a dose-response change in melatonin suppression and alertness across ISI supports the idea that light-induced circadian phase shifting is not regulated by the same neural pathways as either light-induced melatonin suppression or light-induced changes in alertness. Such integration of flashes might be occurring at the retina and/or suprachiasmatic nucleus level. Our results also indicate that using melatonin suppression as an indicator of circadian sensitivity to light is, at least in some circumstances, imprecise.

Support (If Any): Research supported by NHLBI (1R01HL108441-01A1) and Department of Veterans Affairs Sierra-Pacific Mental Illness Research, Education, and Clinical Center

0182
CIRCADIAN TIMING AFTER EXPOSURE TO A NATURAL WINTER LIGHT-DARK CYCLE
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Introduction: The human circadian timekeeping system is synchronized primarily by light exposure. Electrical light after sunset phase delays the circadian clock and changes the phase angle of entrainment (i.e., the timing of the circadian clock relative to the light-dark cycle). We have shown that exposure to a natural summer light-dark cycle resets the circadian clock such that the biological night, denoted by higher melatonin levels, begins near sunset and ends near sunrise. To better understand the influence of modern versus natural light exposure on human circadian physiology, we examined the influence of a natural winter light-dark cycle on the circadian melatonin rhythm.

Methods: Five physically active participants (1-female) aged 30.4 ± 8.6 y (mean ± SD) participated in a 2 week study. Week 1 consisted of ambulatory monitoring in the participant’s typical school-social environment. Week 2 consisted of one week of camping in the Rocky Mountains near the winter solstice with no electrical lights. Light exposure, sleep and activity levels were measured using Actiwatch Spectrums. Salivary melatonin phase assessments were conducted under controlled laboratory dim-lighting conditions immediately following each week to assess the circadian melatonin rhythm.

Results: In the natural winter light-dark cycle, participants were exposed to light levels that were 15x greater than in the typical school-social environment (p < 0.001). After exposure to the natural winter light-dark cycle, average melatonin onset advanced occurring closer to sunset and ~2.6 h earlier than in the typical school-social environment (p < 0.05), whereas melatonin offset did not significantly change. Average bedtime also advanced by ~2.4 h and time in bed significantly lengthened by ~2.2 h (p < 0.05).

Conclusion: Exposure to electrical lighting and reduced exposure to sunlight in the winter contributes to later circadian and sleep timing in modern society, as compared to a natural winter light-dark cycle. Our findings indicate that these effects of light on the circadian clock are not dependent upon season.

Support (If Any): NIH R21 DK092624

0183
LIGHT EXPOSURE IS ASSOCIATED WITH CIRCADIAN PHASE WHEN CONTROLLING FOR BEDTIME IN TODDLERS
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Introduction: A well-established literature demonstrates that light is the strongest environmental time cue to the circadian system. In adults, evening light exposure is associated with melatonin suppression, delayed circadian phase, and decreased sleep propensity. However, very little is known about the extent to which evening light influences the circadian system of young children. This study examined whether evening light exposure was associated with circadian phase in a sample of toddlers.

Methods: Data were collected on 13 toddlers aged 2–5 years (5 females). Subjects followed their habitual sleep schedules for 5 days before an in-home dim-light melatonin (DLMO) assessment during which saliva samples were collected every 30 min for 6 h (< 10 lux). Saliva samples were assayed for melatonin, and DLMO was defined as the clock time at which salivary melatonin levels surpassed 4 pg/mL. Throughout the protocol, sleep timing was measured with wrist actigraphy and light exposure (lux) was assessed with a pendant light recording device (Dimesimeter).

Results: Average bedtime was 20:23 ± 00:40, and DLMO occurred at 19:27 ± 00:68. Children were exposed to an average of 32.8 ± 46.1 lux in the 2 h prior to bedtime on the night preceding the DLMO assessment. Bedtime was positively associated with DLMO (r = 0.70; p = 0.004). After controlling for bedtime, the amount of light in the 2 h before bedtime was positively associated with DLMO (r = 0.69; p = 0.007). Bedtime accounted for 47.6% of the variance in the relationship between evening light exposure and DLMO.

Conclusion: These findings are consistent with research in adults showing circadian sensitivity to evening light exposure. Future studies should examine whether young children are more sensitive to light than adults and if evening light exposure influences nighttime settling difficulties in young children.

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CIRCADIAN INFLUENCES ON SMELL AND TASTE DETECTION THRESHOLDS: PRELIMINARY RESULTS FROM ADOLESCENTS

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Introduction: Reports of links between obesity and timing of food intake raise interest in potential contributing factors. Smell and taste detection have not been examined in this context. We used a forced desynchrony (FD) protocol to assess circadian changes in chemosensory detection.

Methods: Twenty-one adolescents (ages 11–16; 10 girls) took part in a 28-hr FD with 17.5 h wake and 9.5 h asleep. Smell threshold to phenylethyl alcohol (PEA) was measured using a staircase method with Sniffin’ Sticks at 16 concentrations; threshold = mean of 4 staircase reversals. Bitter, sweet, salty, and sour taste strips at 4 concentrations were presented lowest to highest concentration; detection = first of 2 consecutive correct identifications. [N = 18 for taste.] Smell testing preceded taste, began 1 h after waking, and was repeated at 3 h intervals for 6 trials each FD cycle. Circadian phase was determined by dim light melatonin onsets (DLMO), period was estimated by regression through DLMOs for each participant, and data were binned by circadian degree (60-degree bins).

Results: Smell threshold showed a significant effect of circadian phase (F(5,100) = 2.56, p = 0.032), with best detection 60 degrees before DLMO (late afternoon) and worst at 60–120 degrees after DLMO (middle night/early morning). Only bitter taste showed a significant effect of circadian phase (F(5,85) = 5.33, p = 0.0003), with worst detection at 120 degrees before DLMO (midday) and best 120 degrees after DLMO (early morning). Detection of the other tastes showed no effects of phase.

Conclusion: These preliminary data indicate that smell threshold and bitter taste detection are influenced differentially by circadian timing. Our future research will expand this exploration of smell and taste for healthy weight and overweight adolescents and assess whether smell and taste threshold changes affect food choices, food consumption patterns, and weight status.

Support (If Any): NIDDK grant DK101046.

THE ASSOCIATION BETWEEN CIRCADIAN RHYTHM PHASE AND INTER-INDIVIDUAL DIFFERENCES IN NEUROBEHAVIOURAL IMPAIRMENT FOLLOWING SLEEP LOSS

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Introduction: Systematic variability between individuals is often observed in the degree of alertness and neurobehavioural impairment following sleep loss. The underlying basis of individual vulnerability to sleep loss is not well understood. This study examined the effects of short-term sleep restriction on neurobehavioural performance and sleepiness, and the associations between individual differences in impairments and circadian rhythm phase.

Methods: Healthy adults (n = 43; 22 M aged 22.5 ± 3.1 (mean ± SD) years maintained a regular 8:16 h sleep:wake routine for at least three weeks prior to a laboratory visit. Participants were restricted to 5 hours time-in-bed at home the night before admission and 3 hours time-in-bed in the laboratory, aligned by wake time. Dim light melatonin onset (DLMO) was assessed as a marker of circadian phase using saliva samples collected from 5.5 h before until 5 h after the pre-laboratory scheduled bedtime. Two hours after waking participants completed the Karolinska Sleepiness Scale (KSS), a 10-min auditory Psychomotor Vigilance Task (PVT), and had slow eye movements (SEM) measured by electrooculography.

Results: Sleep restriction was associated with substantial inter-individual variability in all measures of sleepiness and neurobehavioural performance. Later timing of DLMO, consistent with participants waking at an earlier circadian phase, was associated with greater sleepiness (r = 0.510, p < 0.0001), increased slow eye movements (r = 0.375, p = 0.022) and more PVT lapses (r = −0.468, p < 0.01). When the difference between DLMO and sleep onset was less than 2 hours, individuals were significantly more likely to have at least three attentional lapses the following morning.

Conclusion: This study demonstrates that the phase of an individual’s circadian system is important in predicting the degree of sleepiness and performance impairment in the hours after waking following sleep restriction. Other factors influencing performance decrements require further investigation.

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THE INFLUENCE OF CHRONOTYPE ON SLEEP INERTIA

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Introduction: Sleep inertia (SI), the state of impaired cognition immediately upon awakening from sleep, is affected by circadian phase. Specifically, SI is worse upon awakening from sleep during the biological day, when core body temperature is low, than upon awakening from sleep during the biological day, when core body temperature is high. Later chronotypes would be expected to have worse SI since they awaken closer to their core body temperature minimum (having a narrower wake time phase angle of entrainment). Later chronotypes also self-report that it takes longer to feel fully awake in the morning. Based on circadian theory, we expected SI to be worse for later chronotypes than earlier chronotypes, even when controlling for prior sleep duration.

Methods: Visual search performance of fifteen healthy participants [5 females (21.47 ± 3.16 yr; mean ± SD)] was assessed ~1, 10, 20, 30, 40, and 60 min following scheduled awakening at habitual wake time from an 8 h laboratory sleep opportunity. Participants maintained ~8 h self-selected sleep schedules the week prior to testing. Chronotype was determined both quantitatively, according to Dim Light Melatonin Onset clock hour, and qualitatively by mid-sleep on free days (MSFsc) using the Munich Chronotype questionnaire. The top and bottom ~33rd percentiles of chronotype were compared. Cognitive throughput and median reaction time for correct responses (MedRTC) were analyzed using mixed-model ANOVA and t-tests for planned comparisons.
**Results:** Regardless of chronotype definition, duration of SI for cognitive throughput and MedRTOC was longer for later chronotypes (p < 0.05). Performance for earlier chronotypes showed significant improvement within 10–20 min after awakening, whereas performance for later chronotypes took 30 min or longer to show significant improvement (p < 0.05).

**Conclusion:** Findings are consistent with circadian theory and suggest that sleep inertia contributes to greater difficulties with morning performance in later chronotypes.

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### 0187

**DAILY ACTIVITY PATTERNS OF 2,213 MEN AND WOMEN FROM FIVE NATIONS DIFFERING IN SOCIOECONOMIC DEVELOPMENT**


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**Introduction:** Daily rhythmicity in locomotor activity has been studied in great detail in laboratory animals, but not in humans. We collected actigraphic data from individuals from five countries to explore the circadian organization of human physical activity.

**Methods:** Physical activity was assessed using the Actical accelerometer in five countries differing in socioeconomic development as defined by the United Nations’ Human Development Index (HDI): Ghana (HDI = 0.541) as a lower “medium” HDI country, South Africa (0.619) as “medium”, Jamaica (0.727) and Seychelles (0.773) as “high”, and the U.S.A. (0.910) as “very high”. Participants (n = 2,213; ages 25–45 years; 50% were female) provided demographic and health data including body mass index. Individual activity records, lasting 7 days, were subjected to cosinor analysis to derive parameters of circadian activity rhythms: mesor (mean level), amplitude (half the range of excursion), acrophase (timing), and robustness (rhythm strength).

**Results:** Activity records exhibited statistically significant 24-hour rhythmicity (p < 0.05). Averaged daily physical activity increased noticeably a few hours after sunrise and dropped off around sunset, peaking at 1:42 pm. Women and men did not differ significantly regarding the acrophase of the daily rhythm in each country, but the acrophase showed considerable between-country variation (~3 hours). In the United States, where there was substantial seasonal variation in photoperiod, acrophase followed local time, rather than the times of sunrise or sunset. Quantification of the socioeconomic stages of the five countries suggested that more developed countries have more obese residents (r = -0.83), who were less active (r = 0.69) and exhibited later activity timing (r = -0.69) than less developed countries (all p < 0.05).

**Conclusion:** These results characterize human daily activity rhythm, revealing similarities and differences among five countries that differ in socioeconomic development. The results also document associations between individuals’ activity rhythm, body mass index, and socioeconomic development of their respective country.
0189
MATERNAL SLEEP QUALITY AND DIURNAL CORTISOL REGULATION OVER PREGNANCY
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Introduction: Poor sleep in pregnancy is a risk factor for numerous adverse neonatal outcomes including preterm birth, low birth weight, small for gestational age, gestational diabetes, and preeclampsia. Maternal cortisol has been proposed as a key biomarker linking poor sleep to adverse outcomes; however the association between sleep and cortisol in pregnancy is not well understood. The goals of the current study were to examine 1) associations between maternal sleep and cortisol in pregnancy, 2) maternal medical conditions and psychological well-being as potential intervening variables that may explain associations between sleep and cortisol, and 3) associations among maternal sleep and neonatal outcomes.

Methods: Participants were 217 pregnant women from a racially/ethnically diverse, low income sample. Participants completed three study sessions in second and third trimesters of pregnancy. Participants completed the Pittsburgh Sleep Quality Index (PSQI) at two time points over pregnancy and provided salivary cortisol samples at wake-up, 30 minutes after wake-up, and bedtime for three days at 3 time points over pregnancy.

Results: Fifty-three percent (53%) of women reported poor sleep quality in pregnancy. Poor sleep quality was associated with elevated evening cortisol at 36 weeks but not at 24 or 30 weeks gestation. The association between sleep quality and evening cortisol became nonsignificant after adjusting for psychological distress. We did not observe significant associations among sleep and neonatal outcomes.

Conclusion: Poor sleep in pregnancy is associated with elevated evening cortisol levels in late third trimester. Possible explanations for this association are discussed.

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0190
SEX DIFFERENCES IN IMPACT OF “WRONG-TIME” FEEDING IN MICE
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Introduction: Previous studies on mice in our laboratory revealed a significant impact of feeding time on weight gain from high-fat food (Arble et al., 2009). These findings have been replicated in other laboratories and other species. Since previous studies only included male mice, we sought to determine the effect of “wrong-time” (light period) vs. “right-time” (dark period) feeding on body weight regulation in female mice.

Methods: C57BL/6J mice were maintained on a 12:12 Light:Dark cycle with regular chow (RC: 6% calories from fat) available ad libitum. At 9 weeks of age, female mice were assigned to one of four different treatment groups. 1. Ad lib (24 hr/day) High Fat (HF) diet (60% calories from fat). 2. Ad lib (24 hr/day) RC diet. 3. HF food 12 hr/day dark period (Right-time). 4. HF food 12 hr/day light period (Wrong-time). Male mice were assigned to treatment groups 3 and 4. Mice were kept in these conditions for 6 weeks. Body weight, food consumption, and locomotor activity were monitored.

Results: “Wrong-time” fed male mice gained significantly more weight than “Right-time” fed males, replicating our previous results. Female mice fed ad lib HF diet increased body weight nearly 30% over their baseline weights, while ad lib RC fed females gained only 5%.

In contrast, there were no significant differences between the “Right-time” and “Wrong-time” fed females. Both groups gained approximately 15% over their baseline body weights.

Conclusion: Female mice, like male mice, exhibit significant and substantial weight gain when given high-fat food for six weeks. However, unlike male mice, female mice restricted to 12 hr/day access to HF diet show no differences in weight gain related to the phase that they have food access. This suggests that the role played by circadian timing in body weight regulation differs between sexes.

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0191
CIRCADIAN PERIOD (TAU) FROM ADOLESCENCE TO ADULTHOOD: THE INFLUENCE OF AGE, SEX, AND RACE
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Introduction: Shortening or lengthening of circadian period (tau) has been hypothesized as a mechanism to explain changes in sleep timing across the lifespan. Results are mixed, however, possibly due to differences in methodology or demographics (limited age, race or sex distributions). We examine age, race, and sex in predicting circadian period length in individuals ranging in age over four decades.

Methods: In three studies, 182 healthy participants (92 male; 66 Black) between 14 and 43 years spent 3 days on an ultradian light/dark (LD) cycle (LD 2:5:1.5, LD 3:2, or LD 2:2) in the laboratory. Salivary dim light melatonin onset (DLMO) was measured before and after the ultradian LD cycles, from which tau was computed. Step-wise multiple linear regression models examined associations between circadian period and age, race (Black = 1; other race = 0), and sex (female = 1; male = 0) (entered in this order). A quadratic age term was entered into the first model. Season (spring/summer = 1; fall/winter = 0) was entered into a final model to account for any seasonal variation in tau.

Results: Tau ranged from 23.5 to 24.9 h (mean = 24.2, SD = 0.3 h). There was an age-related quadratic pattern such that tau was longest at about 25 to 28 years and shorter at younger and older ages [R² = 0.22, F(2,181) = 4.538, p = 0.01]. Race explained an additional 13.3% of the variance; Black participants had shorter taus than other races [R² = 0.43, F(3,181) = 13.17, p < 0.01]. Sex and season did not explain additional variance in tau beyond age and race. In the final model, the quadratic age term (B = −0.001, p = 0.01) and race (B = −0.192, p < 0.01) remained significant independent factors.

Conclusion: A long tau during emerging adulthood may explain previously reported late sleep timing (late chronotype) during this life stage. Taus of Black participants were shorter than other races regardless of age, and race accounted for the most variance in tau.

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**AFRICAN-AMERICANS SLEEP LESS THAN EUROPEAN-AMERICANS AFTER A 9-HOUR ADVANCE OF SLEEP**
Crowley SJ, Smith MR, Tomaka V, Eastman CI

**Introduction:** Previous studies indicate racial differences in sleep duration. This analysis examined sleep duration differences between African-American and European-American participants before and after a 9-hour advance of sleep (dark).

**Methods:** Thirty-seven healthy adults (20 African-Americans, 20 males) between 21 and 43 years participated in this laboratory study. An 8-hour baseline sleep (dark) episode similar to pre-study home sleep occurred on four consecutive nights. Participants were kept awake for 31 hours and then the 8-hour sleep (dark) episodes shifted 9 hours earlier than baseline for 3 consecutive days (like flying 9 time zones east). Participants completed sleep logs and wore actigraphs on their non–dominant wrist throughout the study. Actigraphy recordings for 7 participants (3 African-Americans) were lost due to device failure. Total sleep time (TST) derived from sleep logs and actigraphy on baseline nights were averaged and compared to TST on shifted days 1, 2, and 3 in a repeated measures analysis of variance. Statistics for actigraphic TST are reported because results are similar between sleep logs and actigraphy.

**Results:** TST decreased after the 9-h sleep advance [F(3,84) = 5.13, p = 0.007]. African-Americans slept less than European-Americans [F(1,28) = 6.07, p = 0.02]; this difference was driven by less TST for African-Americans on shifted days 1 (p = 0.043) and 2 (p = 0.005) compared to European-Americans, who showed TSTs similar to baseline on these 2 days. On shifted day 3, TST of European-Americans decreased and was similar to African-Americans.

**Conclusion:** Sleep duration remained at baseline levels for the first two shifted days in European-Americans, either in response to extended wake or greater tolerance to sleeping at an adverse circadian phase. African-Americans, however, slept less than European-Americans even after this extended wake. African-Americans may be more vulnerable to sleep loss and jet lag after flying east across many time zones. These data may suggest racial differences in homeostatic sleep responses, circadian phase tolerance, or both.

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levels (P = 0.65). Circadian misalignment increased IL-6 levels by 17% (P = 0.01), resistin levels by 5% (P < 0.001), and TNF-alpha levels by 2% (P = 0.003).

Conclusion: The increase in BP and inflammatory markers, and the decrease in cardiac vagal modulation during circadian misalignment may help explain the increased cardiovascular disease risk in shift workers.

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0196
EUROPEAN-AMERICANS HAVE A LONGER FREE-RUNNING CIRCADIAN PERIOD THAN AFRICAN-AMERICANS AND ARE MORE LIKELY TO PHASE SHIFT IN THE WRONG DIRECTION
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Introduction: Our previous retrospective study showed that African-Americans (Blacks) had a shorter free-running circadian period than European-Americans (Whites). This study aimed to replicate those results and examine phase shifts in response to a large, abrupt advance of the zeitgebers.

Methods: 19 Blacks and 17 Whites lived in the lab for 14 days. They spent 3 days on an ultradian light/dark (LD) cycle (LD 2.5:1.5 or LD 3:2) forced desynchrony protocol. The dim light melatonin onset (DLMO) was determined before and after the ultradian LD cycles to yield circadian period. Then subjects were put on a baseline 24-h LD cycle (LD 16:8), with sleep (dark) scheduled similar to their home sleep for 4 days. Then the LD, sleep/wake and meal schedules were advanced 9 h for 3 days. The DLMO was determined after the 4 baseline days and after the 3 advanced days to determine the phase shift.

Results: The free-running period of Blacks was shorter than that of Whites (24.07 ± 0.15 h vs. 24.36 ± 0.22 h, p < 0.0001). Of those who shifted more than 0.5 h, 47% (7/15) of Whites delayed after the 9 h advance of zeitgebers, whereas only 13% (2/16) of Blacks phase shifted in the wrong direction (p < 0.05). When the absolute phase shift was calculated, without regard to direction, Whites had larger phase shifts (2.5 ± 1.7 vs 1.4 ± 1.0 h, p < 0.05). Shorter periods were associated with larger phase advance shifts, and longer periods were associated with larger phase delay shifts (r = −0.56, p < 0.001).

Conclusion: We speculate that a short circadian period was advantageous during our evolution near the equator and lengthened with northern migrations out of Africa. The differences remaining today are relevant for understanding and treating circadian misalignment due to shift work, jet travel and delayed sleep phase.

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dian transcriptome reveals pathways that share circadian orchestration across many tissues, including lipid metabolism and cell cycle regulation. On a gene-set level, the lung was phase-shifted in comparison to other organs. Finally we show that in the liver, restricted feeding alters the relative timing between anabolic and catabolic processes.

Conclusion: The phase set enrichment package offers a simplified method for the interpretation of circadian transcriptomic data with increased sensitivity. Gene set analysis highlights the underlying cellular biology regulated by the circadian clock and demonstrates how the temporal organization of transcription is altered by restricted feeding.

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0198
TRANSCRANIAL BRIGHT LIGHT ALLEVIATES JET LAG SYMPTOMS - A RANDOMIZED, DOUBLE-BLIND, PLACEBO-CONTROLLED TRIAL
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Introduction: Jet lag is caused by rapid travel over multiple time zones which results in transient de-synchronization between the individual’s biological clock. Symptoms include increased daytime sleepiness, reduced sleep duration and quality, and performance impairments. Exposure to ocular bright light is known to facilitate adaptation to the new time zone as well as alleviate jet lag symptoms. Recently, transcranial bright light (TBL) via the ear canals has been shown to have antidepressant, anxiolytic, and psychomotor performance-enhancing effects. This study examines whether intermittent TBL exposure can alleviate jet lag symptoms in a randomized, double-blind, placebo-controlled study.

Methods: Fifty-five healthy male subjects between 25–50 years (mean age ± SD: 39 ± 7 years) completed the 3 week study consisting of a baseline period (1 week), travel period (at least 1 week of travel), and post-travel period (1 week). The pre-travel period started on the day of return (post-travel day 0). Intermittent light exposures (4 x 12 minutes; day 0: 8 am, 10 am, noon, 14 pm; days 1–6: 10 am, noon, 14 pm, 16 pm) were administered during the 7-day post-travel period after eastern transatlantic flight. The symptoms of jet lag were measured by the Visual Analogue Scale (VAS), the Karolinska Sleepiness Scale (KSS), and the Profile of Mood States (POMS).

Results: Results showed a significant reduction of overall jet lag symptoms (VAS), subjective sleepiness (KSS), and the fatigue, inertia, and forgetfulness subscales of the POMS when comparing the active TBL treatment group (n = 30) to the placebo group (n = 25). On average, subjects in the TBL group showed a greater rate of overall recovery based on their VAS scores than subjects in the placebo group.

Conclusion: Intermittent TBL seems to alleviate symptoms of jet lag. The effects emerged on post-travel days 3–4, suggesting a cumulative effect of TBL.

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0199
THE EFFECTS OF CIRCADIAN DISRUPTION ON SLEEP
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Introduction: One of the most perceivable outputs of the circadian (daily) clock is the timing of the sleep-wake cycle. However, artificial lighting and an “always on” society have led to the breakdown between the circadian system and the solar day. Given circadian and sleep disruption are associated with negative mental and physical health outcomes, understanding how circadian disruption (CD) alters regulation of the sleep-wake cycle is imperative. Using a rodent model, we explored CD effects on sleep to establish if our model disrupts the normal sleep processes.

Methods: Environmental CD was induced by housing adult male mice in an altered light-dark (LD) cycle with a period of 20 h (10 h light, 10 h dark). Prior to CD, adult male mice were instrumented for EEG and EMG recording. Recordings were taken for 5 d in LD12:12, followed by 6 h sleep deprivation (gentle handling) on day 4, followed by 24 h recovery. Mice were then transferred to CD for 4 wks, and this protocol was repeated. Sleep parameters were recorded and compared between the baseline and CD conditions.

Results: Our model of CD does not result in marked sleep deprivation as measured by changes in the overall sleep quantity; however, CD does affect sleep/wake timing. Additionally, sleep onset delta power was reduced following CD compared to baseline. Following sleep deprivation there was a marked increase in NREM delta power for both baseline and CD recovery sleep period, with no other observed effects of CD.

Conclusion: Our results suggest the negative health effects observed following CD may not be due to sleep loss, but instead a reduction in sleep quality and appropriate timing of sleep. That sleep deprivation responses seem unaffected by CD suggests the sleep homeostat may be unaffected, though additional work is required to fully explore the effects of disrupted circadian clocks on sleep.

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0200
BIG-DATA MINING THROUGH CIRCULAR COMPONENT ANALYSIS REVEALS DIURNAL OSCILLATIONS IN THE HUMAN TRANSCRIPTOME
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Introduction: Circadian rhythms modulate human physiology. Chronotherapy promises to leverage this knowledge to improve treatments. However, circadian oscillations in human tissues are poorly characterized. Traditional studies involve repeated sample collections with well-synchronized subjects. These studies are practically impossible for most human tissues. Nonetheless, non-circadian databases amass transcriptomic data from thousands of patients. These databases do not provide the time at which samples were collected and conventional tools are unable to analyze this data for rhythmicity. Here we develop a new approach to uncover biological rhythms in temporally unstructured big-data.

Methods: When genes share a common periodicity, the pooled expression data lies on a high-dimensional ellipse. This circular structure persists when the temporal ordering between samples is unknown. We identify the first circular component of a data matrix as the projection of a single circle that best reconstructs the data. The significance of that reconstruction is evaluated through permutation. The relative ordering of samples is determined by their angular position on the circle. The cycling of individual transcripts is assessed assuming this ordering. We used circular components to reanalyze transcriptional data from the mouse and applied the method to three large, publicly available microarray datasets (n > 1300) describing the normal human lung.
**A. Basic Sleep Science**

Results: Circular component analysis successfully reconstructs the temporal ordering of samples from the mouse. In the human lung, a statistically significant reconstruction using the first circular component is identified in all three datasets. Genes identified as rhythmic through independent analysis of the three human datasets showed a high degree of overlap. Differences in the relative timing of circadian outputs are observed when comparing mouse and human lung data.

Conclusion: Circular component analysis is a powerful tool to mine temporally unstructured data and uncover oscillations in human molecular physiology. Tissue specific rhythms in the human and mouse show important differences.

Support (If Any): This work was supported by the Defense Advanced Research Projects Agency (DARPA-D12AP00025).

**0201**

**CK1 INHIBITOR LONGDAYSIN SUPPRESSES SLEEP DURING DARK PHASE BUT NOT LIGHT PHASE**

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**Introduction:** Bmal1/Clock heterodimers in the SCN are a well-defined master trigger of the internal circadian clock, which synchronizes biological rhythms including sleep/wake cycles. The Bmal1/Clock cycle is negatively controlled by many factors including Per. CK1 is a binding site of Per’s phosphorylation. We hypothesized that sleep/wake would be affected when CK1 and subsequently Per is suppressed.

**Methods:** To test the hypothesis, we surgically implanted electrodes for sleep recording and guide cannula for intracerebroventricular (icv) injection in adult mice. After 10 days recovery and adaptation, polysomnograph was recorded for two baseline and three treatment days. Control animal received 2 µl vehicle (12.5% DMSO) and longdaysin group received 2 µg longdaysin dissolved in the vehicle by icv injection. In one experiment, recording was started from light phase and the injection was made daily in 30 minutes before the start of the (light phase) third day. In another experiment, recording was started from dark phase and the injection was made in 30 min before the start of dark phase.

**Results:** As expected, longdaysin significantly (at several time points) suppresses sleep in the dark phase every day after injection. This effect includes suppression on both NREM sleep and total sleep. The effect on REM sleep was different between first day and later days. Interestingly, most effect occurred in the dark phase except first day REM sleep no matter the injection was given in front of the light phase or dark phase. This meant that if injection was made 30 min before the start of light on, the effect occurred 12 and half hours later and if the injection was made right before the dark phase start, the effect occurred immediately.

**Conclusion:** Longdaysin suppresses sleep of dark phase and not light phase no matter the injection was made in any phase. However, if injection is made in the beginning of the light phase, it may induce an increase of REM sleep.

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**0202**

**DOES MID-SLEEP TIMING PREDICT CIRCADIAN PERIOD?**

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**Introduction:** Mid-sleep time on free days from the Munich Chronotype Questionnaire (MCTQ) has been proposed as an accurate way to assess chronotype and an alternative to the Morningness-Eveningness Questionnaire (MEQ). While there are many published reports on the relationship between MEQ and physiologic measures of circadian rhythmicity, there are few published reports relating MCTQ mid-sleep time to physiologic measures. We therefore conducted a retrospective analysis to examine the relationship between circadian period and chronotype as assessed by the MEQ or by mid-sleep time on free days.

**Methods:** 152 healthy participants (51 women, 101 men; mean±SD age 33.19±17.32 years) were studied under forced desynchrony conditions. Core body temperature and plasma melatonin data were analyzed to determine circadian period using non-orthogonal spectral analysis. Mid-sleep times on work days (WD) and free days (FD) were calculated from a screening questionnaire or the MCTQ. Pearson correlation was used to examine the relationship between mid-sleep measures and circadian period.

**Results:** MEQ score correlated significantly with melatonin (n = 129; r = -0.21; p = 0.02) and temperature period (n = 152; r = -0.22; p = 0.01). The mid-sleep times from the screening questionnaire were significantly different from first day to later days. MID-sleep times from the MCTQ showed weaker correlations with melatonin (n = 149; r = 0.21; p = 0.01; FD: n = 148; r = 0.23; p = 0.0045). In the subset of subjects who took the MCTQ, MID-sleep times from the MCTQ showed weaker correlations with melatonin (n = 62; r = 0.12; FD: n = 63; r = 0.12) and temperature period (WD: n = 69; r = 0.11; FD: n = 70; r = 0.11; p all > 0.3).

**Conclusion:** We found that a fundamental property of the circadian timing system, circadian period, was significantly correlated with chronotype assessed using the MEQ or mid-sleep time. While these relationships were significant they were not strong, although 20–25% of the variability in mid-sleep time or MEQ score was explained by variations in circadian period.

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**0203**

**NEURAL MODULATION OF BEHAVIORAL AGGRESSION VIA THE CIRCADIAN TIMING SYSTEM**

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**Introduction:** Circadian rhythm disruption is a prevalent comorbidity of numerous neuropsychiatric disorders, many of which are associated with behavioral aggression. Yet it is unclear whether the circadian system directly modulates aggressive behavior. We have recently shown...
that GABAergic neurons of the subparaventricular zone (SPZ) send dense projections to the ventromedial hypothalamus, a structure that has been extensively implicated in the regulation of emotion and aggression. The SPZ receives the majority of the axonal output from the suprachiasmatic nucleus, the mammalian master circadian pacemaker, and has been shown to exhibit rhythmic multiunit activity. Here we tested the hypothesis that GABAergic transmission from the SPZ influences emotional state and behavioral aggression across the 24-h day.

**Methods:** Using Cre-lox technology in transgenic mice to delete VGAT, the vesicular GABA transporter, we selectively silenced GABAergic transmission from SPZ neurons. We then assessed levels of aggressive behavior in these mice, and their intact littermates, using the resident intruder paradigm at four different time points: zeitgeber time (ZT)1, ZT7, ZT13, and ZT19. We are also analyzing rhythms of locomotor activity and serum corticosterone in a subset of these mice.

**Results:** Our preliminary data reveal a rhythm of aggressive behavior similar to that reported in other nocturnal rodents, with a peak during the early dark period and lower levels of aggression at all other time points. We also find that VGAT-deletion in the SPZ substantially alters this pattern, leading to increased duration of biting attacks during the light period.

**Conclusion:** Our preliminary findings suggest that GABAergic transmission from the SPZ inhibits behavioral aggression during the light period. This work demonstrates a direct neural contribution to the daily timing of aggressive behavior that may be dissociable from disruptions of sleep-wake and corticosterone rhythms, based on the axonal output of the SPZ.

**Support (If Any):** F32 NS084582-01A1 (WDT) and R01 NS072337 (CBS)

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**0204 SOCIAL JETLAG IS ASSOCIATED WITH ALTERED HPA ACTIVITY**

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**Introduction:** Many individuals experience social jetlag (SJL), an indicator of habitual circadian misalignment, due to a discrepancy between their endogenous circadian rhythm and actual sleep schedules imposed by social obligations. Greater SJL has been linked to depressive symptomatology and higher body mass index. It is possible that SJL-linked mood and metabolic effects are mediated by dysregulation of the hypothalamic-pituitary-adrenocortical (HPA) system, but whether SJL disrupts HPA activity remains unclear.

**Methods:** Here, we examined the relationship between SJL, sleep characteristics, and three indices of HPA functioning in 446 employed, healthy volunteers (42.7 ± 7.4 yrs old; 52% Women; 82% White). Participants wore an actiwatch for at least 7 nights. SJL was calculated as the absolute difference between the average midpoints of sleep on free days versus workdays. Salivary cortisol was measured five times daily, for four days. The cortisol awakening response (CAR) was calculated as percent change in cortisol from awakening to 30 min after awakening; regression-derived slope of the diurnal decline in cortisol was calculated from measurements taken at awakening and at +4 hr, +9 hr and bedtime; and cortisol area-under-the-curve (AUC) was calculated from the same four measurements by trapezoidal integration.

**Results:** Hierarchical regressions controlling for age, sex, and race showed greater SJL related to a greater CAR (β = 0.14, p = 0.003) and shallower diurnal slope (β = 0.14, p = 0.003), but unrelated to AUC (p > 0.05). Although shorter sleep duration was similarly associated with these two cortisol metrics (p’s < 0.05), controlling for sleep duration, as well as for awakening time, sleep debt, sleep efficiency and nighttime awakenings, did not mitigate effects of SJL on CAR or the diurnal slope.

**Conclusion:** Day-to-day circadian dysregulation may alter HPA function; this mechanism may contribute to the relationship between circadian disturbances, mood disorders, and cardiovascular risk.

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0205
EFFECTS OF SCHEDULED SLEEP AND ENHANCED LIGHTING DURING SIMULATED SHIFT WORK ON CIRCADIAN PHASE, PERFORMANCE, AND SUBJECTIVE SLEEPINESS IN OLDER ADULTS
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Introduction: In studies of young adults, a combination treatment of scheduled evening sleep and enhanced lighting resulted in significant improvements in on-shift alertness, performance, and circadian adaptation to simulated night work. Aging reduces circadian phase shifts to light and the ability to sleep in the evening, and thus whether these treatments will also be effective in older adults is unclear.

Methods: Eight healthy adults (2 females) aged 50–65 y (56.8 ± 3.3 y; mean ± SD) participated. Four day shifts were followed by four night shifts in the laboratory, and dim light salivary melatonin onset was assessed following each set of shifts. PVT reaction time and subjective sleepiness were examined hourly across each shift. Subjects slept at home and maintained 8 h sleep schedules for one week before study and while on day shifts. Treatment subjects (n = 4) received a combination of enhanced lighting (2500 lux) in the latter half of night shifts and a scheduled 8 h evening sleep episode, while control subjects were in standard lighting (90 lux) during shifts and had ad lib sleep following night shifts.

Results: Compared to day shifts, sleepiness was greater and reaction time was slower on all night shifts for control subjects (p < 0.0001). For treatment subjects, by night 2 reaction time was not different from day shifts (p < 0.05), and by night 3 subjective sleepiness was not different from day shifts (p ≤ 0.01). Subjects in the treatment group showed significant circadian phase advance shifts (p = 0.014) compared to control subjects.

Conclusion: Our preliminary data indicate that a combination treatment of scheduled evening sleep before night shifts and enhanced lighting during night shifts improves on-shift sleepiness and reaction time, and that this improvement is likely due to partial circadian adaptation. While additional studies to determine the effectiveness of each treatment aspect should be carried out, these findings show promise for treating shift work disorder in older adults.

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0206
NOCTURNAL MELATONIN PROFILES IN PATIENTS WITH DELAYED SLEEP-WAKE PHASE DISORDER AND CONTROL SLEEPERS
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Introduction: A significant delay in the timing of endogenous circadian rhythms has been associated with Delayed Sleep Phase Disorder (DSPD) although more recently other mechanisms have been proposed to account for the persistent delay in the timing of patients’ sleep.

Methods: To further explore the aetiology of DSPD, the present study compared nocturnal melatonin profiles of 26 DSPD patients (18m, 8f, age: 21.73 ± 4.98) and 17 normally timed sleepers (10m, 7f, age: 23.82 ± 5.23) in a time-free, dim-light (< 10 lux), laboratory environment. A 30-hour modified constant routine with alternating 20-minute sleep opportunities and 40-minutes of enforced wakefulness was used to measure the endogenous melatonin circadian rhythm. Salivary melatonin was sampled half-hourly between 1820 h–0020 h and then hourly from 0120 h until 1620 h.

Results: DSPD patients had significantly later timed melatonin profiles that were delayed by approximately 3 hours compared to normal sleepers, and there were no notable differences in the relative duration of secretion between groups. However, melatonin secretion following the DLMO and acrophase was lower in DSPD patients compared to good sleepers who showed a more robust initial surge of melatonin following the DLMO.

Conclusion: Although the regulatory role of melatonin is unknown, abnormal melatonin profiles have been linked to psychiatric and neurological disorders. The present results suggest that in addition to a delayed endogenous circadian rhythm, a lack of initial surge of melatonin secretion following DLMO may contribute to the aetiology of DSPD.

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0207
NIGHT WORK ALTERS TIMING OF FOOD INTAKE, BODY WEIGHT AND CIRCADIAN RHYTHMICITY IN RATS
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Introduction: In humans, night work can have profound effects on performance, well-being and health, and has been linked to metabolic disorders. Animal models can aid in exploring the mechanisms underlying these consequences. Here we aimed to model night work in rats and investigated the effects on circadian rhythmicity and metabolic regulation.

Methods: To mimic different work schedules in humans, male rats were exposed to forced activity in rotating wheels for 8 hours either in their resting phase (RW; n = 25) or active phase (AW; n = 16) in constant 12 h L/D conditions. Body weight, food intake and peripheral body temperature (BT) were monitored for 4 baseline days, 4 experimental days and 8 recovery days.

Results: Forced activity decreased body weight and food intake in both groups (24 h). RW lost more weight than AW on days 1 and 2, but showed similar food intake. During 8 h work, RW and AW initially maintained their food intake at baseline level, but RW increased to the level of AW at day3. RW gradually advanced the nadir of the BT rhythm (day4; ~3.5 h), with subsequent recovery to baseline requiring about 3 days. In AW the nadir of the BT rhythm remained stable. In the
RW group, mean difference in BT between the light and dark phase decreased on day1, then inverted on day2.

Conclusion: Work during rats’ resting phase caused greater decrease in body weight compared to work in inactive phase, but the food intake was similar under the two work conditions. Rest workers advanced their circadian rhythm and shifted food intake toward working hours. Moreover, rest work inverted mean BT in active compared to inactive phase. Recovery to baseline values took more than 3 days. These results indicate that night work has consequences for body weight, timing of food intake, and circadian rhythmicity of body temperature.

0208
FORCED ACTIVITY IN RESTING PHASE CAUSES SLEEP DISTURBANCES IN RATS: AN ANIMAL MODEL OF NIGHT WORK
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Introduction: Working night and being forced to shift sleep to other times of day is known to shorten and disturb sleep in humans. However objective EEG-findings are sparse. We aimed to model night work in rats and examine the degree of sleep disturbances during and in the recovery from a night work period.

Methods: Mimicking human night and day work, rats were exposed to forced activity in rotating wheels for 8 h on 4 successive days, either in their resting (RW) or active (AW) phase under normal 12 h L/12 h D cycle. One subgroup of RW was kept in DD during recovery. EEG/EMG was monitored throughout the experiment. Data are presented as 24 h values compared to baseline.

Results: On the first experimental day, forced activity reduced total sleep time (TST), SWS, REM-sleep and sleep was less fragmented. In the RW group TST was further reduced on day3 to 4, mostly due to a reduction in SWS. In the AW group a further reduction was only observed in day4. RW showed more fragmented sleep than AW. The AW group showed an increase in TST and SWS on the first recovery day. RW first showed an increase in recovery day4. If RW were kept in DD during their recovery, TST, SWS and REM-sleep were similar to baseline already on the first recovery day. RW-LD was similar to baseline in recovery day4. Independently of DD or DD condition, the sleep in RW was more fragmented than AW throughout recovery.

Conclusion: Forced activity in the rats’ resting phase resulted in reduced sleep time. Particularly, SWS was reduced and sleep was more fragmented. It took longer for ‘night workers’ to recover than ‘day workers’. These results indicate that night work induces sleep disturbances lasting several days after work termination. The animal model can be used to further investigate sleep disturbances after night work.

0209
WAKE-RELATED LINGUAL MUSCLE ACTIVITY IS SUPPRESSED IN RATS WITH CIRCADIAN RHYTHM DISRUPTED BY CONSTANT LIGHTS-ON CONDITION
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Introduction: Obstructive sleep apnea (OSA) patients have elevated lingual muscle activity during wakefulness, which helps them to maintain open upper airway. However, sleep in OSA can be severely disrupted and misaligned relative to the normal circadian cycle with the impact on upper airway muscle tone unknown. In the absence of a suitable animal model of OSA, we studied the effect of disruption of the circadian rhythm of sleep on lingual EMG in rats whose normal lingual EMG is well characterized.

Methods: In 6 chronically instrumented Sprague-Dawley rats, we recorded lingual and nuchal EMGs, cortical EEG and motor activity. One 24 h-long recording was collected under 12:12 light-dark cycle and another after at least 14 days of housing with lights continuously on which disrupts the circadian rhythm of sleep-wake and motor activity.

Results: Under the constant lights-on condition, the rats spent about 3% less time in wakefulness and proportionally more time in slow-wave sleep (SWS) and rapid eye movement sleep (REMS) than under the normal light-dark cycle. Motor activity over 24 h was nearly constant at a mid-level relative to the peak and nadir recorded under the normal light-dark cycle. The average magnitudes of nuchal EMG quantified in successive 10 s intervals separately during wakefulness and SWS were also steady and at mid-level between the peak (at 4–7 am) and nadir (at 1–4 pm) typical of the normal conditions. The magnitude of twitching activity that characterizes lingual EMG during REMS also exhibited this trend. In contrast, lingual EMG during wakefulness under the desynchronized conditions maintained a steady level at 60% of the peak measured during the normal active period which corresponded to the nadir during the normal rest period.

Conclusion: In rats, environmental disruption of the normal circadian cycle is associated with a suppression of spontaneous activity of the muscles of the tongue. Accordingly, OSA patients who require a compensatory elevation of lingual EMG during wakefulness may be more vulnerable to hypoventilation when their sleep-wake pattern is not properly aligned with the normal circadian cycle.

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0210
UBE3A IMPRINTING IMPAIRS CIRCADIAN ROBUSTNESS IN ANGELMAN SYNDROME MODELS
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Introduction: Sleep disorders such as short sleep duration and increased sleep onset latency are very common in Angelman Syndrome (AS). AS is a disease of imprinting the paternal Ube3a allele in neurons when the maternal Ube3a allele is deleted or mutated. There is no available treatment for this disease so far. Although the timing of sleep is regulated by the circadian biological clock, there have been no reports of the consequences of reduced Ube3a dosage on circadian behavior and related mechanistic links in mouse models.

Methods: Circadian behavior in two mouse models of AS was measured by locomotor activity assay. The molecular clocks in the central pacemaker of the suprachiasmatic nuclei (SCN) and the peripheral tissues were measured by bioluminescence reporter recording. Immunob-
lotting and co-immunoprecipitation were applied to analyze proteins expression and interaction respectively. The transcripts regulation of Ube3a was defined by RT-PCR and the promoter luciferase analysis.

**Results:** In two AS models, we find enfeebled circadian activity behaviors and slowed molecular rhythms in ex vivo brain tissues. As a consequence of compromised circadian behavior, metabolic homeostasis is also disrupted in AS mice. Unsilencing the paternal Ube3a allele pharmacologically restores circadian periodicity in neurons deficient in maternal Ube3a, but does not affect periodicity in peripheral tissues that are not imprinted for uniparental Ube3a expression. The ubiquitin ligase encoded by Ube3a directly interacts with BMAL but not with other central clock components (e.g., PER1/2 and CRY1/2). Moreover, inactivation of Ube3a expression elevates BMAL levels in the hypothalamus of AS model mice, indicating an important role for Ube3a in modulating BMAL turnover. Finally, a reciprocal regulatory network between Ube3a and Bmal1 is observed.

**Conclusion:** Ube3a expression constitutes a direct mechanistic connection between symptoms of a human neurological disorder and the central circadian clock mechanism. The lengthened circadian period leads to delayed phase, and this characteristic can explain the short sleep duration and increased sleep onset latency of AS subjects. Moreover, pharmacological rescue of Angelman Syndrome functional symptoms, in this case, circadian period reveal potential treatments and biomarkers for sleep disorders in AS patients and some autism patients, whose ube3a is overexpressed.

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**MEAN LIGHT TIMING IS CORRELATED WITH BODY MASS INDEX AND BODY FAT IN ADULTS**

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**Introduction:** Timing and intensity of light exposure has been shown to be correlated with self-reported body mass index (BMI) in adults. The goal of this analysis was to test the hypothesis that mean light timing (MLiT) is associated with objectively measured BMI and body fat.

**Methods:** Twenty three healthy adults (16 females, ages 26.1 ± 7.1 years, BMI 29.3 ± 5.6 kg/m²) wore a wrist monitor (Actiwatch Spectrum) for 7 days to determine light patterns. Light data was binned into 2 minute epochs, smoothed using a 10-minute moving average, and then aggregated over 24 hours for each individual. The mean light timing above a threshold light level C (MLiTC) was defined as the average clock time of all aggregated data points above C lux with thresholds ranging from C = 20–2,000 lux at 20 lux intervals. Height and weight were objectively measured to determine BMI. Seventeen participants (11 females, ages 25.3 ± 6.4 years, BMI 29.5 ± 5.9 kg/m²) also had total % body fat measured using dual axis absorptiometry (DXA). The relationships between BMI, total % body fat, and MLiT for all examined thresholds were analyzed with Pearson bivariate and partial correlations.

**Results:** There was a significant positive correlation between BMI and MLiT from 460–920 lux, with the strongest correlation at C = 700 lux (r = 0.60, p = 0.007). There was also a significant positive correlation between total % body fat and MLiT from 700–780 lux, with the strongest correlation at C = 700 lux (r = 0.53, p = 0.04). Controlling for sleep midpoint, sleep duration, and season, the relationship between MLiT and BMI remained (r = 0.72, p = 0.03), however the relationship with total % body fat was no longer significant.

**Conclusion:** The timing of exposure to moderate levels of light may influence body mass index and body fat. These results provide further support that changes to environmental light exposure in humans may impact body weight regulation.

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0212
ALTERED PROCESSING OF AFFECTIVE STIMULI FOLLOWING SLEEP RESTRICTION IN ADOLESCENTS: PUPILLARY RESPONSES TO SOCIAL FEEDBACK AND SOUNDS
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Introduction: Sleep loss negatively affects emotion regulation. Adolescents may be particularly responsive to social cues that influence emotion regulation. Therefore, we examined how transient sleep deprivation affects the neural processing of emotional (affective) stimuli and social feedback among healthy adolescents. The outcome measure was pupil dilation, a physiological indicator of emotional reactivity.

Methods: Healthy adolescents (11.5–14.5 years) underwent two nights in the sleep lab under two conditions: sleep extension (SE; 10 hours in bed) and sleep restriction (SR; 4 hours in bed). Two tasks were performed. A sound task (n = 38) consisted of positive, negative, and neutral sounds (14 each) from the International Affective Digitized Sounds (IADS), each presented for 6 s in duration. In a chatroom task (n = 27), participants believed they were virtually interacting with peers, including trials in which peers had to accept or reject each other for the discussion of certain topics. Peak pupil dilation responses to stimuli in both tasks were averaged and analyzed with mixed effects ANOVA.

Results: The sound task revealed a significant interaction between sleep and affective valence, with larger responses to negative sounds (F = 7.7, p = 0.01), but not neutral or positive, following SR. The chatroom task revealed a main effect of sleep condition, with larger pupil responses following SR during both acceptance and rejection trials (F = 4.22, p = 0.043), but no interaction of sleep and task condition (accept/reject).

Conclusion: During transient sleep loss compared to extended sleep, adolescents showed greater pupillary reactivity only to negative emotional sound stimuli, whereas they were more responsive to both positive and negative social feedback. Sleep restriction may have varying effects on the processing of affective stimuli depending on the nature of the stimulus and the peer social context. These findings may have implications for understanding the development of emotionally-influenced behaviors within the peer social context.

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0213
USE OF MOBILE ELECTRONIC DEVICES IN BED ASSOCIATED WITH SLEEP DURATION, INSOMNIA, AND DAYTIME SLEEPINESS
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Introduction: In recent years, mobile devices have become ubiquitous in bedrooms. The extent to which use of these devices is related to habitual sleep factors among adults is not well studied.

Methods: Data from the Sleep and Healthy Activity, Diet, Environment, and Socialization (SHADES) study were used. Data were collected from surveys of adults age 22–60 in southeastern Pennsylvania (N = 1007). Sleep duration was assessed using the NHANES item and was categorized as short (≤ 6 h), normal (7–8 h, reference), and long (≥ 9 h). Insomnia was assessed using the Insomnia Severity Index (ISI) and was categorized as none (reference), mild, moderate, or severe. Sleepiness was assessed as scores of ≥ 10 on the Epworth Sleepiness Scale (ESS). Subjects were asked to rate the frequency of mobile electronic device use at night on a scale of 0 (“Never”) to 4 (“Every night”). Variables included presence of device, any use, texting, emailing, browsing internet, calling, or social networking in bed, being woken by a call/text/email, being woken by device alarm, and checking device during the night. Since most use was among younger participants, age was restricted to 22–29 (N = 473) and analyses were adjusted for age, sex, education, and race/ethnicity.

Results: Simply having access to a device near the bed was not associated with short sleep, insomnia, or sleepiness, nor were most specific behaviors (e.g., calling or texting). Short sleep duration was associated with Emailing “every night” (OR = 2.95; p = 0.003), browsing the internet (OR = 5.73; p = 0.003) and checking the device at night (OR = 2.78; p = 0.015). Being woken by a call “every night” was associated with moderate insomnia (OR = 5.03; p = 0.029), and checking the device was associated with mild (OR = 4.25; p = 0.001) and moderate (OR = 17.69; p < 0.0001) insomnia, as well as excessive sleepiness (OR = 2.31; p = 0.037).

Conclusion: Using the internet in bed was associated with shorter sleep duration and frequently checking the device at night was associated with less sleep, more insomnia, and excessive sleepiness.

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0214
IRREGULAR SLEEP IN COLLEGE STUDENTS: CONSEQUENCES FOR SLEEP CONSOLIDATION, CIRCADIAN RHYTHMS, AND PERFORMANCE
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Introduction: The sleep-wake schedules of college undergraduates are notoriously irregular. However, this variability and its impact on sleep consolidation have not been systematically quantified.

Methods: 61 Harvard undergraduates completed online sleep diaries twice daily for a month. Sleep data were analyzed using a new quantitative metric for classifying sleep regularity that computed the likelihood of arousal state being the same at time points 24 hours apart. The most irregular and regular quintiles (N = 12/group) were selected for salivary melatonin collection. Tendency to distribute sleep around the clock was calculated by summing vectors for each sleep episode (length = duration, angle = clock-time) and normalized by total daily sleep duration.

Results: Nighttime sleep was significantly shorter and daytime sleep was significantly longer in irregular than regular students (5.70 ± 0.88 h (s.d.) vs. 7.05 ± 0.54 h, and 1.46 ± 0.82 h vs. 0.19 ± 0.16 h, respectively; P < 0.0002 for both); total daily sleep time (7.24 ± 0.66 h vs. 7.25 ± 0.6 h) was not significantly different. The average times of sleep onset, mid-sleep, and wake time were 1.74 h (P = 0.001), 1.41 h (P = 0.005), and 1.2 h (P = 0.02) later in irregular sleepers, respectively, on class days and 1.57 h (P = 0.002), 1.24 h (P = 0.03), and 1.41 h (P = 0.03) later, respectively, on weekends. Sleep-propensity peaked 1.5 h later (P = 0.002), sleep-propensity amplitude was significantly lower and the sleep vector was significantly shorter for irregular than regular sleepers (P = 0.001 for both). Dim-light-salivary-melatonin onset occurred 2.5 h later in irregular sleepers (p = 0.01)(Clerx et al SRBR, 2013). Sleep regularity, but not duration, was significantly positively correlated with GPA (r = 0.36, P = 0.006; r = 0.11, P = 0.39, respectively).

Conclusion: Sleep-wake variability in college students is associated with less nighttime sleep, increased compensatory daytime sleep, later phase and reduced amplitude of the sleep-propensity rhythm, and later circadian melatonin phase. The sleep regularity metric can be used to...
quantify the impact of sleep-wake irregularity on physiological variables and academic performance.

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0215
SLEEP, MOOD, AND SOCIAL MEDIA USE IN COLLEGE STUDENTS
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Introduction: College students are notoriously poor sleepers. The overwhelming opportunities to be connected with their peers, demands of class schedules, and study hours often leave little time for sleep. Add to this the social expectations of being ‘plugged in’ to their networks and even rest time can be less than optimal. In order to better reach this at risk population we need to understand the relationships between college student sleep quality, depressive symptoms, and their use of social media.

Methods: We used a descriptive cross-sectional design to explore the relationships between college student sleep quality, depressive symptoms, and their use of social media. Sleep disturbance and impairment (PROMIS scales), sleep habits, depressive symptoms (CESD) and social media use were assessed using an online survey administered to full-time undergraduate and graduate students at The University of Texas at Austin.

Results: 141 students have completed the survey to date. Students are primarily female (84.5%), Caucasian (62.7%), and in their first two years of college (77.5%). Students reported moderate sleep disturbance and impairment and moderately high depressive symptoms. Sleep habits indicated irregular sleep schedules and an average of 5 hours sleep per 24/hour period. A majority of participants (93%) accessed social media at least daily using smart phones or computers. Sleep latency was significantly correlated with depressive symptoms (r = 0.256, p = 0.002). Social media use was significantly correlated with later sleep onset times (r = 0.232, p = 0.006).

Conclusion: College students are at increased risk for sleep deprivation and depressive symptoms. Social media use was correlated with later sleep times and may contribute to irregular sleep onset times. Further work needs to be conducted to inform students of the impact sleep quality can have on their mood and how poor sleep habits may contribute to lower sleep quality.

0216
DRINKING ALCOHOL IN THE FIRST SEMESTER: DOES SLEEP TIMING PLAY A ROLE?
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Introduction: Insufficient sleep may increase impulsivity and risk taking; epidemiological studies associate reduced, delayed, and poor sleep to substance use. We explored sleep patterns and drinking behavior in first-year college students with the hypothesis that sleep would be short and/or delayed in students who drink alcohol.

Methods: Students completed a Phase I survey in spring before fall college enrollment (high school) and submitted online daily sleep and drink diaries from day 1 of college. 715 (58% female) students (mean age = 18.6 ± 0.5 years) completed at least 50% of diaries. Any indication of alcohol use from Phase 1 measures was assigned positive for pre-collegiate drinking. From daily diary, male binge assignment = 5 or more alcoholic drinks on one day; female binge = 4 or more. Three groups were derived from those negative for high school drinking: NONE = no college drinking (n = 207, 65% female); SOME = drinking one bing day or less (n = 143, 49% female); HEAVY = more than one bing day (n = 118, 52% female). A fourth group (DRINKER) included students positive for drinking in high school who reported more than one binge event in college (n = 197, 50% female).

Results: Average nocturnal sleep time showed no group differences; however, heavier drinkers (HEAVY and DRINKER groups) had later bedtimes (F = 7.3, p < 0.001) and rise times (F = 8.2, p < 0.001), and more day-to-day variability in sleep length (F = 5.56, p = 0.001), bedtime (F = 5.59, p = 0.001) and rise time (F = 6.0, p = 0.001).

Conclusion: These data indicate that students who initiate and/or continue drinking and engage in binge drinking in college have more delayed sleep timing and more variable sleep schedules. Sleep schedules are related to drinking continuation and drinking initiation in college students, although they do not show direct evidence of pathways that may be involved. We hope to follow these students and determine whether continued drinking or alcohol abuse can be predicted from these early collegiate findings.

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and higher FTWC (B = −0.11, SE = 0.06, p = 0.05), independent of associations with having children under age 18 and greater job demands. **Conclusion:** Sleep measures were more consistently associated with WTFC than FTWC. Given that lower WTFC is associated with better sleep quality, reduced sleep maintenance insomnia symptoms, and greater perceived sleep sufficiency, future research should test interventions to reduce WTFC.

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**0219**

**UNEQUAL BURDEN OF SLEEP-RELATED OBESITY AMONG BLACK AND WHITE AMERICANS**

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**Introduction:** This study ascertained whether inadequate sleep places unequal burden on blacks, relative to their white counterparts.

**Methods:** Analysis was based on data obtained from adult Americans (age range: 18–85 years) who participated in the National Health Interview Survey, an important surveillance study of the health of the US population providing sociodemographic, health risk, and medical data from 1977–2009. Sleep duration was coded as either very short sleep [VSS] (≤ 5 hours), short sleep [SS] (5–6 hours), or long sleep [LS] (> 8 hours), referenced to 7–8 hour sleepers. Overweight was defined as BMI ≥ 25.0 and ≤ 29.9 kg/m² and obesity, BMI ≥ 30 kg/m², referenced to normal weight (BMI = 18.5–24.9 kg/m²).

**Results:** Multivariate-adjusted regression analyses indicated that among whites VSS was associated with a 10% increased likelihood of being overweight and 51% increased likelihood of being obese, relative to 7–8 hour sleepers. SS was associated with a 13% increased likelihood of being overweight and 45% increased likelihood of being obese. LS was not a significant predictor of overweight, but it was associated with 21% increased likelihood of being obese. Among blacks, VSS was associated with a 76% increased likelihood of being overweight and 81% increased likelihood of being obese. SS was associated with a 16% increased likelihood of being overweight and 32% increased likelihood of being obese. As for whites, LS was not a significant predictor of overweight, but it was associated with a 25% increased likelihood of being obese.

**Conclusion:** Our investigation demonstrates strong linkages between inadequate sleep and overweight/obesity among both black and white Americans. While it cannot be said that insufficient sleep causes overweight or obesity, it is apparent that blacks sleeping 5 hours or less may be unequally burdened by sleep-related overweight/obesity.

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0220

**WHAT FACTORS PREDICT SLEEP CONTINUITY COMPLAINTS?**

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**Introduction:** Little is known about what factors prompt individuals to identify themselves as having a problem with insomnia. The present analysis evaluated whether complaint status is mediated by insomnia severity or frequency, and/or whether other factors are relevant for this determination.

**Methods:** This analysis was performed on a recruitment database that corresponds to an on-line screening questionnaire ([www.sleeplessinphilly.com](http://www.sleeplessinphilly.com)). The database contains 3111 screening questionnaire submissions for studies of individuals with good sleep, insomnia, depression (acute and remitted), sleep apnea, and cancer (acute and remitted). Three-step analyses were performed for each sleep variable (SL, WASO, NWAK, TST): participants were divided into two groups (Problem vs. No-Problem), demographics and sleep variables were profiled by group, and step-wise logistic regressions were performed to predict complaint status.

**Results:** The Problem group reported higher severity and frequency for all four sleep continuity variables. Prospective subjects that endorsed a problem with their sleep tended to be older, less educated,
have higher BMIs, more medical/psychiatric comorbidities, and higher rates of depression and chronic pain. The regressions showed that the most important predictors of complaint status for each sleep variable were (in order): SL - frequency, severity, psychiatric comorbidity; WASO - frequency, chronic pain, severity; NWAK - frequency, severity, chronic pain, cumulative psychiatric comorbidity, education, age, and ethnicity; and TST - severity, chronic pain, frequency, age, depression, and cumulative medical comorbidity.

**Conclusion:** Insomnia severity and frequency appear to be associated with self-identified sleep problems. The incidence of chronic pain and psychiatric comorbidity appear to further moderate this effect while demographic variables appear to be of less relevance. Further analyses are on-going regarding e.g., the relevance of chronicity, employment and marital status. Additional work is needed taking into account other factors like cumulative life stress, coping style, locus of control, etc.

### 0221
**BIDIRECTIONAL, TEMPORAL ASSOCIATIONS OF SLEEP WITH POSITIVE EVENTS, EMOTIONS, AND STRESSFUL EXPERIENCES IN DAILY LIFE ACROSS A WEEK**

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**Introduction:** Sleep is intricately tied to emotional well-being, yet few studies have evaluated the reciprocal links between sleep and well-being in the context of everyday life. We test daily experiences as predictors of same-night sleep quality and duration across a week, as well as the reversed associations (i.e., sleep predicting next-day experiences).

**Methods:** Daily diary data were obtained from two cohorts. Participants were 131 information technology and 181 extended care (nursing home) employees. During telephone interviews on 8 consecutive evenings, participants reported their previous night’s sleep quality and duration, in addition to the current day’s emotions, positive events, and stressors. Multilevel models evaluate between- and within-person associations of daily experiences with sleep quality and duration. Analyses adjust for previous day’s experiences and sleep measures, and additional day-level covariates.

**Results:** On average, employees had positive events on 38% of interview days and stressors on 36–44% of days. At the between-person level in both samples, participants with higher negative emotions had significantly poorer sleep quality. Those with more frequent stressors reported poorer sleep quality and shorter sleep duration. Accounting for between-person differences, significant within-person analyses in both samples indicated that experiencing a positive event at home was linked to better sleep quality that night. Better sleep quality predicted subsequently elevated positive emotions, lower negative emotions, and fewer work and non-work stressors on the following day. Among information technology employees, longer sleep duration predicted next-day higher positive emotions and fewer work stressors.

**Conclusion:** Daily experiences, both positive and stressful, are associated with sleep that night; likewise, adequate sleep promotes emotional well-being and protects against stress on the following day. Given the mutually reinforcing effects of sleep and daily experiences, efforts to improve sleep could consider the importance of psychological and contextual factors in daily life.

**Support (If Any):** This research was conducted as part of the Work, Family, and Health Network, which is funded by a cooperative agreement through the National Institutes of Health and the Centers for Disease Control and Prevention: Eunice Kennedy Shriver National Institute of Child Health and Human Development (U01HD051217, U01HD051218, U01HD051256, U01HD051276), National Institute on Aging (U01AG027669), Office of Behavioral and Social Sciences Research, the National Heart, Lung and Blood Institute (R01HL107240), and National Institute for Occupational Safety and Health (U01OH008788, U01HD059773). Grants from the William T. Grant Foundation, Alfred P Sloan Foundation, and the Administration for Children and Families provided additional funding.

### 0222
**SELF-PERCEIVED INVINCIBILITY IS ASSOCIATED WITH SLEEP ONSET LATENCY AND DURATION**

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**Introduction:** Insufficient sleep is associated with altered risk-taking tendencies, but the magnitude and direction of these effects seem to differ according to a number of factors that remain poorly understood. One potential modifying influence on risk-taking is their level of perceived “Invincibility”, i.e., the degree to which an individual believes that he or she will not be affected by the consequences of high-risk behavior. Here, we examined the relationship between subjective sleep parameters and perceived invincibility.

**Methods:** Sixty-one healthy individuals (Males = 31, M age = 30, range 18–45) completed a number of self-report instruments including a brief questionnaire about typical sleep habits, and the Invincibility Beliefs Index (IBI), a validated measure that measures beliefs about the probability of various behavioral consequences during risk-taking. A bivariate correlational analysis was used to examine the relationships between scores on the IBI, sleep onset latency (SOL), and sleep debt.

**Results:** Shorter SOL on weekdays was related to higher self-perceived total Invincibility scores (r = −0.292, p = 0.023). Furthermore, participants who typically slept less than their optimum preferred amount (i.e., typical sleep hours - hours of sleep necessary to feel best) tended to show lower scores on total Invincibility (r = −0.248, p = 0.045). These relationships were found to be driven by the Audacity (i.e., boldness) subscale of the IBI for both participants who slept less than their optimum preferred amount (r = −0.355, p = 0.005) and those with shorter SOL (r = −0.377, p = 0.003).

**Conclusion:** Individuals who typically obtain more sleep and fall asleep faster tend to report greater self-perceptions of Invincibility than those who receive less sleep. These findings are consistent with evidence that sleep loss reduces motivation and self-confidence. Thus, it is doubtful that prior findings of increased risk-taking during sleep loss originate from increased self-perceptions of Invincibility and may be due more to altered decision-making, impaired inhibition, or limited information processing.

**Support (If Any):** The data for this project was collected under W81XWH-09-1-0730.

### 0223
**DO SHORT SLEEPERS MAKE MORE RISKY DECISIONS?**

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**Introduction:** Total sleep deprivation has long been reported to predict risky decision-making, but it remained unclear whether similar relationships could be found in people with short sleep duration in naturalistic setting. We aimed to study whether short sleep duration would interplay with risky decision-making behaviors.
Methods: Sixty-three young adults (aged 17–25) reported their habitual sleep duration using a 5-day sleep diary. Fourteen (22.2%) of them whose average sleep duration was between 4–6.5 hours per night formed the “short sleep duration group”, while the rest (77.7%) who slept for > 6.5 hours formed the “middle/long sleep duration group”. All completed the Risky-Gains-Task, and the number of choices in choosing safe- and risky options was taken as indication of their decision-making behavior.

Results: Group differences on age, gender and body-mass-index were non-significant (ps > 0.05). Independent t-test showed that there was significant group difference in the number of choices in choosing safe- and risky options. Short sleepers chose significantly more risky options (t(14) = 2.91, p = 0.006) and fewer safe options (t(14) = −3.00, p = 0.004) than the middle/long sleepers, particularly following a rewarded trial. Yet, there was no significant group difference in the number of choices in choosing the two options following a punished trial (ps > 0.05).

Conclusion: Short sleep duration was associated with more risky decision-making after the participants were rewarded for their preceding choice. Our results shed light on the importance of short sleep duration in heightening reward sensitivity in risky decision-making under uncertainty and in haste.

0224
TO NAP, PERCHANCE TO DREAM: A MODEL OF REASONS FOR NAPPING
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Introduction: Napping has received increasing attention because of its associations with health and its use as a tool to understand the function of sleep. Understanding the reasons why people nap, as well as the correlates of these behaviors, can provide insights into normal and pathological nap behaviors. Thus, we systematically assessed why people nap using factor analysis.

Methods: 434 participants (age = 19.45 ± 2.1; 57% male) completed a survey of sleep habits, nap behaviors, and psychosocial well-being. Exploratory factor analysis was used to reduce 29 reasons for napping into interpretable factors, taking into account eigenvalues, interpretability of factor loadings, previous theory, and reliability. Psychosocial profiles for napping were examined using linear regression.

Results: The results suggest there are five reasons for napping, which can be summarized using the acronym DREAM: Dysregulative (napping due to physical or occupational dysfunction), Restorative (napping due to short sleep or poor sleep quality), Emotional (napping because of poor mood or to avoid a social situation), Appetitive (napping because of enjoyment or habit), and Mindful (napping to refocus, increase alertness). Overall, only Emotional reasons for napping were associated with poor sleep and psychosocial well-being, including poor sleep quality (b = 0.33, p = 0.002), high daytime sleepiness (b = 0.39, p = 0.002), depression (b = 2.01, p < 0.0001), stress (b = 1.28, p < 0.0001), low conscientiousness (b = −0.10, p < 0.0001), high neuroticism (b = 0.12, p < 0.0001), and poor general health (b = −3.10, p < 0.0001).

Conclusion: Factor analysis allows examination of the psychological motivation underlying health behaviors, including napping, and sheds light on relevant psychosocial correlates that can be obscured without separating behaviors into theoretically and practically meaningful subtypes. Our results suggest that poor psychological and physical health is primarily associated with Emotional reasons for napping. The use of factor analysis raises possibilities for future research, including examining the stability and structure of reasons for napping throughout the lifespan, as well as the psychological, social, and health processes associated with napping behaviors.
was analyzed using a repeated measures ANOVA with condition (pre or post-nap) as the within-subjects factor and group (nap or no-nap) as the between subjects factor.

**Results:** Results revealed that those in the no-nap condition showed an increase in self-reported impulsivity, F(1,37) = 6.24, p = 0.02, and decreased tolerance for frustration, F(1,36) = 5.04, p = 0.03, while nappers showed a significant decrease in impulsivity, and a significant increase in frustration tolerance.

**Conclusion:** Our results indicated that extended wakefulness decreased emotion regulation with regard to self-reported impulsivity and frustration tolerance. Napping, however, prevented these impairments, and may represent an effective countermeasure to executive function dysregulation associated with extended wakefulness.

**Support (If Any):** This work was supported by a predoctoral research grant from the Rackham School of Graduate Studies, University of Michigan.

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**0228**

**LONG AND SHORT SLEEP INCREASES THE PROBABILITY OF RISKY BEHAVIORS AMONG SUICIDAL ADOLESCENTS**

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**Introduction:** Sleep and behavioral problems are frequently co-morbid and might be more problematic for at-risk populations. Previous research links increased suicidal thoughts and behaviors with insufficient sleep. The current study examines the relation between sleep and risky behaviors among adolescents who have attempted suicide.

**Methods:** Using the Youth Risk Behavior Surveillance System, adolescents with at least one suicide attempt in the previous year were identified. The sample was 66.3% female and 15.95 ± 1.28 years in age. Sleep was measured by a self-report question of how many hours participants slept on an average school night. Sleeping 8 or 9 hours a night was considered sufficient sleep (SUF). Seven or fewer hours was categorized as short sleep (SHO), and participants getting 10+ hours were considered long sleepers (LONG).

**Results:** Of the 919 respondents reporting any suicide attempt, LONG reported significantly more suicide attempts (M = 3.65; SD = 1.25) than SUF (M = 2.62; SD = 0.85) or SHO (M = 2.76; SD = 0.95) (F(2,916) = 2464.11; p < 0.001). The omnibus MANOVA was significant [F(6,1578) = 5.57; p < 0.001] with LONG engaged in unhealthy behaviors such as smoking (M = 3.10; SD = 0.37), alcohol use (M = 4.5; SD = 0.45), and binge drinking (M = 3.4; SD = 0.37) significantly more frequently than SHO, respectively (M = 2.09; SD = 0.07) (M = 3.91; SD = 0.08) (M = 2.07; SD = 0.07), who engaged in unhealthy behaviors significantly more frequently than SUF, respectively (M = 1.65; SD = 0.14) (M = 3.33; SD = 0.17) (M = 1.46; SD = 1.4).

**Conclusion:** This study links sleep duration with risk for suicide attempt among adolescents. Long and short sleepers with previous suicide attempts are at particularly high risk for subsequent cigarette and alcohol abuse. Results suggest that monitoring the sleep of adolescents with a history of suicide attempts is particularly important to understand the overarching patterns of risky behaviors within this population and possibly reduce the incidence of these behaviors.

**Support (If Any):** Youth Risk Behavior Survey is conducted by the Adolescent and School Health Centers for Disease Control and Prevention (CDC).
and GPA via depression and/or motivation (in this case, operationalized as self-efficacy). We expected that (H1) freshman students at risk for sleep disorders would be more likely to leave the institution during a three-year period, and (H2) those who remained would have lower grades. We also hypothesized (H3) indirect effects through both self-efficacy and co-varied depression. The final two models tested indirect associations of sleep with GPA via depression followed by self-efficacy (H4: sleep > depression > self-efficacy > GPA), or, alternatively, from sleep to self-efficacy to depression (H5: sleep > self-efficacy > depression > GPA).

Results: Analyses controlled for demographic and disability status, general health, sleep practices and chronicity. Students at risk for a sleep disorder were more likely to leave the institution over the three-year period, although this association was weakened when covariates were included. Risk for sleep disorder predicted GPA at the end of the first and second years. When entered simultaneously, indirect effects emerged through self-efficacy but not depression. Sequential entry of depression and self-efficacy indicated a significant indirect effect through depression followed by self-efficacy in year one.

Conclusion: Risk for sleep disorders among freshmen may be a predictor of retention and academic success, and indirect effects through self-efficacy might explain some of its association with GPA.

0230
PERCEIVED BEHAVIORAL CONTROL AS A PREDICTOR OF SLEEP PROBLEMS IN COLLEGE STUDENTS
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Introduction: College students constitute a chronically sleep-deprived population. Ajzen’s Theory of Planned Behavior, which stipulates that attitudes, subjective norms, and perceived behavioral control influence intentions and behavior, is useful for predicting a variety of health behaviors. It has been employed only once to predict sleep; perceived behavioral control was found to be the most predictive variable in sleep behavior. This study aimed to determine whether perceived behavioral control is predictive of self-reported sleep behavior in college students and investigates potential variables through which it affects these behaviors.

Methods: University students (n > 47) ages 19–22 filled out a questionnaire regarding current sleep behaviors and a measure of perceived behavioral control regarding sleep. Participants were also asked to list factors they perceived helped or hindered in getting sufficient quality sleep. Correlational analyses were conducted analyzing relationships between perceived behavioral control and sleep behavior, sleep problems (such as not being able to fall asleep at bedtime), the number of days in the past week the participant slept at least 7–8 hours, the quality of sleep, and sleepiness.

Results: Perceived behavioral control was found to be highly predictive of student sleep behaviors (r = −0.676, p < 0.01), including sleep duration (r = 0.694, p < 0.01), quality (r = −0.440, p < 0.01), and sleep problems (r = −0.559, p < 0.01). It also predicted sleepiness (r = −0.484, p < 0.01), likely resulting from sleep behaviors. Participants also frequently cited environments not conducive to sleep (light, noise, and phone use) and anxiety as reasons for poor sleep, and medications, exhaustion, and low stress as helpful for sleep.

Conclusion: This study suggests that perceived behavioral control is an influential factor in student sleep and should be targeted along with some of the factors participants identified as conducive or harmful to sleep in follow-up interventions that aim to improve healthy sleep behavior in this chronically sleep-deprived population.

0231
ELECTRONIC TECHNOLOGY USE TWO HOURS BEFORE BED AND DURING THE NIGHT ARE ASSOCIATED WITH SLEEPINESS AND DISRUPTED SLEEP IN COLLEGE STUDENTS
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Introduction: Electronic technology use immediately before bed and after lights out may result in next day sleepiness by disrupting sleep and circadian rhythms through promotion of arousal before and/or during sleep (e.g. alerts or monitoring for alerts). This three day diary study examined the relationship between technology use, sleep, and next day sleepiness in a home setting.

Methods: Forty-six college students (M = 19.5 years old, SD = 1.2, women = 36) with no psychological or medical disorders related to sleep were recruited through advertisement. Participants completed questionnaires (caffeine use, PSQI, and the Sleep Hygiene Index), attended diary training, kept three days of sleep and technology diaries (assessing amount and type of technology used two hours before bed), and were given $20 for participation.

Results: Sleep onset: More technology use in the two hours before bed was strongly associated with greater sleepiness at bedtime (r(43) = 0.720, p < 0.05), but not shorter sleep latencies (r(43) = 0.065, p > 0.05). Sleep quality: During diary nights, high technology users reported more arousals than low technology users (t(41) = 2.21, p < 0.05). These high technology users also reported greater daily caffeine intake, poorer subjective sleep quality on the PSQI, and poorer sleep hygiene than low technology users (all p < 0.05). Participants who reported using technology during arousals (15%) had poorer subjective sleep quality (t(20) = 3.09, p < 0.05) and more arousals (t(42) = 2.60, p < 0.05) than participants who did not. Sleepiness: More active technology use (video gaming, online correspondence, social networking, and texting) was associated with greater next day sleepiness (r(43) = 0.306, p < 0.05) for night 1 but not night 2.

Conclusion: These findings suggest technology may interfere with sleep onset (preventing sleepier high technology users from being able to fall asleep more easily than less sleepy low technology users), sleep quality, and next day alertness and support advice to limit technology use in the hours before bed and during sleep time to help protect sleep.

0232
SLEEP ELECTROENCEPHALOGRAM DELTA POWER SPECTRA IN HEAVY AND LIGHT DRINKING COLLEGE AGE STUDENTS
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Introduction: In long-term alcohol dependency, spectral analysis of the electroencephalogram (EEG) in non-rapid eye movement (NREM) sleep show diminished Delta frequency EEG power during slow wave sleep (SWS) over and above that associated with natural aging. These deficits are believed to reflect alcohol related neural disruption. It is currently unknown at what stage sleep EEG differences might emerge in heavy drinking individuals who are yet to undergo age related decreases in delta EEG power (e.g. young adults). The current study assessed the effects of alcohol drinking history, as well as acute alcohol ingestion, on SWS Delta EEG power in 18–21 year old college students.

Methods: PSG was conducted in 6 heavy drinking (HD: 19.83 ± 0.98 yrs; 142.88 ± 110.08 drinks in the previous month) and 6 light drinking (LD: 19.50 ± 1.38 yrs; 13.06 ± 9.34 drinks) young adults. Participants...
underwent two conditions: pre-sleep alcohol (dosed to 0.1% peak BAC; BAC at lights out 0.085 ± 0.02%), and placebo (0.0% BAC). Data were evaluated from frontal scalp sites during SWS in the first sleep cycle, where delta EEG power is known to be most prominent.

**Results:** By design, groups differed on drinking history in the previous month (p = 0.016), but did not differ in age, BMI or age drinking was initiated (p > 0.05). Cycle one frontal SWS Delta power was higher after alcohol consumption (2612.42 ± 1174.1 uV2) compared to placebo (2106.84 ± 1060.2 uV2) [p = 0.027], however HD had lower Frontal EEG Delta power during the first sleep Cycle compared to LD (1735.06 ± 730.8 uV2 Vs 2984.21 ± 1121.0 uV2, p = 0.035). No interaction was observed (p > 0.05).

**Conclusion:** Despite their relatively short drinking histories, HD young adults show a similar pattern of NREM SWS Delta power deficits to those seen in long-term alcohol dependency. It is unclear if these delta power differences precede heavy alcohol use in this age group, or if they are the result of neurophysiological changes associated with their heavy alcohol use.

**Support (If Any):** Australasian Sleep Association (Ripke-Granting) & NH&MRC (Fellowship #1012195) - CLN. National Institute on Alcohol Abuse and Alcoholism (AA021696) - IMC.

### 0234

**SOCIAL TECHNOLOGY USE AND SLEEP HYGIENE ASSESSMENT**

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**Introduction:** Sleep hygiene is a set of behaviors and environmental variables which impact sleep quality and quantity. The use of social media/technology (e.g. cell phones, Facebook) is relatively new, yet virtually ubiquitous among some populations. Social technology use has been demonstrated to be related to daytime sleepiness and is therefore an important aspect of sleep hygiene. We examined the usefulness of adding a social technology question to the Sleep Hygiene Index (SHI) in predicting sleep quality and sleepiness in college students.

**Methods:** 256 university students (M = 20.18 years old, SD = 4.05) were recruited from introductory psychology courses and given extra credit for participation. Each participant completed the SHI, an additional question addressing use of social technology: “I wake up early or during the night to check or respond to social technology (for example: Facebook, Twitter, Email, text, phone),” the Epworth Sleepiness Scale (ESS), the Pittsburg Sleep Quality Index (PSQI), additional questions regarding associated features of inadequate sleep hygiene, and demographic information.

**Results:** There was a significant positive correlation between the added social technology question of the SHI and global PSQI score (r(227) = 0.209, p < 0.05) and the associated features of inadequate sleep hygiene (e.g. daytime sleepiness (r(236) = 0.197, p < 0.05), preoccupation with sleep (r(235) = 0.159, p < 0.05), mood disturbance (r(236) = 0.200, p < 0.05), motivation (r(235) = 0.173, p < 0.05), and cognition (r(236) = 0.215, p = 0.05).

**Conclusion:** The social technology question added to the Sleep Hygiene Index was related to sleep quality and other features associated with inadequate sleep hygiene. These findings support the addition of a social technology question to the SHI. A rewording of the new question to distinguish between individuals waking to check social media and those who check social media upon awakening may resolve the unexpected lack of correlation between this question and the ESS.

**Support (If Any):** Marie Wilson Howells Endowment

### 0235

**SUBJECTIVE SLEEP PROFILES IN ELITE ATHLETES USING THE ATHLETE SLEEP SCREENING QUESTIONNAIRE**

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**Introduction:** Research on elite athletes’ sleep is limited. Some studies have found a high proportion of elite athletes with poor subjective sleep quality. However, the questionnaires used were not designed specifically for athletes, and may overestimate the prevalence of sleep disturbance in this population. Therefore, we assessed the subjective sleep of elite athletes using the Athlete Sleep Screening Questionnaire (ASSQ), which is still in the validation process.

**Methods:** 264 Canadian National and Olympic team athletes (ages 27.1 ± 7.9; 45% females; 52.2 ± 4.2 years at current level) from various sports completed the ASSQ. Descriptive statistics were analyzed for
XI. Behavior

**A. Basic Sleep Science**

**XI. Behavior**

The data for this project was collected under HD#069498 (RB).

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**0236**

**SLEEP MEDIATES THE RELATIONSHIP BETWEEN ETHNIC DIFFERENCES AND SELF-REPORTED PAIN AND PHYSICAL FUNCTION**


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**Introduction:** Ethnic differences in sleep duration, efficiency and quality are well-documented, with African American participants being more likely to experience disturbed sleep when compared to non-Hispanic whites. Substantial evidence also demonstrates ethnic differences in pain, with African Americans reporting greater prevalence, severity and pain-related outcomes. Osteoarthritis (OA), a leading cause of disability among older adults, has higher prevalence rates and poorer pain-related outcomes in African American patients when compared to non-Hispanic whites. The current study sought to examine the relationship between sleep and pain in a sample of otherwise healthy older adults diagnosed with osteoarthritis (N = 144, mean age = 60.8, SD = 9.88, 74.3% female, AA = 56, NHW = 88).

**Methods:** The Western Ontario and McMaster Universities Osteoarthritis Index (WOMAC) was used to measure pain and functional status. The Pittsburgh Sleep Quality Index (PSQI) was used to measure the participant’s self-reported sleep quality. To examine the potential mediating effect of sleep quality on pain and functioning, a statistical bootstrapping technique recommended for tests of indirect effects (Hayes’ Process model #4) was conducted.

**Results:** Results indicate a significant difference in sleep quality, pain and physical functioning between African Americans and non-Hispanic whites (p's < 0.05), with African Americans endorsing lower sleep quality, more pain and poorer physical functioning. Sleep quality mediated the relationship between ethnicity and pain (t = 4.9; p < 0.001) and ethnicity and physical function (t = 4.8; p < 0.001), controlling for sex. When sleep quality was included in each model, the effect of ethnicity on pain and functioning was no longer significant (p's > 0.05).

**Conclusion:** These findings suggest that the greater pain and poorer physical function observed in African American patients may be explained, at least partially, by differences in sleep quality. These results also indicate that poorer sleep quality in African Americans may strongly affect pain and functioning; consequently, sleep quality may be an important clinical factor to consider and address in chronic pain treatment.

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**0237**

**HIGHER DAY-TO-DAY TIME IN BED VARIABILITY PREDICTS LOWER LIFE SATISFACTION IN RECENTLY SEPARATED ADULTS**

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**Introduction:** Recently divorced adults report considerable sleep problems, but little research has explored this area. Night-to-night variability of sleep is both common in insomnia and associated with poor subjective well-being. Whether there is an association between night-to-night variability in sleep and well-being in recently separated adults is currently unknown. The goal of the present study was to examine the relationship between night-to-night variability in sleep and both subjective sleep quality and psychological well-being.

**Methods:** Ninety-seven (N = 97) adults (all of whom had been in a marriage or marriage-like relationship for at least 3 years) who had physically separated from their ex-partner within the past five months completed the study measures, including the Satisfaction with Life Scale (SWLS) and sleep diaries. Regression analyses were used to predict SWLS from night-to-night variability in total sleep time (TST) and time in bed (TIB), derived by combining night to night differences in minutes and averaging across a week.

**Results:** Variability in TST and TIB were highly correlated. As a result, we tested them in two separate regressions predicting SWLS. Both TIB variability (β = −0.31, p < 0.05) and TST variability (β = −0.23, p < 0.05) significantly predicted SWLS. In a second set of regressions, we included relevant covariates to determine if these effects were still significant after accounting for depression, time since separation, age, sex, parental status, and absolute levels of TST and TIB. TIB variability still significantly predicted SWL (β = −0.25, p < 0.05), while TST did not (β = −0.16, p = 0.08).

**Conclusion:** Adults experiencing recent marital separation may benefit from having more uniform sleep schedules where their time in bed is less variable. Future research should explore night-to-night sleep variability using objective measures of sleep and the relationship between objective sleep variability and well-being.

**Support (If Any):** The data for this project was collected under HD#069498 (RB).
0238
SLEEP DURATION IN TWO DIFFERENT NAVY WATCHSTANDING SCHEDULES
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Introduction: Many Naval surface operations involve rotating watchstanding schedules with limited sleep opportunities. One schedule, the “5/15,” rotates backward through periods with 5 h on, 15 h off duty. The timing of sleep varies over days, and sleep is split once every 4 days. Another schedule, the “3/9,” cycles through periods with 3 h on, 9 h off duty. This allows for consistent sleep timing over days, but sleep may need to be split to accommodate nighttime watchstanding. In both the 5/15 and 3/9 schedules, four watch sections alternate so that there is a watchstanding crew at all hours. In this pilot study, we compared sleep durations in simulated sections of the 5/15 and 3/9, keeping total watchstanding duration and sleep opportunity equal across schedules.

Methods: N = 15 healthy, male subjects (ages 18–29) spent 5 consecutive days and nights in a laboratory. Subjects were assigned to one of four watch sections, each with 6.5 h sleep opportunities daily: (A) 5/15 with sleep at 00:30 (day 1), 22:30 (day 2), 18:30 (day 3), and split sleep at 19:00 (2 h) and 03:00 (4.5 h) (day 4); (B) 5/15 equivalent to (A), but shifted to begin on day 3; (C) 3/9 with sleep at 22:30 daily; and (D) 3/9 with split sleep at 21:00 (2 h) and 04:00 (4.5 h) daily. Each group had 4 subjects, except (D), which had 3. Sleep was measured with wrist actigraphy and analyzed with mixed-effects ANOVA.

Results: Grand mean sleep duration was 5.56 h (SE: 0.08 h) and did not differ significantly between watch sections (F = 0.19, p = 0.90). However, there was an interaction of section by day (F = 3.82, p < 0.001), with both 5/15 sections sleeping less when sleep was scheduled to begin at 18:30, in the wake maintenance zone. Sleep duration did not decrease when sleep was split, and even tended to increase when split sleep followed a prior sleep period starting in the wake maintenance zone (F = 3.02, p = 0.08).

Conclusion: Although sleep duration did not differ significantly between simulated 5/15 and 3/9 watch sections overall, sleep duration was more steady in the 3/9, which maintained circadian alignment across days. Furthermore, splitting sleep in one of the 3/9 sections did not adversely affect sleep duration. Larger samples are needed to investigate whether the increased sleep stability of the 3/9 schedule also yields a performance advantage.

Support (If Any): Naval Postgraduate School award N62271-13-M-1228

0240
INTENTION AND WILLINGNESS TO DRIVE WHILE DROWSY AMONG UNIVERSITY STUDENTS
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Introduction: Few studies have examined sleepiness-related risk behaviors using health behavior theories. This study assessed the utility of constructs from the Theory of Planned Behavior (TPB) and the Prototype Willingness Model (PWM) to predict intention and willingness to engage in drowsy driving in a population of university students.

Methods: An online questionnaire was used to collect data from 497 university students (Mean Age = 23.24 ± 5.58 years) on their attitudes, subjective norms, and perceived behavioral control concerning drowsy driving behavior in various situations, as well as on their intention and willingness to engage in such drowsy driving behaviors in the future. Hierarchical multiple regression was used to assess: (1) the utility of attitudes, subjective norms, and perceived behavioral control (“the TPB constructs”) in predicting intention and willingness to engage in drowsy driving behavior; and (2) the utility of augmenting the TPB constructs with the PWM construct of willingness to better predict drowsy driving intention.

Results: After adjusting for personal characteristics and past driving behavior, the TPB constructs significantly (p < 0.001) explained an additional 39–46 percent of the variance in drowsy driving intention and an additional 24–37 percent of the variance in drowsy driving willingness. Perceived behavioral control was consistently the strongest predictor for both drowsy driving intention and willingness. Augmenting the TPB constructs with willingness significantly (p < 0.001) explained an additional 4 to 7 percent of the variance in drowsy driving intention. Perceived behavioral control and willingness were consistently the strongest predictors for drowsy driving intention in the augmented model, which together with the control variables explained 64–70 percent of the variance in intention.

Support (If Any): This study was made possible by Wynand Serfontein and was funded by South African Airways.
Conclusion: The TPB and PWM are promising theoretical frameworks for understanding motivational influences on drowsy driving behavior and for developing effective drowsy driving prevention interventions in young people.

0241
THE RELATIONSHIP BETWEEN SLEEP QUALITY AND RESILIENCE IN VETERANS AND ACTIVE DUTY PERSONNEL OF THE IRAQ AND AFGHANISTAN CONFLICTS
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Introduction: Two-thirds of returning US troops complain of post-deployment sleep disturbance. Despite the growing link between poor sleep and negative psychological health outcomes, the impact of chronic poor sleep quality on resilience has not been studied. Resilience, defined as positive adaptation to trauma or adversity, is a focal point in military health initiatives, particularly within post-deployment reintegration settings. This study aims to provide a first look into the relationship between sleep quality and resilience.

Methods: This analysis included 2,597 Iraq and Afghanistan military Veterans (average age = 37.2 years, 80.4% male, average tours = 1.48, combat: 27.9%, combat support: 40.5%) drawn from the Mid-Atlantic Mental Illness Research, Education, and Clinical Center (MIRECC) Study of Post-Deployment Mental Health. An in-person assessment captured resilience (Connor-Davidson Resilience Scale), Post-Traumatic Stress Disorder (Davidson Trauma Scale), sleep quality (Pittsburgh Sleep Quality Index), and combat exposure (Combat Exposure Scale). Pearson correlations were used to examine the relationship between resilience and components of sleep quality. A regression model was used to examine predictors of resilience, including sleep quality and combat exposure.

Results: Sixty-three percent of participants endorsed poor sleep quality (PSQI > 5; M = 9.15, SD = 4.9), which was negatively associated with resilience (r = -0.46, p < 0.001). Longer sleep onset, lower sleep efficiency, shorter sleep duration, worse sleep quality, and greater daytime disturbance were each associated with lower resilience (all p's < 0.001). After adjusting for age, gender, and combat exposure, sleep quality explained an additional 18% of the variance in resilience scores, with poorer sleep quality being associated with reduced resilience (F = 16.22, p < 0.001).

Conclusion: Our results suggest that poor sleep quality is associated with reduced resilience among Veterans and returning military personnel, underscoring the need to better understand how untreated sleep disturbance impacts adaptation and functional health upon reintegration. Further research regarding the directionality between sleep, resilience, and physical and psychological health outcomes is warranted.

Support (If Any): Mid-Atlantic Mental Illness Research, Education and Clinical Center, Department of Veterans Affairs (VISN 6 MIRECC) of the Department of Veterans Affairs Office of Mental Health Services & the VA Mid-Atlantic Healthcare Network (VISN 6)

0242
ACTIGRAPHY AND SELF-REPORTED BASELINE SLEEP DURATION IN COMMERCIAL AIRLINE PILOTS
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Introduction: Most published studies have focused on measuring airline pilots’ sleep while in flight and during layovers. Less is known about how much pilots sleep at home while off duty. Here we compare average total sleep duration from 323 pilots measured by actigraphy and self-report.

Methods: Commercial pilots from 4 airlines volunteered to be part of 7 separate studies monitoring fatigue during long range and ultra-long range flights. Sleep was usually monitored (wrist actigraphy and sleep diaries) for 3 days prior to a trip, through the trip, and for at least 3 days after their return home.

Baseline sleep was defined as sleep taken during the 24 hour period 12:00-12:00 local time in the trip departure city, excluding the 24 hours immediately prior to the first flight (to exclude preparatory sleep changes) and approximately 72 hours after returning from the previous trip (to exclude recovery sleep changes). Participants were also asked to estimate the total amount of sleep they obtain while off duty and sleeping at home.

Results: Pilots (median age = 51 years; range 23–64) self-reported sleeping a mean of 7.64 h (SD = 1.1 h) while off duty at home. Number of actigraphy baseline sleep days ranged from 1 to 19, with 90% of participants having ≥ 4 days baseline sleep (median = 2 days). Each individual’s baseline total sleep was averaged. Overall mean total sleep per 24 h = 6.75 h (SD = 0.98 h). When measured with actigraphy, pilots obtained a mean of 52 fewer minutes than self-reported off duty sleep duration at home. One-way ANOVA showed no significant differences in mean total sleep duration between studies or airlines for both self-report and actigraphically measured sleep (all p > 0.05).

Conclusion: These analyses provide objective baseline sleep duration data for a large population of airline pilots, who are a highly medically screened, healthy workforce. While off duty, their mean total sleep duration per 24 h is about 50 min less than their self-reported nightly sleep duration.

Support (If Any): Delta Air Lines

0243
WHERE ARE THE SLEEP DURATION DISPARITIES? THE RELATIONSHIP BETWEEN SLEEP DURATION AND RACE/ETHNICITY DEPENDS ON STATE OF RESIDENCE: DATA FROM 50 STATES AND THE DISTRICT OF COLUMBIA, BRFSS 2013
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Introduction: Several studies have shown that sleep duration is associated with race/ethnicity, and these associations may play a role in health disparities. It is plausible that different social/environmental contexts may reflect different relationships to sleep.

Methods: Data from the 2013 BRFSS was used (N = 484,401 with sleep duration data). The BRFSS is a state-based telephone survey conducted by the CDC. Data from 50 states and the District of Columbia were included. Sleep duration was assessed as habitual sleep in a typical day during the last 7 days. The BRFSS was stratified by median household income, state, and race/ethnicity. Covariates were included, age, sex, education, access to insurance, smoking, and BMI.
Population-weighted multinomial logistic regression analyses examined the relationship between race/ethnicity and sleep duration in the complete sample, and stratified by state.

**Results:** Overall, short sleep was more prevalent among Black/African-American (OR = 1.74; 95% CI [1.66–1.82]; p < 0.0001), Asian/Pacific-Islander (OR = 1.40; 95% CI [1.28–1.54]; p < 0.0001), Native-American (OR = 1.38; 95% CI [1.23–1.54]; p < 0.0001), and Other/Multiracial (OR = 1.58; 95% CI [1.44–1.74]; p < 0.0001) groups, and long sleep was more prevalent among Black/African-American (OR = 1.65; 95% CI [1.53–1.77]; p < 0.0001), Native-American (OR = 1.45; 95% CI [1.21–1.74]; p < 0.0001), and Other/Multiracial (OR = 1.42; 95% CI [1.17–1.72]; p = 0.0003) groups. Blacks/African-Americans exhibit greater prevalence of short sleep in 40 states and long sleep in 19 states. Hispanics/Latinos demonstrated increased short sleep in 9 states and increased long sleep in 3 states. Asians/Pacific-Islanders demonstrated increased likelihood of short sleep in 9 states, more long sleep in 1 state, and less long sleep in 7 states. Native-Americans demonstrated more short sleep in 14 states, more long sleep in 7 states and less long sleep in 1 state. Others/multiracial demonstrated more short sleep in 25 states, and more long sleep in 7 states.

**Conclusion:** The relationship between sleep and race/ethnicity varies by state of residence. It is possible that factors unique to different regions may exert differential influence over sleep as it relates to other factors such as race/ethnicity.

**Support (If Any):** K23HL110216, R21ES022931

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0244

**IS A SAILOR’S LIFE FOR YOU? ACHES AND PAINS OF U.S. NAVY SAILORS**

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**Introduction:** Musculoskeletal (MSK) symptoms are associated with physical and psychosocial aspects of work. Previous epidemiological investigations assessed MSK injuries at-sea, finding they accounted for majority of medical visits and lost man-hours compared to other injuries. Additionally, personnel at-sea often experience chronic sleep restriction countered by excessive caffeine consumption. This epidemiological, questionnaire-based study explores prevalence of and associations among MSK symptoms, sleep, alertness, and fatigue in active duty USN personnel at shore-based and at-sea commands.

**Methods:** Surveys were collected from two populations: at-sea group (USN aircraft carrier; n = 767, 14% response) and shore-based group (USN educational facility; n = 69, 11% response). Surveys included demographics, work-out frequency, sleep duration, caffeine consumption, Epworth Sleepiness Scale (ESS), Fatigue Severity Scale (FSS), and a standardized MSK symptoms survey.

**Results:** MSK symptoms were most prevalent in the upper-body (45%) in both populations. At-sea group reported lower-back (39.5%) and knees (33.6%) as highest reported anatomical sites of MSK symptoms, whereas shore-based group reported lower-back (55.3%), neck (40.3%), and shoulders (38.8%). MSK symptoms were associated with elevated fatigue levels and excessive daytime sleepiness in both populations. Compared to personnel without MSK symptoms, personnel with symptoms received less sleep (p < 0.0001), felt sleep duration was inadequate (p < 0.0001), experienced elevated daytime sleepiness (p = 0.0014), increased fatigue levels (p < 0.0001), were more likely to use sleep-promoting medications (p = 0.0039), and consumed more caffeine (p = 0.0055). Compared to the at-sea group, the shore-based group reported receiving 20-minutes more sleep per night on average (p = 0.0091) and had reduced daytime sleepiness (p = 0.0172). However, the shore-based group had higher BMI (p = 0.0089) and more MSK symptoms (p = 0.0073), particularly upper-body (p = 0.0062).

**Conclusion:** We hypothesized that shore-based duty would be less demanding on sailors than at-sea. However, this initial look shows evidence that shore-based duty in office-like sedentary environments has greater negative impacts on physical health as measured by BMI and MSK symptoms.

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0245

**BEYOND THE MEAN: A SYSTEMATIC REVIEW ON THE CORRELATES OF DAILY SLEEP VARIABILITY**

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**Introduction:** Correlates of mean sleep duration and quality have been extensively researched, but correlates of daily sleep variability have rarely been examined and are poorly understood. This systematic review identifies factors that are associated with daily sleep variability, and discusses opportunities and challenges in examining variability as a dimension of sleep parameters.

**Methods:** A systematic search and review following the PRISMA guidelines were conducted in five major databases from inception to November 2014. Unique records (N = 3411) that imply the presence of daily sleep measures and the examination of its variability were identified and screened, with 70 records meeting the following criteria for review: (a) human adults; (b) peer-reviewed empirical publications; (c) daily assessment of sleep for ≥ 3 consecutive days; (d) variability of daily sleep parameters were quantified and examined in relation to other variables.

**Results:** Included studies spanned 1974 to 2014, with 45.7% published in the last 5 years. Most studies quantified variability using individual standard deviations (ISD; 58.6%) or ISD/individual mean (14.3%). Overall, this literature appeared ad hoc, with under-developed theoretical frameworks and inconsistent methodologies. Nevertheless, the following themes emerged. (a) Insomnia (21.4% of studies): higher variability in sleep duration and quality were associated with greater insomnia complaints; cognitive behaviour therapy for insomnia reduced such variability. (b) Psychopathology (20%): variable sleep patterns were associated with bipolar disorder, depression, posttraumatic stress disorder, and schizophrénia. (c) Health: variable sleep duration was associated with obesity, inflammation, and mortality. (d) Daytime functioning and cognitive performance: the roles of daily sleep variability were inconsistent. Across themes, older age consistently predicted less variable sleep timing.

**Conclusion:** Variability in daily sleep patterns was associated with important mental and physical health outcomes, and should be considered as an additional dimension when sleep is examined across multiple days. The existing literature highlights the need to adopt consistent methodology and to systematically investigate both the correlates and underlying mechanisms of daily sleep variability.

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0246

**PHYSICAL ACTIVITY AND HABITUAL SLEEP DURATION: DOES THE SPECIFIC TYPE OF ACTIVITY MATTER?**

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**Introduction:** Physical activity is associated with healthy sleep. It is unknown, though whether the source of physical activity is relevant.

**Methods:** Data from the 2013 Behavioral Risk Factor Surveillance System was used. N = 429,110 adults provided information about sleep and physical activity. Sleep duration was assessed as total habitual sleep within 24 hrs and was categorized as very short (< 4 hrs), short
(5–6 hrs), normal (7–8 hrs, reference), and long (≥ 9 hrs). Participants were also asked whether they engaged in non-occupational physical activity in the past 30 days and, if so, what specific activity, resulting in N = 75 separate activities coded. In addition to those who reported no activity (N = 125,314), the most commonly-reported activity was walking (N = 179,996). The 10 next most common activities were gardening/yard work (N = 26,637), running (N = 23,153), aerobics/calisthenics (N = 19,008), biking (N = 15,780), weight-lifting (N = 10,222), golfing (N = 6,511), swimming (5,001), yoga/pilates (N = 3,370), jogging (3,270), and household/childcare (N = 2,691). Population-weighted regressions, adjusted for age, sex, education, and BMI, assessed whether each activity (adjusted for all 74 others) was associated with sleep duration relative to both no activity and to walking.

Results: Compared to no activity, walking was associated with decreased likelihood of very short (OR = 0.59; p < 0.0001), short (OR = 0.83; p < 0.0001), and long (OR = 0.76; p < 0.0001) sleep. Similarly, aerobics/calisthenics, biking, gardening, golfing, running, weight-lifting, and yoga/pilates were associated with decreased likelihood of very short, short, and long sleep. Swimming and jogging were negatively associated with very short sleep and jogging was negatively associated with long sleep. Compared to walking, aerobics/calisthenics, biking, and running were associated with a greater decreased likelihood of very short, short, and long sleep. Weight-lifting and yoga were also negatively associated with very short and short sleep, golf was negatively associated with very short sleep, golfing was negatively associated with long sleep, and household/childcare was positively associated with both very short and long sleep.

Conclusion: Most types of physical activity were associated with greater likelihood of 7–8 hrs sleep. Some activities, especially running, biking, and aerobics/calisthenics, had effects over and above simply walking.

Support (If Any): K23HL110216, R21ES022931

0247 COLLEGE STUDENT PREFERENCES FOR SLEEP PROMOTION INFORMATION DELIVERY PLATFORMS
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Introduction: Information about the impact sleep deprivation can have on students success in college is critical; however, traditional methods of disseminating health information (e.g. posters) are not as effective for this population. College students are continuously searching for electronic ways to stay connected and up to date about information that they find important. This study describes student use of social media platforms to obtain health information.

Methods: This descriptive-cross-sectional study investigated college student use of and preferences for social media platforms for health information delivery. Full-time graduate and undergraduate students at the University of Texas at Austin were invited to participate. An online survey was used to measure student sleep (PROMIS scales), academic performance (Sleep in School), and use of and preference for social media platforms.

Results: Data collection is ongoing. 141 students have completed the survey. Students are primarily female (84.5%), Caucasian (62.7%) and in their first two years of college (77.5%). Students reported moderate sleep disturbance and impairment. Additionally, students reported moderate negative impact of sleep on their academic performance (e.g. falling asleep in class). Finally, 93% of participants used their smart phone to access the internet at least daily. Participants accessed health information on Facebook (46%), Pinterest (35%), Instagram (30%), and Twitter (19%). Gender and ethnic differences were noted regarding usage of these platforms.

Conclusion: College students are at increased risk for sleep deprivation. Although, many are unaware of the negative impact sleep deprivation can have on their everyday lives and success in college. Disseminating this information to an increasingly ‘plugged in’ population may be best done through social media platforms. This study found college students frequently use social media platforms to obtain health information; it is a natural transition to offer sleep information this way as well.

0248 STUDENT PERCEPTIONS OF IMPORTANCE LEVEL OF SLEEP PROMOTION MESSAGE CONTENT
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Introduction: Sleep is an essential aspect of life that affects academics, social functioning, and physical and emotional health. Because college students often do not realize how at risk they are for negative effects of sleep deprivation, constructing messages that will reach this group is a challenge. Therefore, it is critical to design messages that will focus on the areas college student’s find most important. This study seeks to discover which sleep information is of most interest and importance for college students. This data can be used to design future health promotion messages for this at risk population.

Methods: A cross-sectional descriptive correlational study design was used to determine students’ sleeping patterns, mood and sleep topic interest rankings. The sample includes the University of Texas full-time students. An on-line survey is sent out containing two PROMIS sleep scales (Sleep Disturbance Scale & the Sleep Related Impairment Scale), the Center for Epidemiological Studies Depression (CESD) scale, and sleep health promotion topic rankings.

Results: Data collection is ongoing. 141 students have completed the survey. Students are primarily female (84.5%), Caucasian (62.7%) and in their first two years of college (77.5%). Students reported moderate sleep disturbance and impairment and depressive symptoms. Participants ranked the interest and importance of sleep topics in the following order: #1 academic impact (e.g. study time, test performance); #2 social impact (e.g. relationships); #3 physical health (e.g. sick days, athletic performance); and #4 emotional health (e.g. mood).

Conclusion: College students are at increased risk for sleep deprivation; however, they do not often recognize this risk. Based on the findings here, in order to change this perception in college students, future public health messages should target the impact sleep deprivation has on academics, social functioning, and health.

Support (If Any): This project was supported in part by an Undergraduate Research Fellowship from The University of Texas at Austin Office of Research.
PARTIAL OCCLUSION OF CORTICAL LTP-LIKE PLASTICITY AFTER SLEEP DEPRIVATION IN HEALTHY VOLUNTEERS

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Introduction: The synaptic homeostasis hypothesis posits that there is i.) an increase in synaptic strength (cortical excitability) and ii.) a decrease in the inducibility of associative synaptic plasticity (long-term potentiation, LTP) due to saturation after sleep deprivation. This study used paired associative stimulation and transcranial magnetic stimulation (PAS-TMS) as non-invasive indices of cortical excitability and LTP-like plasticity in healthy volunteers to further test this prediction that has been largely derived from animal studies.

Methods: Nineteen healthy volunteers (10 males, 9 females, aged 18–30 years) completed a repeated-measures study with PAS-TMS assessments after one night of sleep and after one night of sleep deprivation. The order of the conditions was counterbalanced (one week interval). The motor threshold (MT) at baseline (cortical excitability) and pre-post PAS changes of the MEP (LTP-like associative plasticity) were assessed as the primary outcome parameters. Wake EEG theta activity, performance on the psychomotor vigilance task (PVT) and word-pair learning were investigated as secondary outcome parameters.

Results: Repeated-measures ANOVAs demonstrated a significantly reduced motor-threshold at baseline (enhanced cortical excitability) and a significantly reduced increase in the MEP after PAS (reduced inducibility of LTP-like cortical plasticity) after the sleep deprivation compared to the sleep condition (both p < 0.05). Particularly, no increase in the MEP could be induced by PAS after sleep deprivation. EEG theta activity of the wake EEG was increased, PVT and word-pair learning performance were decreased after the sleep deprivation compared to the sleep condition.

Conclusion: The results of the study are consistent with the predictions of the synaptic homeostasis hypothesis that cortical excitability is increased whereas the inducibility of LTP-like plasticity is decreased after sleep deprivation. Further characterization of the interplay of homeostatic and associative plasticity and the impact of sleep on these processes appears to be relevant for the understanding of basic mechanisms of plasticity, memory and adaptive behavior and pathophysiological models of major neuropsychiatric disorders, such as depression.

PARVALBUMIN POSITIVE INTERNEURONS IN CA1 PLAY A ROLE IN COORDINATING THETA FREQUENCY OSCILLATIONS AND SLEEP-DEPENDENT MEMORY CONSOLIDATION

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Introduction: Human neuropathologies like epilepsy, Alzheimer’s disease, and schizophrenia have both cognitive (e.g., long-term memory) deficits as well as disrupted sleep patterns. Consolidation of contextual fear memory (CFM) in mice is dependent on sleep, although the network-level mechanisms are unknown. In C57Bl/6 mice, during CFM consolidation there are increases in CA1 neuronal firing and in hippocampal theta (4–12 Hz) oscillations during post-training rapid eye movement (REM) sleep. We tested the role parvalbumin-expressing (PV+) interneurons play in state-specific patterns of hippocampal activity (e.g. REM theta), and whether this coordination facilitates memory consolidation.

Methods: Pharmacogenetic tools in combination with chronic in vivo recording were used to characterize neuronal and network activity changes during CFM consolidation. Adeno-associated virus (AAV) was used to express the inhibitory designer receptor hM4Di in a CRE-dependent manner in hippocampal CA1 in Pvalb-CRE mice. Following single-trial contextual fear conditioning (CFC), PV+ cells were silenced via systemic administration of an hM4Di-selective agonist, CNO; control mice were treated with vehicle. CFM consolidation was measured 24 hours later. CA1 recordings were carried out during a 24 h baseline period, and for 24 h following CFC. Functional connectivity was assessed over time in CA1 based on spike timing relationships among recorded neurons. Stability of connectivity was assessed by comparing connectivity maps across successive 1-min recording intervals throughout baseline and post-CFC periods.

Results: Silencing of PV+ FS-interneurons led to impaired CFM consolidation (assessed by quantification of context-specific freezing behavior) in hM4Di-expressing mice. While CNO treatment caused no significant changes in sleep architecture, inhibiting PV+ interneurons in CA1 attenuates p-CFC theta activity increases associated with learning in control mice. Functional connectivity within CA1 also becomes unstable following PV+ interneuron silencing.

Conclusion: Taken together, these data suggest that activity among CA1 PV+ interneurons is required for establishing network dynamics that underlie sleep-dependent CFM consolidation.

COMPLEX ASSOCIATIVE MEMORY PROCESSING AND SLEEP: A SYSTEMATIC REVIEW AND META-ANALYSIS OF BEHAVIOURAL EVIDENCE AND UNDERLYING EEG MECHANISMS

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Introduction: The beneficial influence of sleep on memory consolidation is well established; however, the mechanisms by which sleep can dynamically consolidate new memories into existing networks for the continued environmental adaptation of the individual are unclear. The role of sleep in complex associative memory is an emerging field and the literature has not yet been systematically reviewed. Here, we systematically review the published literature on the role of sleep in complex associative memory processing to determine (i) if there is reasonable published evidence to support an active role for sleep facilitating complex associative processes such as rule and gist extraction and false memory; (ii) to determine which sleep physiological events and states impact these processes, and to quantify the strength of these relationships through meta-analysis.

Methods: Search criteria were optimised to focus on memory in healthy human adults. We included studies which contrasted a normal night sleep or a nap with day wake, and excluded those which used physiological (e.g., TMS) or pharmacological (e.g., SSRIs) interventions. An initial sample of 2551 was reduced to a final sample of twenty-seven studies for inclusion in the meta-analysis.

Results: Population estimates of effect size indicate a moderate effect (r = 0.37) of sleep in facilitating associative memory as tested behaviourally. Studies which have measured sleep physiology have reported mixed findings, with every sleep stage having been found across the sample to relate to complex associative processing. Effect sizes (r) of...
sleep physiology in terms of behavioural outcomes ranged between 0.31 and 0.65.

**Conclusion:** Sleep influences complex associative processing. Significant associations between sleep electrophysiology and outcome appear to be based largely on mode of acquisition. We interpret these findings as supporting reactivation based models of associative processing, and perhaps suggesting that memory association and consolidation may represent a single underlying construct.

### 0252

**HIPPOCAMPAL ACTIVITY MEDIATES THE RELATIONSHIP BETWEEN CIRCADIAN ACTIVITY RHYTHMS AND MEMORY IN AGING**

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**Introduction:** Older adults experience parallel declines in sleep, circadian rhythm robustness, and episodic memory. These age-related changes appear to be linked such that disruptions in sleep contribute to deficits in memory. Although declines in circadian rhythm robustness are a common feature of aging and predict pathology, little is known about whether changes in circadian rhythms contribute to new episodic learning in healthy older adults. The purpose of this study was to investigate whether associative memory was related to circadian rhythm robustness and whether this relationship was mediated by hippocampal functioning.

**Methods:** Healthy older adults underwent structural and functional magnetic resonance imaging (fMRI) while performing an associative memory task, following 10 days of recording sleep-wake patterns using actigraphy. The memory task involved learning a list of unrelated word pairs and then being tested on whether newly presented pairs were previously seen together.

**Results:** Better associative recognition accuracy was related to greater circadian rhythm robustness. These relationships were independent of sleep and level of physical activity. Left anterior hippocampal activity during successful memory retrieval was positively correlated with associative recognition accuracy and circadian rhythm robustness. A mediation analysis demonstrated that the link between circadian rhythm robustness and associative recognition accuracy was mediated by hippocampal activity.

**Conclusion:** These findings indicate that greater circadian rhythm robustness is directly related to hippocampal functioning and that in turn contributes to successful memory performance in older adults. Most importantly, activity rhythms may provide early indications of systemic changes that may mark early stages of neurocognitive disorders.

**Support (If Any):** Grant to West Point’s Network Science Center and Office of the Vice President for Research, University of Texas at Austin - Research Grant Award

### 0253

**THE ASSOCIATION OF DAYTIME SLEEPINESS AND WORKING MEMORY**

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**Introduction:** Working memory is important for children’s learning behavior and optimal school performance. However, little is known about the effect of daytime sleepiness on working memory.

**Methods:** 483 community-based Chinese children completed a self-report questionnaire of daytime sleepiness and four working memory tests. Daytime sleepiness questionnaire contained seven items (e.g. feeling very sleepy during the day, falling asleep very easily, taking a long time to become alert) and was measured on a 1–4 Likert scale. Higher score represented severer daytime sleepiness problems. Four working memory tests included dot trajectory test, dot memory, digital span and block transform and the total score was used for analysis. Higher score represented better working memory.

**Results:** There were 239 (50.96) boys and 230 girls (49.04%) with a mean age of 10.88 (SD = 0.87) years. The mean of average item score on daytime sleepiness was 1.53 (SD = 0.60, range 1–4). The mean of working memory total score was 25.34 (SD = 4.43, range 10–44). Children who reported daytime sleepiness almost every day had more than 2 points lower on working memory performance than those with minimal daytime sleepiness problems (i.e. once per week (b = −2.59, se = 1.12, p = 0.031), or once or twice a week (b = −2.18, se = 1.17, p = 0.064) after adjusting children’s sex and age.

**Conclusion:** The finding suggests that daytime sleepiness is associated with poorer performance on working memory in school-age Chinese children. Future research on the mechanism of this relationship is warranted.

### 0254

**SLEEP, INDEPENDENT OF CIRCADIAN PHASE, BENEFITS TRAINING PERFORMANCE AND CONSOLIDATION OF A MOTOR MEMORY TASK**

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**Introduction:** We tested the effect of sleep, circadian phase, and their interaction on motor skill performance and consolidation using a simulated night work protocol.

**Methods:** Sixteen healthy adults were studied over two 8-day in-laboratory visits. The last four days of each visit sleep was timed normally (at night) or was shifted 12 hrs (during the day). Twice on each of these four days (8 am and 8 pm), subjects trained on the Motor Sequence Task (MST), typing a predetermined 5-digit sequence (e.g., 4-1-3-2-4) as fast and accurately as possible across twelve 30-second trials. Twelve hours later they were retested, followed again by training on a new MST sequence. Performance was measured as the number of correctly typed sequences per trial. MST training performance was measured as the average score on the last 3 training trials, and improvement was measured as retest performance (first 3 retest trials) minus training performance, reflecting memory consolidation. Number of correct sequences on random sequence typing tests was used to correct for general motor performance at each session.

**Results:** At the end of training, subjects performed better following sleep v. wake (p = 0.02), but not after the circadian night v. day (p = 0.20). Twelve hours following training, subjects showed greater improvement in performance if they had slept than if they stayed awake (p = 0.003), but showed similar improvements over the circadian day and night (p = 0.22). As expected, performance was impaired if subjects stayed awake during normal sleep hours but, surprisingly, subjects showed the most improvement after sleeping during the day.

**Conclusion:** Sleep, regardless of whether it occurs during the day or night, enhances performance during learning of a new motor skill, and supports sleep-dependent improvement on a previously learned MST.
sequence. These results clarify the interrelationship between sleep, circadian factors, and sleep-dependent processing of motor skill memory.

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0255 REM SLEEP WITHOUT ATONIA SEVERITY PREDICTS COGNITIVE IMPAIRMENT IN REM SLEEP BEHAVIOR DISORDER
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Introduction: REM Sleep Behavior Disorder (RBD) is a potentially injurious parasomnia that is strongly associated with synucleinopathy. Patients with RBD exhibit REM sleep without atonia (RSWA), the loss of normal muscle atonia during REM sleep, on polysomnography (PSG). We aimed to determine whether RSWA severity was associated with cognitive functioning in RBD.

Methods: Both idiopathic (iRBD) and symptomatic RBD (sRBD) patients completed two cognitive batteries: CNS Vitals Signs (CNS-VS) and Useful Field of View (UFOV). All subjects underwent PSG and muscle (SM: submentalis; AT: anterior tibialis) tone during REM sleep was visually and automatically scored. Group differences between sRBD and iRBD were then compared, and regression models fit to determine the relationship of RSWA and dependent cognitive measures.

Results: Twenty iRBD and 10 sRBD participated. Demographics were similar between groups. Greater deficits on cognitive testing were observed on CNS-VS for sRBD patients in processing (p = 0.014) and psychomotor (p = 0.019) speed, and on Total UFOV and subtests 2 and 3 (all p < 0.002). sRBD patients had greater combined phasic and tonic RSWA in SM (p = 0.026) and longer mean phasic burst duration (p = 0.03). Regression analyses demonstrated that SM RSWA independently predicted overall CNS-VS Neurocognitive Index (NCI) (F = 4.5, p = 0.006), adjusting for age, gender, depressive symptoms (Zung Score), and sleep disturbances (PSQI), and this relationship (F = 4.5, p = 0.006) remained significant for the iRBD group after excluding sRBD patients from analysis to account for the effect of co-morbid neurologic or cognitive disorders (F = 3.5, p = 0.03). SM RSWA was not predictive of total UFOV performance.

Conclusion: RSWA severity is predictive of lower overall cognitive performance in patients with RBD. Future prospective analysis of a larger cohort is planned to determine whether RSWA severity may also predict other neurological signs of phenocconversion to overt synucleinopathy in iRBD patients.

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0256 THE EFFECT OF SLEEP APNEA ON EMOTIONAL MEMORY
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Introduction: Patients with obstructive sleep apnea show impairment in sleep-dependent off-line processes for declarative and procedural memories. Sleep has also been shown to play an active role in the consolidation of emotional memories. Given the high prevalence of psychopathology in patients with sleep apnea, this study investigated the effect of sleep-disordered breathing on the ability to recall emotional elements of scenes.

Methods: A total of 40 participants were included, 20 of whom were newly diagnosed with obstructive sleep apnea (OSA) and 20 of whom were healthy controls (matched for age, education level and depression scores). Subjects underwent an overnight testing session, which included the Psychomotor Vigilance Task (PVT) and the emotional trade-off task in which they are asked to study scenes with negative or neutral objects placed on neutral backgrounds followed by a full night PSG. In the morning, all subjects repeated the PVT and underwent a recall test for objects and backgrounds separately.

Results: Both groups showed similar recall for the neutral background pictures (p = 0.15). However, the healthy control group showed significantly better recall for the emotional (p = 0.04) as well as the neutral (p = 0.01) objects compared to patients with OSA. The apnea hypopnea index correlated with recall of both emotional (p = 0.005) and neutral (p = 0.02) objects. In addition, participants with OSA showed higher rates (p = 0.03) for false alarms during recall (identified novel stimuli as “similar” to previously seen objects rather than “new”), which also correlated with their apnea hypopnea index (p = 0.001).

Conclusion: Our study confirms that there are two separate memory processes for backgrounds and objects and that disrupted sleep as seen in patients with sleep apnea will block sleep-dependent consolidation processes for both neutral and emotional scenes. Moreover, the higher rates of false positive responses may offer some insight into the coping mechanisms of memory impairment in this patient population.

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0257 THE ROLE OF REM AND NREM SLEEP IN THE ENCODING AND CONSOLIDATION OF EMOTIONAL MEMORIES
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Introduction: Recent evidence suggests a critical role of sleep in consolidating emotional memories. Most studies have focused on REM sleep and targeted negative vs. neutral memories, reporting inconsistent results. Here, we further explore the role of REM, NREM and sleep spindles in the encoding and consolidation of pleasant, unpleasant and neutral memories.

Methods: Forty-seven (33F) healthy university students were exposed to a first set of 40 pleasant, 40 unpleasant and 40 neutral pictures at 1:00 pm and to a second equivalent set at 5:00 pm. During a later recognition test (5.15 pm), participants saw the previous 240 pictures in random order, with 40 of each type forgotten. Participants were then assigned to two groups for the evening testing session: a Nap group (N = 31) and a No-Nap group (N = 16). Participants were awakened by phone and assigned to one of the groups without prior notice.

Results: Memory discrimination (d’), arousal and valence ratings did not differ between the REM and NoREM groups, therefore their data were collapsed into a Nap group. d’ was greater for sleep relative to wake. Although the Nap and No-Nap groups showed significantly better discrimination recent (15 m pre-retirement) versus delayed (4 h pre-retirement) pictures, only the Nap group showed a significantly higher d’ for recent compared to delayed emotional pictures. Overall, neutral pictures showed a greater d’ than pleasant items, but no difference relative to unpleasant stimuli. An association between N2 sleep spindles and d’ for delayed negative stimuli was also observed.
A. Basic Sleep Science

Conclusion: Taken together, our results indicate that daytime nap, regardless of the presence of REM sleep, facilitates the consolidation of declarative memories independent of their valence. We suggest that sleep promotes the formation of new emotional memories and that sleep spindles may critically affect their subsequent consolidation.

0258
PARTIAL SLEEP DEPRIVATION PROMOTES FALSE MEMORY FORMATION: THE NEED FOR SLEEP STUDY
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Introduction: False memory formation is elevated after one night of partial or total sleep deprivation in young adults. Here, we investigated the effects of 7 nights of sleep restriction on false memory in adolescents.

Methods: ‘Need for Sleep’ was a 2-week, dormitory-based, parallel-group study that compared neurobehavioral performance under sleep restriction (SR) and sleep extension (SE) conditions. The sample consisted of 56 middle or high school students (15–19 y; 25 males) who slept less than the recommended 9 h on weekdays. After 7 nights of either 5 h (SR group) or 9 h sleep opportunity (SE group), participants were administered a misinformation task. They viewed 100 photographs portraying two crimes. After 40 minutes, 100 sentences were presented, each corresponding to a previously shown photograph. Of these, 24 contained misinformation (critical items). After another 20 minutes, memory of the photographs was tested with a three-alternative forced-choice test that probed all 24 critical items and 12 non-critical items (consistent content in photographs and sentences). A subsequent source memory test assessed whether participants’ responses were based on the photographs and/or the sentences.

Results: For non-critical items, the proportion of correct responses was similar for the SR and the SE groups (mean ± SEM: 55.5 ± 2.8% vs. 53.0 ± 2.6%, t = 0.64, p = 0.53). For critical items, the proportion of misinformation-consistent responses, i.e. the tendency to incorporate inaccurate content from the sentences into their responses, was higher in the SR than the SE group (34.5 ± 2.9% vs. 25.8 ± 3.2%, t = 2.01, p < 0.05). The SR group demonstrated errors in source memory and attributed misinformation-consistent responses to the photographs as often as the SE group (14.2 ± 1.8% vs. 12.0 ± 2.0%, t = 0.82, p = 0.42).

Conclusion: In adolescents, sleep curtailment promotes the formation of false memory but appears not to affect verbal memory.

Support (If Any): National Medical Research Council (NMRC/STaR/0004/2008)

0259
SLEEP RESTRICTION IMPAIRS VOCABULARY LEARNING IN ADOLESCENTS: THE NEED FOR SLEEP STUDY
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Introduction: Sleep is important for learning and consolidation of memory, but few studies have examined the impact of sleep restriction on declarative memory. Here, we examined the role of sleep and study spacing on vocabulary learning in adolescents.

Methods: In the Need for Sleep Study, a dormitory-based, parallel group protocol, adolescents aged 15–19 years were exposed to 7 nights of sleep restriction (SR; n = 30; 5 h time in bed) or sleep extension (n = 26 after exclusions; 9 h time in bed) under constant supervision, as part of a 2-week protocol. Participants completed a vocabulary learning task in which they studied 40 GRE-level English words using digital flashcards. All flashcards were shown 8 times, but study spacing was manipulated such that half of the word pairs were shown twice over 4 consecutive days (spaced studying), whereas the others were shown 8 times on a single day (massed studying; 5 different word pairs per day over 4 days). Cued recall performance was assessed 24 h and 120 h after the final study session.

Results: Cued recall accuracy of the SR group was about 5 percentage points lower (~90% versus 95%; P < 0.001) at both retention intervals. For both groups, spaced studying resulted in better learning than massed studying (~97% versus 89%; P < 0.01). There was an interaction between group and study spacing, such that the ability to remember massed words was impaired by a greater amount in the SR group (P < 0.05).

Conclusion: The effects of study spacing on vocabulary learning were modulated by sleep duration. Students who underwent sleep restriction showed a reduced ability to learn massed items, but not spaced items. These results highlight the importance of combining good study habits and good sleep habits to optimize learning outcomes.

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XII. Learning, Memory and Cognition

0260
EFFECTS OF AGING ON SLOW WAVE SLEEP DISRUPTION AND REDUCED OVERNIGHT CONSOLIDATION OF SPATIAL NAVIGATIONAL MEMORY
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Introduction: Sleep consolidates spatial navigational memory, including improvement in maze task performance. Evidence supports a role for slow wave sleep (SWS) in this process. Given the decline in SWS with aging, we investigated how aging and changes in SWS affect consolidation of spatial memories.

Methods: We recruited 9 cognitively normal elderly subjects (age = 70 ± 10 years) and 13 younger subjects (age = 21 ± 1 years), who underwent one night of standard polysomnography with sleep staging and power spectral analysis. Subjects performed training and 3 timed trials before and after sleep on the same computer-generated 3D spatial maze. Improvement in average completion time after sleep was calculated. A 20-minute psychomotor vigilance test was performed in the morning prior to the maze trials.

Results: Total sleep time, sleep efficiency, and percent of N1 and N2 sleep were not different between young and elderly subjects. The elderly group displayed significantly reduced relative slow wave activity (SWA) in the prefrontal leads (79.1 ± 2% in younger subjects, 68.5 ± 1% in elderly subjects, p < 0.001, t-test) that was accompanied by increased SWS fragmentation (average SWS run duration 1.8 minutes vs 5.1 minutes, p = 0.002, rank sum test). Younger subjects showed the predicted improvement (38.8%) in maze completion time (median pre- to post-sleep completion time = 135.7 seconds versus 83 seconds, p = 0.001, signed rank test). Elderly subjects showed a non-significant 12.7% improvement in maze completion time overnight. There was no significant change in morning psychomotor vigilance between groups. Across all subjects, overnight completion time improvement was significantly correlated with relative SWA in the prefrontal leads (r = 0.54, p = 0.009).

Conclusion: Sleep of elderly subjects does not impart the same benefit toward consolidation of spatial navigational memory as sleep of younger subjects. This correlates with and may be a consequence of reduced slow wave activity across ontogeny.
0261 ACCESS TO RETROSPECTIVE EPISODIC MEMORY AND PROSPECTIVE MEMORY ACROSS STATES OF CONSCIOUSNESS

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Introduction: We present a quantitative study of retrospective episodic memory and prospective memory across states of consciousness. Strong evidence at the level of brain function suggests that while sleep may play a crucial role in memory consolidation, access to retrospective memory must be limited especially in REM sleep.

Methods: A total of 569 mentation reports from REM, non-REM, hypnagogia and waking were analysed. Physiology was monitored with the Nightcap system. Linguistic references to retrospective episodic and prospective memory were measured via objective and reliable third person analysis. Four independent, blind native speaker judges used a grammatical tool basing on a modification of our linguistic tools for the analysis of simulated motor movement and auditory verbal hallucinations (Speth, Frenzel & Voss, 2013; Speth, Frenzel & Harley, submitted).

Results: Reports from REM sleep exhibited the lowest degree of linguistic references to past or future mental scenarios, followed by NREM sleep. Sleep onset hallucinations showed a higher degree of memory access, although still significantly lower than waking mentation.

Conclusion: Our preliminary data support the prevailing physiological hypothesis that retrospective memory is a function of the physiologically distinct states of consciousness. Our results further suggest that prospective memory is similarly strongly limited in REM sleep.

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0262 RELATIONSHIP BETWEEN AMOUNT OF SLEEP AND THEORY OF MIND

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Introduction: Previous research has determined a relationship between amount of sleep and cognitive dysfunction. Cognitive abilities that have commonly been affected by amount of sleep are attention, concentration, memory, mood regulation, and response time. However, metacognitive abilities and amount of sleep have not been as closely examined.

Methods: 150 participants were recruited from a college population ranging in age from 18 to 22 with a mean of 19.5. The sample was predominantly (76.5%) female. Participants completed the Hinting Task to measure the social-cognitive domain of Theory of Mind. The Hinting task consists of 10 vignettes describing interactions between two characters where one character drops a hint to the other character. Participants hear each vignette and are asked by the experimenter what the main character “really means.” Higher scores suggest better metacognitive functioning. Mind-in-the-Eyes Test measures the social-perceptual domain of ToM. Participants were provided with 36 photos that were cropped to an individual’s eyes and asked to choose from four adjectives surrounding each photo the one that best describes the mental state of the individual in the photo. Participants’ answers are coded either correct (1) or incorrect (0), yielding a possible range of 0-36. Finally, participants were asked to indicate how many hours they slept the night prior to the study and how many hours they usually sleep.

Results: A number of correlation analyses were conducted between sleep variables and Theory of Mind. Correcting for multiple comparisons, none of the correlations came out to be significantly different from zero.

Conclusion: This preliminary data suggests that there is no relationship between amount slept and Theory of Mind. Future research should consider more sensitive sleep measures, as well as more sensitive measures of metacognitive ability.

0263 TRAIT-LIKE INDIVIDUAL DIFFERENCES IN SLEEP AFFECT COGNITIVE AND EMOTIONAL PROCESSING

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Introduction: Past research suggests that sleep, particularly Slow-Wave-Sleep (SWS) and Rapid-Eye-Movement (REM) sleep, contributes to various aspects of cognition, from memory consolidation to emotional regulation. However, these findings are mostly based on single-night studies, limiting the ability to differentiate between effects arising from trait-dependent individual differences and those resulting from state-dependent alterations that vary over time.

Methods: We investigated the long-term relationship between sleep and two behavioral tasks that were previously shown to be sensitive to sleep in single-night studies: Valence judgments of emotional facial expressions and the learning of probabilistic categorization. Natural sleep patterns of 20 participants were measured for two weeks using mobile sleep monitoring devices. The first week was used as ‘baseline’. In each day of the second week, at both morning and evening, participants: (a) rated the valence (negative to positive) of several types of facial expressions and the learning of probabilistic categorization. Natural sleep patterns of 20 participants were measured for two weeks using mobile sleep monitoring devices. The first week was used as ‘baseline’. In each day of the second week, at both morning and evening, participants: (a) rated the valence (negative to positive) of several types of facial expressions portraying positive, negative, or ambiguous emotions; and (b) trained on learning, by trial and error, the probabilistic relationships between four cues and two outcomes.

Results: Averaging the sleep and behavioral measures over the testing week for each participant, we found that: (1) the more REM sleep participants experienced, the more positively they rated ambiguous facial expressions; (2) the more SWS participants experienced, the more positively they rated negative facial expressions; (3) the more SWS participants experienced, the faster and better they learned the probabilistic categorization. The same correlations were found using the average baseline sleep measures in place of the concurrent sleep measures. In contrast, daily sleep fluctuations did not correlate with daily behavioral performance in either task.

Conclusion: Our results suggest that correlations between sleep stages and cognitive processing might be mainly a trait-dependent effect, signifying individual differences, rather than a state-dependent effect by which the sleep patterns in one night directly influence behavioral performance the following day.

Support (If Any): This work was supported by NSF Grant #1231515 to MAG from the Smart & Connected Health program.
Introduction: Previous research suggests that too little or too much sleep time in adults can have negative consequences on mortality, health, mood and cognitive outcomes. Most of these studies have measured sleep subjectively. In the present study we explored how average or long sleep measured objectively with actigraphy and sleep diaries is associated with cognitive function. We hypothesized that long sleepers would have worse cognitive performance than average sleepers.

Methods: As part of a larger longitudinal study, we measured total sleep time among 72 healthy older adults (mean age = 65.01, range = 60–77 years old, 63.9% were female) using actigraphy and sleep diaries. They were classified as average (6–7.25 h in bed) or long sleepers (8–9.25 h in bed). At baseline, we measured set shifting, visual attention and inhibition among 69 participants using the Stroop Task and the Trail Making Test.

Results: Stroop Task: N = 69 participants completed this task at baseline. Completion time significantly differed (p < 0.05) between average (N = 39, 103.40 ± 25.90 seconds) and long sleepers (N = 30, 117.61 ± 30.74 seconds) with a moderate corresponding effect size (Cohen's d = 0.50). We found no significant difference (p > 0.5) between accuracy of average (4.74 ± 6.63 errors) and long sleepers (3.73 ± 5.52 errors). Trail Making Test: N = 64 participants completed this task at baseline. We found no significant difference (p > 0.9) in completion time between average (N = 35, 80.25 ± 39.88 seconds) and long sleepers (N = 29, 79.87 ± 30.77 seconds) and no significant difference (p > 0.65) between accuracy of average (0.74 ± 0.98 errors) and long sleepers (0.86 ± 1.19 errors).

Conclusion: We found that older sleep among older adults was associated with slower completion time on a task that requires inhibition of an automatic response, the Stroop Task, but that there were no significant differences on a task that requires set shifting and visual attention, the Trail Making Test.

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0265

SLEEP-DEPENDENT MEMORY CONSOLIDATION IN INDIVIDUALS WITH SCHIZOPHRENIA

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Introduction: Learning and memory impairments are a core feature of schizophrenia (SZ). SZ is associated with significantly reduced sleep spindle activity that correlates with impaired sleep-dependent consolidation of motor procedural learning as measured by the finger tapping motor sequence task (MST). The purpose of the present study is to investigate whether deficits in sleep-dependent consolidation generalizes to declarative memory.

Methods: SZ patients (n = 10) and demographically-matched healthy controls (HC, n = 8) learned a series of word-pairs (WP) and were tested 24 hrs later after a night of sleep, monitored by actigraphy. In a separate session, participants were trained on the MST at bedtime and tested in the morning in the Clinical Research Center. Sleep was monitored for two consecutive nights using a 64-channel high-density PSG system.

Results: Overnight improvement of the MST was significantly reduced in SZ relative to HC (t(16) = 2.73, p < 0.05). In addition, SZ patients showed a non-significantly greater decrement in WP recall (8.9%, SD = 15.4) than HC (2.3%, SD = 14.3); t(16) = 0.95, p = 0.33). Importantly, baseline performance was similar between groups (HC: 70.6%, SZ: 68.2%; t(16) = 0.38, p = 0.71) In HC participants only, change in WP recall correlated with the average duration (r = 0.92, p = 0.03) and average delta power (r = 0.81, p = 0.09) of NREM3 sleep suggesting a role for slow waves in verbal declarative memory.

Conclusion: The current study replicates previous findings of impaired sleep-dependent consolidation of motor procedural memory in SZ. Increasing the sample size will determine whether SZ is also associated with a deficit in the sleep-dependent consolidation of declarative memory.

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A. Basic Sleep Science

0267
EXPOSURE TO DIM LIGHT OF 10 LUX FOR ONE NIGHT DURING SLEEP COULD DECLINE ONE’S BRAIN ACTIVATION DURING WORKING MEMORY TASK
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Introduction: This study was conducted to investigate the effect of the exposure to dim light during sleep on the brain activation during the task requiring working memory.

Methods: 23 young healthy subjects of 19 to 29 years olds participated in this study. The subjects were instructed to sleep in the polysomnography room with no light exposure on the first night and to sleep under a dim light condition of 5 lux or 10 lux on the second night. After the first and the second night, the participants underwent functional magnetic resonance imaging (fMRI) while they performed n-back test. 20 subjects were included in the analysis of fMRI imaging.

Results: Statistical parametric maps of brain regions showed more activation in the right inferior frontal gyrus (p FWE-corrected = 0.014) before exposure compared to the post exposure to 10 lux light during the n-back task. The decreases of fMRI activity in right inferior frontal gyrus (p FWE-corr = 0.033) and left frontal gyrus (p FWE-corr = 0.010) area were more significant during 2 back task rather than 1 or 0 back task in the group exposed to the light of 10 lux. The decreases of fMRI activity in right inferior frontal gyrus were more significant in 10 lux rather than 5 lux exposure group (p uncorr = 0.012).

Conclusion: To our knowledge, this is the first report on the decline of brain activation using fMRI during N back task after an exposure to dim light during sleep. This study is meaningful because the effect of dim light at night on the brain function and cognition was scientifically identified through this study.

Support (If Any): The authors have indicated no financial conflicts of interest.

0268
WITHDRAWN

0269
EXPLORING THE INFLUENCE OF SLEEP INERTIA SEVERITY ON UTILITY OF A CAFFEINE GUM COUNTERMEASURE
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Introduction: Findings from our laboratory indicate that 5 minutes of chewing caffeine gum (CG) immediately upon awakening from sleep improves performance on the psychomotor vigilance task (PVT). We sought to examine the effectiveness of CG among individuals with varying cognitive performance impairment during sleep inertia.

Methods: Eighteen healthy adults (15 active-duty service members) aged 28 ± 6.8 years completed three days of consistent sleep schedules prior to admittance to the laboratory for two overnight visits. After a pre-sleep 10 minutes PVT baseline, subjects were woken from a scheduled 2 hour nocturnal sleep episode, and 200 mg CG or placebo gum was immediately given double-blind in a counterbalanced design. The PVT was administered after 5 minutes of chewing CG. A median split (n = 9 per group) classified subjects into groups of “high” or “low” sleep inertia, defined by median PVT reaction time (MRT) after pla-

cbo, relative to baseline: ([baseline MRT – placebo MRT] / [baseline MRT]). Effect of CG on sleep inertia was then quantified as percent improvement relative to placebo: ((placebo MRT – CG MRT) / [placebo MRT]). Un-paired t-tests compared group means.

Results: MRT for baseline, placebo, and caffeine gum are as follows for low (294.2 ± 31.4, 327.2 ± 43.0, 329.2 ± 44.8) and high (297.3 ± 12.0, 386.8 ± 20.8, 348.9 ± 20.8; all means ± SD) groups. For the placebo group this equated to −11.0% and −28.3% change from baseline for low and high respectively. CG significantly improved MRT relative to placebo in the high group only (high = 9.6% improvement vs. low = −0.7% improvement; p < 0.01).

Conclusion: Findings from this preliminary analysis suggest individuals who experience more sleep inertia may receive greater benefit from CG as a countermeasure to impairments in sustained attention than individuals whose sleep inertia is less severe. These results may be extended to military operations where managing sleep inertia is important during sustained operations.

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0270
CAFFEINE GUM IMPROVES PSYCHOMOTOR VIGILANCE AND SIMULATED DRIVING PERFORMANCE DURING SLEEP INERTIA
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Introduction: As part of a preliminary analysis, we previously found caffeine gum (CG) showed potential as a countermeasure for impairments during sleep inertia assessed by the psychomotor vigilance task (PVT) and a simulated drive. We now examine the full data set to determine the effectiveness of caffeine gum during sleep inertia.

Methods: Twenty-two healthy adults (19 active-duty service members) aged 29 ± 7.1 years completed three days of consistent sleep schedules prior to admittance to the laboratory for two overnight visits. 200 mg CG or placebo gum was administered double-blind immediately upon awakening from a scheduled 2 h sleep episode in a counterbalanced design. After 5 minutes (min) of chewing, the gum was discarded and a 10 min PVT occurred followed by a 10 min simulated drive that included a divided attention task. Repeated measures ANOVA and paired t-tests examined differences in PVT outcomes [median reaction time (RT), mean RT, slowest 10%, fastest 10%, # of omissions and lapses], and simulated driving outcomes [speed variability, lateral lane position, # of crashes, and divided attention mean reaction time (DivAttRT)].

Results: CG significantly improved median RT, mean RT, slowest 10% and # of lapses relative to placebo (all P < 0.05). For all PVT outcomes except median RT this improvement occurred during the first half of the PVT. CG significantly decreased DivAttRT and speed variability during the 10 min simulated drive (both P < 0.05).

Conclusions: These results indicate that 5 min of chewing CG immediately upon awakening maybe a useful countermeasure to sleep...
inertia, especially for RT. Results were mixed on driving measures, suggesting CG may not be as useful for improving road safety. This may have implications for populations such as emergency responders and with military operational readiness. More research will be needed to determine if effects generalize to other tasks.

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0271
A PHASE-LOCKED LOOP FOR ACOUSTIC STIMULATION DURING SLOW-WAVE SLEEP
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Introduction: We developed a Brain-Computer Interface that measures the sleep electroencephalogram (EEG) in real time and delivers acoustic stimuli to enhance the slow oscillations (SO) that comprise slow-wave sleep (SWS). This system uses a Phase-Locked Loop (PLL) to predict SO phase so as to stimulate during the up-state of the slow wave. Because the PLL uses real-time measurements, it can rapidly adjust to changes in EEG rhythms. Given the relationship between SWS and cognition, our aim was to examine the efficacy of this PLL-based method for enhancing SWS and producing corresponding benefits for memory.

Methods: The sample consisted of four healthy young adults (age 20.3 ± 1.2 yrs, 2 male). Sleep was monitored using one channel to record EEG at the Fpz scalp location referenced to an adjacent forehead location, such that it was also sensitive to the electro-oculographic activity. Participants were randomized in a cross-over design to receive acoustic or sham stimulation during a nap (which contained ≥20 min of SWS) with a 1-week wash-out. Participants were blinded to condition. When NREM sleep was detected, the PLL synchronized acoustic pulses (50-ms bursts of pink noise) with the SO up-state. Stimulation occurred in blocks of 5 followed by a 5-s refractory time. Participants learned a set of 88 word-pairs, were tested 20 min prior to sleep, and retested 15 min after wake. We calculated the change in number of word-pairs recalled across the nap.

Results: Comparison between stimulation and sham naps showed an increase of 23.5% ± 6.3% increase in power in the SO delta frequency band (0.8 Hz-2.1 Hz). Recall change scores increased after both conditions and were 249% greater after stimulation compared to sham.

Conclusion: Delivery of acoustic stimulation using the PLL system can increase delta power and potentially enhance memory consolidation during sleep.

Support (If Any): Dixon Translational Research Grant, NIH T32 NS047987.

0272
FOOD AND DIET AS PERCEIVED INSTIGATORS OF ALTERED SLEEP AND DREAMS
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Introduction: Beliefs that food influences sleeping and dreaming persist with little empirical justification. This exploratory study examined: 1) the prevalence of such beliefs in students and the foods most commonly identified; 2) associations between sleep and dreams and dietary habits/motivations.

Methods: 382 students (126M: 21.65±3.3 yrs; 256F: 21.45±1.5 yrs; 1 unspecified) completed the Sleep Quality Scale, Intuitive Eating Scale, Three-factor Eating Questionnaire, other measures of dietary habits/motivations, and students’ perception that foods influenced their sleeping and dreaming.

Results: 49.7% of subjects reported food effects on sleeping (43.4%) and dreaming (17.2%). Foods identified as leading to better sleep were beverages (38.3%; mainly milk [20.2%]), fruit (25.5%), meat (23.4%), and vegetables (20.2%). Foods identified as leading to worse sleep were caffeinated (31.4%), sugary (26.7%), dairy (17.4%), greasy/fried (16.3%), “junk”/fast-foods (14.0%), spicy (8.1%), meat (8.1%), and vegetables (4.7%). Dairy products were most frequently blamed for disturbing or bizarre dreams (43.7% vs. 38.5% respectively), followed by sugary (12.5% vs. 26.9%), spicy (18.8% vs. 7.7%), and junk/fast-foods (6.3% vs. 11.5%). Subjects who perceived food effects on sleep had fewer hours of sleep (t = -1.87, p = 0.063) than others, more difficulty falling asleep (t = 2.35, p = 0.019), more nightmares (t = 2.16, p = 0.032), higher BMI (t = 0.36, p = 0.014), and more snacking when not hungry (t = 1.96, p = 0.054). Correlations also revealed a pathological constellation of variables involving disturbing dreams, poor sleep, binge-eating, emotional eating, and low reliance on hunger/satiety cues (all p < 0.01), and a healthy constellation of variables involving vivid dreams, good sleep, healthy diet, and longer times between meals/snacks (all p < 0.05).

Conclusion: Although the extent to which these perceived effects of food stem from accurate observations, misattributions, or folklore influences has yet to be determined, the results suggest that foods and dietary habits may significantly impact sleeping and dreaming. Results also suggest possible dietary strategies for improving sleep and reducing the incidence of disturbing dreams.

Support (If Any): Natural Sciences and Engineering Research Council of Canada; Canadian Institutes for Health Research

0273
NOVELTY EXPOSURE, SLEEP, AND MEMORY CONSOLIDATION
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Introduction: The encoding, storage, modification, and retrieval of memories depend on several factors. One such factor is exposure to novelty, and its effect is not limited to the novel nature of the test material itself. Memories for words are enhanced if they are studied after exposure to unrelated novel scenes, and this effect is preserved over 24 hours. Furthermore, mice studies have shown that this benefit can be nullified retroactively via dopamine antagonists, indicating that this effect is partially dependent on selective consolidation and not just encoding. Sleep has been shown to be necessary or beneficial to the preferential consolidation of certain memories such as those involving emotions, reward, and directed forgetting. The relationship between
sleep and novelty in this regard has gone unstudied, and this experiment aims to elucidate potential interactions between sleep, novelty, and memory.

**Methods:** College students were tested in two sessions over 48 hours. The first session involved familiarization with all tested words as well as a selection of scenes. The second session entailed studying words after having viewed novel or familiar scenes, a 90-minute sleep or wake delay, and immediate and post-delay tests of word memory.

**Results:** Current post-delay corrected scores for the familiar wake (n = 7, mean = 0.25), familiar sleep (n = 8, mean = 0.21), novel wake (n = 8, mean = 0.14), and novel sleep (n = 7, mean = 0.13) groups show no interactions between sleep, novelty exposure, and memory performance. Surprisingly, there is also no main effect of sleep on post-delay memory scores, nor is there a main effect of novelty exposure on either immediate or delayed tests.

**Conclusion:** Though preliminary, these data contradict typical findings on sleep and memory and challenge existing research on memory and novelty exposure. One potential explanation for the disparate sleep results may be the relatively short delay period for consolidation. Further data collection will include longer delays to control for this difference.

**0274**

**NON-REM SLEEP PLAYS A SUBSTANTIAL ROLE IN MEMORY ENCODING INDEPENDENT OF EMOTIONALITY**  
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**Introduction:** While it is known that sleep is critically related to memory, the role of sleep in emotional memory encoding has not been well documented. In the present study, we investigated the effects of total sleep deprivation (TSD) and of selective rapid eye movement (REM) sleep deprivation (REMD) on the encoding of emotional and neutral pictures (taken from the IAPS).

**Methods:** Fourteen (21.4 ± 1.65 years old) and eighteen male subjects (22.0 ± 2.09 years old) participated in the TSD study and the REMD study, respectively. In the TSD study, subjects stayed awake for 38 hours. In the REMD study, REM sleep was selectively prevented by tones (80 dB) presented contingently upon the first signs of REM sleep. In the control conditions of both studies, subjects slept in undisturbed conditions. In both studies, subjects were presented with aversive, pleasant, and neutral pictures on the day after the experimental night (between 18:00–19:00) and recognition was tested 10 min after learning.

**Results:** Analyses confirmed that the time in REM sleep, but also time in sleep stage 2 decreased during REMD compared with the control condition (from 78.83 ± 18.50 min; from 224.31 ± 183.78 min, respectively). Wake-time and sleep stage 1 increased during REMD (from 26.19 to 76.47 min; from 62.17 to 112.42 min, respectively). Recognition of the pictures was significantly impaired after TSD (negative (0.64 to 0.56), positive (0.72 to 0.58), neutral (0.76 to 0.58)], whereas no significant change was observed after REMD (negative (0.56 to 0.64), positive (0.59 to 0.57), neutral (0.57 to 0.62), p > 0.13, for all comparisons). Effects of TSD did not depend on the emotional tone of the pictures (p > 0.42, for respective ANOVA interactions).

**Conclusion:** The results point towards an enhancing role of non-REM sleep for stimulus encoding that does not depend on the emotionality of the stimulus material.

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THE EFFECT OF SLEEP ON RECONSOLIDATION OF HUMAN VISUOSPATIAL MEMORIES
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Introduction: Following reactivation, consolidated memories can be strengthened, impaired, or updated via the process of reconsolidation. Encoding new information at the time of reactivation may facilitate this process. It has been proposed that, like initial consolidation, reconsolidation may depend on sleep. However, little research has directly investigated this possibility. The current study seeks to determine the effect of sleep on reconsolidation.

Methods: Young adults learn 30 picture-location pairs (Set-1). After a night of sleep, they are tested on Set-1 to assess initial consolidation (Session-2). The following day (Session-3), all participants learn a new set of 30 picture-location pairs (Set-2) either in the morning (Wake condition) or the evening (Sleep condition). Immediately prior to learning Set-2, half of participants (Reactivation groups) are tested on Set-1 to reactivate their memory. Twelve hours later (Session-4), participants are tested first on Set-1, then on Set-2. Sleep participants in the Reactivation group undergo polysomnography between Sessions 3 and 4.

Results: In the sleep condition, there is no significant difference between groups on Set-1 learning (% correct - Reactivation: M = 88.33, SD = 5.40; Control: M = 86.84, SD = 8.78), Set-1 consolidation (change in % correct between learning and Session-2 - Reactivation: M = −1.55, SD = 5.23; Control: M = 0.00, SD = 5.67), or Set 2 learning (% correct - Reactivation: M = 88.62, SD = 3.91; Control: M = 90.37, SD = 4.31). However, between Sessions 2 and 4, memory for Set-1 declines significantly more in the Control group (M = −11.75, SD = 11.02) than the Reactivation group (M = −3.54, SD = 5.09; t = 2.902, p = 0.007), signifying reconsolidation. If reconsolidation depends on sleep, then, in the Wake condition, we expect no significant difference between groups in Set-1 memory change between Sessions 2 and 4. Furthermore, we expect memory change in the sleep condition to be related to slow-wave sleep characteristics.

Conclusion: Results indicate that triggering reconsolidation before a night of sleep strengthens human visuospatial memories. Future work in a Wake condition will test sleep-dependence of such effects.

Support (If Any): This work was funded by NIH R01 AG040133 (PI: Spencer).
solidated differentially between sleep and wake groups. Unexpectedly, significantly more neutral than negative scenarios were remembered at immediate \( t(19) = -2.46, p = 0.023 \) and delayed recall \( t(18) = -2.21, p = 0.04 \). Further, the sleep group remembered significantly more neutral scenarios than the wake group \( t(17) = -2.66, p = 0.02 \), but no differences were seen for negative scenarios.

**Conclusion:** Given that sleep enhanced memory for future scenarios, it may be that future-oriented memories rely on similar or equivalent consolidation mechanisms as past-oriented event memories. Our findings suggest that neutral event memories are preferentially consolidated over sleep, possibly because they have greater plausibility. Polysomnography may provide insight into sleep-stage correlates of past- and future-episodic memory consolidation.

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**0280**

**SOCIAL JET-LAG: IMPLICATIONS FOR FEAR EXTINCTION MEMORY**

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**Introduction:** Social jet-lag (SJ) is misalignment of sleep/wake schedule with social norms due to evening chronotype or circadian disorder causing curtailed sleep across weekdays and compensatory oversleep on weekends. Both SJ and poor extinction memory are linked with psychopathology. We examined their associations.

**Methods:** Seventy-three healthy males (aged 18–29) produced 7–9 nights of actigraphy. Event-markers delineated rest periods within which sleep/wake epochs were algorithmically scored. Naps, drugs and alcohol were proscribed, and a 2 am bedtime curfew and 7-hr minimum sleep opportunity prescribed. Sleep midpoint was midway between algorithmically determined sleep onset and waking event mark, averaged for weekday (MWD) and weekend (MWE) nights (SJ = MWE-MWD). During Fear-Conditioning, a shock established skin-conductance responses (SCR) to 2 differently colored lamps (CS+) but not a third (CS-). One CS+ (CS+E) was then extinguished. After a 3-, 12- or 24-hr delay, all 3 CS were presented (Extinction-Recall). SCRs were square-root transformed. Differential SCR was SCR to a CS+ minus SCR to its corresponding CS-. Four extinction retention indices (ERI) were computed using mean SCR to the first 2 (ERI1, ERI2) and first 4 (ERI3, ERI4) CS+E at Extinction-Recall, normalized to maximum Fear-Conditioning-phase SCR to the future CS+E (ERI1, ERI3) or either CS+ (ERI2, ERI4). Each ERI-type was correlated with SJ controlling for time-of-day and delay.

**Results:** Negative correlations between SJ and extinction recall were found using ERI1 \( r = -0.242, p = 0.036 \) with trends for ERI2 \( r = -0.212, p = 0.067 \) and ERI3 \( r = -0.195, p = 0.094 \). Using differential ERI (ERI1, negative correlations were found for ERI1 \( r = -0.246, p = 0.034 \), ERI2 \( r = -0.243, p = 0.037 \), ERI3 \( r = -0.243, p = 0.037 \), ERI4 \( r = -0.288, p = 0.013 \). No time-of-day or delay main effects or interactions were found.

**Conclusion:** Greater SJ predicts poorer extinction memory, especially computed using differential SCR which corrects for nonspecific responses to the CS-. SJ may contribute to poor extinction increasing risk of psychopathology.

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**0281**

**THE IMPACT OF INDIVIDUAL NAPPING DIFFERENCES ON RELATIONSHIP BETWEEN NAP AND WORKING MEMORY**

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**Introduction:** Prior work in our lab suggested that sleep gain during a daytime nap significantly improved working memory ability of college students. Further to the findings, this study examines if individual differences in napping and sleep characteristics would moderate the change of working memory following nap or wakefulness.

**Methods:** 81 healthy college students (aged 17–23, 36 males) were recruited to complete the Nap Habit Survey for measuring habitual nap duration and frequency; a 5-day sleep diary and Pittsburgh Sleep Quality Index for measuring habitual sleep duration and sleep quality, days prior to the experimental day. On lab day, participants were tested on the 2-back visual-spatial working memory task for two times, and randomized to either have a 90-minute polysomnography-monitored daytime nap (Nap group, \( n = 40 \)) or stay awake (Wake group, \( n = 41 \)) between the tasks. Change score of overall accuracy in pre and post condition was indicated as improvement or deterioration of working memory ability.

**Results:** Correlation analysis was done to study the relationship between variables, while factors of individual napping and sleep differences were taken in form of continuous variable. For the nap group, there was no significant correlation found between change score of 2-back accuracy and habitual nap duration, nap frequency, sleep duration or sleep quality \( (p > 0.05) \). For the wake group, only significant negative correlation between habitual nap duration and change score was found, \( r(41) = -0.877, p < 0.01 \).

**Conclusion:** Our findings give implication of interrelationship between individual differences in napping, cognitive functioning and nap. College students with habitually longer duration of nap might be more prone to have deteriorating working memory when they were not given a daytime sleep opportunity, suggesting the need for a daytime nap to preserve working memory ability. Further research may need to take individual difference in napping behaviour into account when examining the role of daytime nap in cognitive functioning.

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**0282**

**HABITUAL NANDS ARE ASSOCIATED WITH BETTER PERFORMANCE ON A WORD-LEARNING TASK IN 4-YEAR-OLD CHILDREN DESPITE A CHANGE IN CONTEXT**

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**Introduction:** Encoding elements of a memory into a flexible representation is an ability reliant on the hippocampus in adults. Importantly, the hippocampus develops protractedly and previous research suggests young children may instead be fusing objects to their background during word learning (Werchan & Gómez 2013) and object recognition (Edgin et al., 2014). Here, we test this possibility by either changing or keeping task context consistent at test. As sleep is known to impact hippocampal memories, we asked whether habitually napping 4-year-olds would out-perform their non-napping peers on a word-learning task.

**Methods:** Seventeen 4-year-old children received a single exposure to two novel object-label pairs. Children immediately received four trials of a two-choice forced alternative test between the two newly learned objects. Children were tested on the same or a different colored background from training with the different background serving as a change in context. Nap data was collected by parental report.
TO NAP OR NOT TO NAP: IS NAPPING A TRAINABLE SKILL THAT CAN BE OPTIMIZED FOR MEMORY CONSOLIDATION?
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Introduction: Some people nap regularly, whereas others avoid napping at all costs. Compared with nappers, non-nappers have more SWS during a nap (McDevitt et al., 2012), complain of post-nap sleep inertia, and have different memory outcomes following a nap (McDevitt et al., APSS 2014). We investigated if four weeks of “nap practice” could train non-nappers to be more like nappers as measured by sleep and memory performance.

Methods: Thirty-six young, healthy subjects, categorized as nappers and non-nappers via self-report and actigraphy measures, were randomly assigned to four weeks of Nap Practice (at least 3 non-lab naps/week) or Nap Restriction (no non-lab naps). Perceptual learning (PL) was tested pre- and post-intervention using a texture-discrimination-task. During each in-lab visit, subjects took a 90-minute, polysomnographically-recorded nap. Performance change was measured as a pre- to post-nap difference score.

Results: Pre-intervention, nappers showed typical performance improvements (p = 0.03), whereas non-nappers did not show learning benefits following a nap (p = 0.80). Post-intervention, only nappers in the Practice group still showed nap-dependent learning (p = 0.06). Non-nappers’ performance never improved, regardless of Practice or Restriction group assignment. Additionally, nappers had higher sleep spindle density than non-nappers (p = 0.009), and nap habits moderated the relationship between spindles and performance (p = 0.02), such that spindle densities were strongly correlated with PL in nappers (r = 0.44), but negatively correlated in non-nappers (r = -0.40).

Conclusion: Naps have been shown to benefit memory consolidation. However, our results indicate that napping may only benefit people who are regular nappers, and if deprived, these individuals may lose their nap-related learning benefits. On the other hand, for non-nappers, napping may not be an appropriate tool to enhance cognitive performance, even after four weeks of nap practice. These individual differences may be related to a functional difference in sleep spindles during a daytime nap.

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XII. Learning, Memory and Cognition

Alger SE, Payne JD

with two different faces. Baseline memory for these directly paired with either emotionally negative or neutral objects paired with neutral faces. The same objects were present in both picture sets, paired with two different faces. Baseline memory for these directly paired associates was tested immediately after encoding, followed by either a 90-min nap opportunity or an equivalent period of wakefulness. Five participants indicated if each had been studied.

Results: Across participants, there was a main effect of valence on memory (negative > positive > neutral objects). Nap and Nap+Wake participants outperformed the Wake group, and critically, did not differ in any dimension of memory even though the delay period for the Nap+Wake participants was twice as long. There was also a main effect of intentionality within the Nap (p = 0.002) and Nap+Wake (p = 0.04) groups, but not Wake group (p = 0.26), with a nap preferentially enhancing memory for to-be-remembered information.

Conclusion: Overall, this study suggests that a nap immediately after encoding stabilizes memory, preventing it from decay that otherwise would occur during wake. Further, a nap preferentially enhances memory for information of future relevance, which has important implications for educational and vocational domains.

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0286
THE DIFFERENTIAL EFFECTS OF EMOTIONAL SALIENCE ON DIRECT ASSOCIATIVE AND RELATIONAL MEMORY DURING A NAP

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Introduction: Relational memories are formed from shared components between directly learned memory associations, flexibly linking the learned information to better inform future judgments. Sleep has been found to facilitate both direct associative and relational memories. However, the impact of incorporating emotionally salient information into the learned material and the interaction of emotional salience and sleep in facilitating both types of memory is unknown.

Methods: Forty participants initially encoded two sets of picture pairs, with either emotionally negative or neutral objects paired with neutral faces. The same objects were present in both picture sets, paired with two different faces. Baseline memory for these directly paired associates was tested immediately after encoding, followed by either a 90-min nap opportunity or an equivalent period of wakefulness. Five hours after learning, a surprise test was given to assess relational memory (i.e. the indirect association between the two faces paired with the same object during encoding), followed by a retest of direct associative memory.

Results: The nap facilitated both the preservation of direct associative memories from baseline to retest and the formation of relational memories, compared to wakefulness (F1,37 = 6.00, p = 0.02; F1,36 = 5.18, p = 0.03, respectively). Interestingly, this sleep benefit was strictly observed for neutral pairs, not the negative information, for both direct associative (t37 = 3.25, p = 0.002) and relational memories (F1,36 = 4.71, p = 0.04). Further, a role for REM sleep was revealed for both neutral direct associative and relational memories.

Conclusion: Taken together, the current study provides strong evidence that sleep, and perhaps REM sleep in particular, plays a role in processing both direct and indirect neutral associative memories.

0287
NAPPING AND EMOTIONAL MEMORY TRADE-OFFS FOR POSITIVE AND NEGATIVE STIMULI

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Introduction: Sleep as opposed to wakefulness enhances the selective preservation of emotional components of memories at the cost of neutral ones, an effect known as the emotional memory trade-off effect. While previous studies have focused on memory for negative information, there is some limited evidence that similar effects occur for positive information as well. Because such studies largely require negative and positive information to be learned separately, the current study further investigated the effect of sleep on memory trade-offs when positive, negative, and neutral information was learned together.

Methods: Forty participants encoded 60 images depicting a balanced assortment of positive, negative, and neutral objects placed on neutral backgrounds. Participants then either took a 90-minute PSG-recorded nap (n = 20) at 1 pm or remained awake (n = 20) during the afternoon. At 5 pm, all participants took a surprise Remember/Know recognition test of the objects and backgrounds previously viewed, which were separated and intermixed with image components they had not seen previously.

Results: A 2 (Group: Nap, Wake) x 3 (Valence: Positive, Negative, Neutral) mixed ANOVA on trade-off scores (object - background) revealed an interaction for Remember responses, F(2,37) = 4.41, p < 0.02. The nap group (M = 0.40 ± 0.20) had a larger trade-off for negative images than the wake group (M = 0.21 ± 0.20), t(38) = 3.01, p = 0.005. There were no differences between the groups for positive or neutral Remember responses, nor for Know responses.

Conclusion: While the emotional memory trade-off does occur for positive information, and is influenced by sleep to some extent, sleep selectively impacts the trade-off for negative information when positive, negative, and neutral information are learned together. This may suggest that consolidation of negative information trumps positive information during sleep. Alternatively, differences in relative arousal between negative and positive information may be responsible for these effects.

0288
“A HEART TO CREATE”: SLEEP-DEPENDENT HEART RATE VARIABILITY AND CREATIVITY

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Introduction: Dynamic changes in vagally-mediated heart-rate variability (HRV) during nocturnal sleep have been associated with autonomic health benefits (Trinder et al., 2012), and daytime naps have a HRV profile similar to nocturnal sleep (Whitehurst et al., APSS 2014). While sleep, including naps, facilitates memory improvement, no studies have examined the role of HRV for sleep-dependent cognitive performance. Here, we investigated if sleep-specific HRV changes are associated with improvement on a creativity task.

Methods: At 9 am, twenty-one (13F) healthy participants completed 10 Remote Associates Task (RAT) problems, followed by 30 analogies. Ten analogy answers served as primes for afternoon RAT items. At 1:30 pm, waking, supine electrocardiogram (ECG) was recorded followed by a 90-minute nap with polysomnography. At 5 pm, subjects completed 30 RAT problems in three conditions: 10 novel problems, 10 problems repeated from the morning, and 10 novel problems with the answer primed by the analogies. We indexed the high frequency normalized unit (HFnu, 0.15–0.40 Hz) as our measure of vagal HRV during stages wake, N2, N3 and REM. Linear regression models assessed the unique contribution of sleep and HFnu during each stage on performance.

Results: Sleep stage and HFnu predicted repeated and primed performance (Repeated: N2 R2 = 0.40, p = 0.004, N3 R2 = 0.36, p = 0.02, REM R2 = 0.31, p = 0.04; Primed: N2 R2 = 0.28, p = 0.02, N3 R2 = 0.45, p = 0.006, REM R2 = 0.51, p = 0.004), but not novel RAT item performance. In N2, HFnu predicted Repeated (b = 0.44, p = 0.02), but not Primed (b = 0.37, p = 0.07) performance. Within SWS and REM, HFnu
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was the only significant predictor of performance (SWS Repeated: b = 0.62, p = 0.008; SWS Primed: b = 0.67, p = 0.003; REM Repeated: b = 0.56, p = 0.018; REM Primed: b = 0.74, p = 0.001).

Conclusion: This is the first empirical study showing HRV during sleep as a better predictor of creativity than sleep alone. Prior studies support a relationship between the prefrontal cortex (PFC) and both vagal HRV (Thayer et al., 2009) and creativity (Razumnikova, 2007). We hypothesize that HRV may be a signal of sleep-dependent prefrontal processing, a notion that requires further research.

0289

REM-SLEEP AND IMPROVEMENT OF PLANNING ABILITY

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Introduction: Basic cognitive functions, including memory and attention, were found to improve after sleep when compared to wakefulness. Our recent data showed that working memory ability improved following a daytime nap, and the improvement was associated with rapid-eye-movement-sleep (REM-sleep). We here investigated whether sleep, particularly REM-sleep, also facilitated planning ability, as another higher-order cognitive function, subserved by the prefrontal cortex.

Methods: Fifty healthy adults (aged 18–23, 62.1% female) completed two different sets of the Tower of London task (ToL) separated randomly by either a 90-minute nap (Nap, n = 30) or wakefulness (Wake, n = 20). The number of steps and RTs in ToL were used as outcome measures of planning ability. Other measures were used to assess their demographic information, mood (Depression Anxiety Stress Scale) and sleep characteristics (Pittsburgh Sleep Quality Index and 5-day actigraphy-watch before the experimental session).

Results: The groups were matched on age, sex, BMI, mood, sleep quality and average 5-day actigraphy-measured sleep duration (ps > 0.05). A 2x2 mixed factorial model with a within-subject factor (time, as the pre-/post-condition ToL performance) and a between-subject factor (group, Nap-/Wake-group) revealed significant 1)main effect of time on RT, F(1,49) = 62.085, p < 0.001; and 2)interaction effect of time*group on steps, F(2,49) = 5.840, p = 0.019; In the post-condition assessment, both groups had decreased RT, while Nap-group had decreased steps and Wake-group increased steps, indicating improvement and deterioration, respectively. Reduction in steps was associated with longer REM-sleep, r(29) = −0.378, p = 0.043, and shorter REM-sleep latency, r(22) = 0.547, p = 0.008. No other significant effect was noted.

Conclusion: Consistent with the findings on REM-sleep and working memory improvement, this study demonstrated the benefit of daytime sleep opportunity, particularly REM-sleep, on planning ability. While development of prefrontal cortex continues through young adulthood, our data shed light on the important role of REM-sleep, even just from a daytime sleep opportunity, in facilitating planning ability, as a behavioral measure of prefrontal cortex functioning.

0290

SLEEP DURATION PREDICTS SPEECH SOUND LEARNING IN TYPICAL ADULTS, BUT NOT IN ADULTS WITH LANGUAGE IMPAIRMENT

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Introduction: Recent work suggests sleep plays a role in the acquisition of non-native speech sounds. For instance, a period of sleep, but not a comparable interval of wake state, facilitates improved discrimination of learned sounds and facilitates generalization across talkers. Of interest, individuals with language impairment have been observed to have atypical sleep, which leads to the hypothesis that differences in speech perception in this population are attributable to sleep differences.

Methods: We trained typical adults and adults with a history of language-based disorders on the perceptual identification of a non-native (Hindi dental and retroflex) contrast at 8 pm on day 1, tested their performance on perceptual tasks immediately after training, and re-assessed their performance on those tasks at 8 am on day 2. Total sleep duration between day 1 and day 2 was measured using a commercially available EEG device. We ran a regression analysis to determine the association between sleep duration and magnitude of change in performance overnight.

Results: Behavioral results indicate that while typical adults show overnight improvement on both identification and discrimination of non-native contrasts, adults with a history of language-based disorders do not. Moreover, sleep duration was significantly associated with the magnitude of overnight improvement in perception for typical adults, but not for adults with atypical language.

Conclusion: Sleep appears to facilitate encoding of perceptual training in typical adults, but not in individuals with language-based disorders. This finding is consistent with a general view that sleep disturbances in the language impaired population may contribute to negative language learning outcomes. Future work will need to determine whether qualitative differences in sleep among the language-disordered population specifically predict speech sound learning.

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0291

COHERENCE BETWEEN THALAMUS AND CORTEX DURING SLEEP IS REQUIRED FOR CONSOLIDATION OF CORTICAL PLASTICITY IN THE VISUAL SYSTEM

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Introduction: Orientation Specific Response Potentiation (OSRP) is a form of cortical plasticity in primary visual cortex (V1), which is initiated by waking visual experience and dependent on subsequent sleep. OSRP is accompanied by an increase in V1 neuron firing following visual stimulus presentation. We have previously found that optogenetic silencing of cortical feedback to the thalamus, which is hypothesized to be crucial for thalamocortical synchrony, during Non Rapid Eye Movement (NREM) sleep disrupts consolidation of experience-dependent cortical plasticity.

Methods: To understand what mechanisms underlie this disruption, we performed dual site chronic recordings of individual visual thalamic (LGN) and V1 neurons under normal conditions and optogenetically silencing cortical feedback during NREM sleep eliminates this increase in LGN firing. We have previously found that optogenetic silencing of cortical feedback to the thalamus, which is hypothesized to be crucial for thalamocortical synchrony, during Non Rapid Eye Movement (NREM) sleep disrupts consolidation of experience-dependent cortical plasticity.

Results: Preliminary data suggests that following initiation of cortical plasticity, LGN experiences increases in neuronal firing and optogenetically silencing cortical feedback during NREM sleep eliminates this increase in LGN firing.

Conclusion: These preliminary findings suggest that synchrony between cortex and thalamus may be critical for maintaining the increase in LGN firing, which in turn may drive plasticity in visual cortex during NREM sleep.

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0292
THE ROLE OF SLEEP SPINDLES IN MEMORY: OPTOGENETIC MANIPULATION OF THE THALAMIC RETICULAR NUCLEUS IN MICE
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Introduction: A significant link between sleep spindles and memory consolidation has been proposed based on several studies reporting an increase in spindle activity following learning. The thalamic reticular nucleus (TRN) has been suggested to play a central role in the generation of sleep spindles. Specifically, activity of parvalbumin (PV) containing GABAergic TRN neurons may underlie the control of spindle generation. Here we applied an optogenetic approach in mice to test whether spindles generated by TRN neurons during sleep following learning are associated with performance in the novel object recognition (NOR) task.

Methods: AAV-ArchT-GFP was bilaterally injected into the TRN of PV-Cre mice. In order to manipulate spindles, inhibition of TRN PV neurons was performed via laser illumination (532 nm, 1-min on, 4-min off) during the 4-hr inter-trial-interval (ITI); the time period between the familiarization (sample) and recall (test) phases of NOR task, which is widely-accepted as a memory consolidation period. EEG/EMG recording was performed during the ITI to monitor sleep-wake states/spindle activity. Behavioral performance was compared between inhibition (laser on) and control (no laser) conditions.

Results: The NOR task measures recognition memory based on the mouse’s natural preference to explore the novel object. Our data show that recognition memory, measured as percent of time spent exploring a novel object during recall phase, was greater than chance for control condition (no laser), indicating that animals successfully recalled an object presented during familiarization. In contrast, recognition memory was significantly impaired following ArchT inhibition of TRN PV neurons during the ITI. Additionally, spindle density, calculated as a number of spindles over the length of ITI, was positively correlated with NOR performance (p < 0.05).

Conclusion: These findings demonstrate that manipulation of spindles by optical inhibition of TRN PV neurons following learning affects memory performance, supporting the role of sleep spindles generated by TRN PV neurons in memory consolidation.

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0293
SLEEP SPINDLES COUPLED WITH SLOW OSCILLATIONS BENEFIT VERBAL MEMORY
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Introduction: A growing body of research shows sleep facilitates the consolidation of memories. For example, pharmacologically increasing the number of sleep spindles in a post-encoding sleep period produced greater memory retention of declarative verbal memories compared with placebo (Mednick). Additionally, enhancing endogenous slow oscillations (SO) with transcranial stimulation benefits the sleep-associated consolidation of verbal memories (Marshall). Here we examined whether spindles that are temporally-coupled with strong or weak SO benefit consolidation of verbal memories.

Methods: Data analyzed from Mednick et al. (2013). 30 subjects were tested in two drug conditions (zolpidem and placebo) on a verbal memory task. Recorded EEG was first filtered (0.5–1 Hz). Then, if the maximum amplitude of the Hilbert transform (MAHT) of this signal crossed a threshold in the window of 2-sec before a spindle, a spindle with strong SO (SSO+) was identified, otherwise it was considered as a spindle with weak SO (SSO-). The average delay between MAHTs of SO and spindles was calculated for each subject. The correlation between this delay and memory performance was measured.

Results: A strong, positive correlation was observed between the number of SSO+ complexes and the total number of spindles in both the zolpidem (r = 0.99) and placebo (r = 0.99) conditions. Moreover, memory retention was correlated with the average delay between SO and spindle MAHTs, calculated within the window of 2-sec before and 1-sec after spindle markers, for SSO+ complexes in zolpidem condition (r = 0.40), but not for SSO- complexes (r = 0.29). Neither SSO+ (r = −0.05) nor SSO- (r = 0.34) was significant for the same measurement in placebo condition.

Conclusion: Previous research has shown that spindles are related to increased verbal memory performance. Our study suggests, however, that although the number of SSO+ complexes is highly correlated with the total number of spindles, only SSO+ complexes in zolpidem condition may impact on verbal memory performance improvement.

0294
SPECTRAL EEG CORRELATES OF REM SLEEP DREAM POSITIVE AND NEGATIVE MOOD: A PROMISING NOVEL APPROACH
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Introduction: Electrophysiological correlates of REM sleep collected dreams have been studied for many years and have focused mainly on phasic events, particularly eye movements. Of main interest are the potential correlates of dream emotional valence. Few studies have used advanced EEG spectral analysis and correlated it with dream emotional valence taking into account its chronology within the dream experience. The aim of this study is to test a new approach study EEG correlates of dream valence.

Methods: Five participants spent two consecutive nights of sleep lab polysomnography recordings including C3, C4, O1, O2 and EOG measures. Before sleep, participants were asked to report upon being awakened their dream following the chronology of its scenario Participants were awakened during REM sleep periods. In the morning, each dream was divided into different segments that were rated by the participants for their positive and negative valence on 4-point positive and negative scales. EEG spectral analyses were conducted on each REM segment that chronologically was likely to match dream segments and the shared variance between emotion levels and spectral measures was calculated.

Results: Overall, emotional intensity from dream segments was associated with higher levels of theta activity (p < 0.05). Interestingly, negative valence was highly significantly associated with theta activity registered at the right supraorbital site, close to the anterior frontal lobe area (p < 0.01). Thus, increases in the negativity of the emotion in the dream were associated with increases in theta power, especially around the 6.5 Hz frequency.

Conclusion: These preliminary observations revive the question of the relationship between theta activity, the hippocampus, the amygdala, and fear extinction in dreams. This proposed methodology seems to be promising for studying the chronology of dreams and its EEG correlates. Obviously more sites should be recorded, particularly in the frontal region with a larger sample.
AN INCREASE IN STAGE R AND A DECREASE IN STAGE N3 IS ASSOCIATED WITH MOTOR SKILL LEARNING IN INDIVIDUALS WITH CHRONIC STROKE

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Introduction: Studies indicate individuals with chronic stroke benefit from sleep to enhance learning of new motor skills. However, the mechanisms underlying over-night (or off-line) motor skill enhancement remains unknown. Therefore, the purpose of this study was to determine which stage or stages of over-night sleep are associated with off-line motor skill learning in people with chronic (> 6 months) stroke.

Methods: Twenty individuals with chronic stroke and ten age- and sex-matched controls practiced a continuous tracking (CT) task and underwent polysomnographic recording. The following morning, participants were retested on the CT task to assess off-line learning. Paired t-tests assessed for change in tracking performance from practice to retest. Pearson correlations assessed for relationships between off-line motor skill learning and time spent in different stages of sleep.

Results: Participants with chronic stroke demonstrated a significant reduction in tracking error from the last practice block to retention (t(19) = 2.474, p = 0.023) whereas the control participants did not (t(9) = 0.688, p = 0.509). A higher magnitude of off-line motor skill learning was weakly correlated with an increase amount of time spent in stage R sleep (r = 0.247) and a decrease amount of time spent in stage N3 sleep (r = −0.237).

Conclusion: This study confirms that sleep enhances learning in individuals with chronic stroke and is the first to suggest that off-line motor skill learning is associated with time spent in stage R and stage N3 sleep. In conclusion, sleep should be considered when treating individuals following stroke. Furthermore, future studies should consider if altering sleep stages may improve motor skill learning and impact recovery in individuals with stroke.

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A. Basic Sleep Science

0297
REPETITIVE SLEEP RESTRICTION LEADS TO REBOUND SYMPATHETIC DEACTIVATION DURING RECOVERY SLEEP
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Introduction: The normalized low frequency (LF) component of heart rate variability (HRV) spectra is a well-established non-invasive marker of cardiovascular autonomic function, and is considered a quantitative index of sympathetic activation. Short sleep has been linked with increased risk for hypertension, and sympathetic over-activity is an important feature of hypertension. Thus, we investigated autonomic modulation via HRV from continuous 24 h recordings in response to a novel repetitive sleep challenge.

Methods: In a 22-day in-hospital protocol, 45 healthy participants (age 32 ± 2 yrs; BMI 24 ± 1 kg/m²; 23 women) were randomly assigned to 4 cycles of repeated sleep restriction (SR); (permitted 4 h of sleep/night from 0300–0700 for 3 nights followed by a recovery sleep, repeated 4 times), or a sleep control (SC) group (8 h/night from 2300–0700). Two-lead electrocardiography was recorded during six 24 h periods: baseline (BL), experimental (3rd day of each of 4 SR cycles), and recovery. Lomb-scarlge periodogram algorithm was performed to generate the power spectrum analysis of R-R interval (RRI). Spectral power of LF (0.04–0.15 Hz) was analyzed in normalized units (nu; LF/total power- line) as indicator of sympathetic modulation.

Results: Within the first hour of every sleep period, LF dropped precipitously, reaching its daily nadir, and this pattern was consistent in BL sleep, SR condition, and across all nights in SC. During recovery sleep, following the 4 cycles of SR, there was a sleep rebound drop in LF such that LF level dropped below the BL nadir levels by −6.4 ± 2.6 (nu; p < 0.05).

Conclusion: Sympathetic nadir was not altered during repetitive sleep challenge; however, there was a rebound deactivation of sympathetic activity during the recovery sleep night.

Support (If Any): NIH (HL-106782)

0298
TOWARD A BIOMARKER PANEL FOR VULNERABILITY TO SLEEP LOSS
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Introduction: Sizeable, trait inter-individual differences in human vulnerability to performance impairment due to sleep loss may be predictable by genetic biomarkers. We investigated the potential of a panel of genetic polymorphisms to predict psychomotor vigilance task (PVT) impairment during total sleep deprivation (TSD). The panel included 7 polymorphisms: ADORA2A (T1976C), BDNF (Val66Met), DBH*0602 (pos/neg), HCRT (T909C), PER3 (4/5 tandem repeat), TLR4 (Asp299Gly) and TNFα (G308A). 32 ± 2 yrs; BMI 24 ± 1 kg/m²; 23 women) were randomly assigned to 4 cycles of repeated sleep restriction (SR); (permitted 4 h of sleep/night from 0300–0700 for 3 nights followed by a recovery sleep, repeated 4 times), or a sleep control (SC) group (8 h/night from 2300–0700). Two-lead electrocardiography was recorded during six 24 h periods: baseline (BL), experimental (3rd day of each of 4 SR cycles), and recovery. Lomb-scarlge periodogram algorithm was performed to generate the power spectrum analysis of R-R interval (RRI). Spectral power of LF (0.04–0.15 Hz) was analyzed in normalized units (nu; LF/total power- line) as indicator of sympathetic modulation. Within the first hour of every sleep period, LF dropped precipitously, reaching its daily nadir, and this pattern was consistent in BL sleep, SR condition, and across all nights in SC. During recovery sleep, following the 4 cycles of SR, there was a sleep rebound drop in LF such that LF level dropped below the BL nadir levels by −6.4 ± 2.6 (nu; p < 0.05).

Conclusion: Sympathetic nadir was not altered during repetitive sleep challenge; however, there was a rebound deactivation of sympathetic activity during the recovery sleep night.

Support (If Any): NIH (HL-106782)

XIII. Sleep Deprivation

0299
VIGILANCE AND CORTICAL EXCITABILITY AFTER ACUTE SLEEP DEPRIVATION AND CHRONIC SLEEP RESTRICTION
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Introduction: Acute sleep deprivation (aSD) impairs vigilance and increases cortical excitability. Chronic sleep restriction (cSR) results in similar vigilance impairments as observed after aSD, but the effect on cortical excitability in cSR is unknown. We therefore aimed at investigating the changes in vigilance and cortical excitability after aSD and cSR.

Methods: 8 subjects underwent 1 night of aSD and 7 nights of cSR (5 h instead of 8 h sleep/night). We assessed vigilance using the psychomotor vigilance task (PVT), i.e. reaction speed and number of lapses (reaction times > 500 ms; transformed: √x+(x+1)). As a measure of cortical excitability we used early evoked cortical activation (ECA) in response to single-pulse transcranial magnetic stimulation (TMS), i.e. the integrated area under the rectified curve (30–80 ms after TMS-pulses). We analyzed data obtained in the afternoon, when circadian modulations are expected to be smaller than during the wake-maintenance zone in the early evening. We performed a two way repeated measures ANOVA for all parameters above with the factors time point (baseline vs. after sleep loss) and intervention (cSR vs. aSD). Post-hoc comparisons were performed where effects were significant (p < 0.05).

Results: Post-hoc analysis revealed that speed decreased after aSD (−0.5 ± 1.0s², Mean ± SD; p < 0.01) and cSR (−0.4 ± 0.1s²; p < 0.01), completed successfully across all genotypes for N = 78 subjects. There was no significant cosegregation of genotypes in the sample, except for BDNF with PER3 and TLR4. Genotype frequencies were in accordance with the published literature.

Results: One-way ANOVA (controlling for study) showed that the genotypes in the biomarker panel, not accounting for possible gene interactions, explained 14.9% of the variance in PVT performance during TSD over subjects (i.e., r = 0.39). The inter-individual variability in performance impairment captured by the panel ranged from 0.0 ± 4.5 to 13.5 ± 3.9 PVT lapses (mean ± SE). This was similar to the range between grand mean performance of the more resilient and more vulnerable tertiles in the sample, but much smaller than the full range of inter-individual variability in the sample (i.e., leaving 85.1% of the variance unexplained).

Conclusion: To our knowledge, these data represent the first quantitative assessment of a composite genetic biomarker panel for predicting vulnerability to performance impairment due to sleep loss. Analyses of additional genotypes and gene interactions in larger samples are needed to further elucidate these findings. Because inter-individual differences in vulnerability to sleep loss are task-dependent, caution is needed when translating predicted vulnerability to real-world operations.

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while lapses and ECA were increased after aSD (lapses: +4.2 ± 1.0; p < 0.01; ECA: +35.2 ± 36.7%; p < 0.05) and cSR (lapses: +2.1 ± 1.0; p = 0.05; ECA: +28.5 ± 23.3%; p < 0.05), when compared to corresponding baseline levels. There were more lapses after aSD compared to cSR (+3.0 ± 0.8; p < 0.05).

**Conclusion:** Impaired vigilance is accompanied by increased cortical excitability after aSD, as well as after cSR. This electrophysiological measure may provide the means to investigate the underlying mechanisms of vigilance and other cognitive impairments due to sleep loss which is common in our 24/7 society. Moreover, using this perturbational approach may allow to directly examining neuronal functioning in patients with altered vigilance and/or sleep pressure.

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**0300 EFFICACY AND EEG EFFECTS OF VOLUNTARY SLEEP LOSS IN RATS**

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**Introduction:** Animal sleep deprivation (SD), unlike most human SD, involves enforced exposure to aversive stimuli. We investigated intracranial self-stimulation (ICSS), a voluntary and rewarding behavior, as a method for self-imposed, minimally aversive SD. In addition, we explored non-contingent stimulation (NCS) as a less aversive, but voluntary SD model that excites the same neurocircuitry as ICSS.

**Methods:** Male Sprague-Dawley rats were implanted with EEG/EMG electrodes and a contralateral stimulating electrode into the lateral hypothalamus. Rats were then trained to lever press for stimulation (200 Hz, 0.25 ms pulse duration, 60–215 μA). Throughout all experiments sleep-wake EEG was recorded, including a 24 h baseline period and 24 h recovery period. During the SD experiment, rats (n = 7) were allowed to self-stimulate for 6 h (ICSS1) or underwent 6 h gentle handling (GHSD; ZT0–6). A week later, the experiment was repeated with conditions reversed. In a separate SD experiment, rats (n = 5) underwent 6 h ICSS (ICSS2; ZT0–6) and, a week later, 6 h NCS (ZT0–6), during which the individual stimulation patterns recorded during ICSS were replayed in the absence of the lever.

**Results:** All SD methods resulted in 98–99% wakefulness. ICSS1 and GHSD resulted in similar NREMS (p = 0.95) and REMS (p = 0.70) rebounds during the 24 h recovery period. However, SWA rebound differed between the two methods (p < 0.01); SWA following ICSS1 was suppressed compared to GHSD during the initial 2 h of the recovery period (p < 0.05). NCS showed similar NREMS (p = 0.98), REMS (p = 0.99) and SWA (p = 0.60) rebounds compared to ICSS2 during the 24 h recovery period.

**Conclusion:** ICSS can be used to model voluntary SD. Furthermore, the suppressed SWA rebound may indicate that ICSS is less stressful compared to GHSD and perhaps NCS.

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**0301 EFFECTS OF PARTIAL SLEEP DEPRIVATION ON SLOW WAVES DURING NON-RAPID EYE MOVEMENT SLEEP: A HIGH DENSITY EEG INVESTIGATION**

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**Introduction:** Changes in slow waves reflect homeostatic sleep regulation in response to total sleep deprivation. However, evidence of homeostatic changes to slow waves during partial sleep deprivation protocols has been less consistent. Prior investigations have utilized limited EEG derivations to evaluate the effects of sleep restriction on slow waves, and have not typically examined changes in slow wave count/morphology. Thus, this study utilized high-density (hd) EEG to evaluate the topographic effects of partial sleep deprivation on slow waves using spectral and period-amplitude analyses.

**Methods:** Twenty-four healthy adult individuals were drawn from the placebo arm of a larger sleep pharmacotherapy study. After a baseline night (BSL), participants were restricted to a five-hour opportunity for sleep for 4 consecutive nights, followed by a recovery night (RCV). 256-channel hdEEG was recorded on the second and fourth night of sleep restriction (SR2/4), BSL and RCV. Spectral analysis and slow wave detection were performed for each participant night. Data were compared using repeated measures ANOVA and paired t-tests with statistical non-parametric mapping with suprathreshold cluster testing.

**Results:** Compared to BSL, slow wave energy (integrated power 1–4.5 Hz totaled over NREM epochs) increased during RCV, as well as SR2/4 when comparisons were restricted to the first 3.7 hours of sleep (minimum sleep duration among all recordings). Period amplitude analyses demonstrated frontal increases in slow wave amplitude during sleep restriction and recovery. Occurrence of high and low amplitude slow waves also diverged in frontal regions, with increases in the former and decreases in the latter during sleep restriction. Additionally, mean amplitude and slopes of low amplitude slow waves increased in frontal channels across sleep restriction and recovery.

**Conclusion:** Topographic changes in slow waves suggest sleep homeostasis is maintained during partial sleep deprivation in humans. Further research is warranted to determine how local experience-dependent changes during wakefulness modulate sleep homeostasis during sleep restriction.

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**A. Basic Sleep Science**

**0302**

**NAPS NOT AS EFFECTIVE AS A NIGHT OF SLEEP AT DISSIPATING SLEEP PRESSURE**

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**Introduction:** The two-process model of sleep posits that two processes interact to regulate sleep and wake: a homeostatic (Process S) and a circadian process (Process C). Process S compensates for sleep loss by increasing sleep duration and intensity. Process C gates the timing of sleep/wake favoring sleep during the circadian night. In this study we examined whether taking six naps 1.5-h throughout a 24-h period would result in the same amount of dissipation of homeostatic pressure at the end of the day as a night of sleep, when time in bed (TIB) is equivalent.

**Methods:** Data from 46 participants ages 10 to 23 years were analyzed (mean age = 14.5 ± 2.9; 25 females). Slow wave energy (SWE), normalized to account for individual differences in slow-wave activity (SWA; delta = 0.4 to 4.6 Hz), was used as a measure of sleep homeostasis. SWE was defined as accumualted SWA during NREM sleep. In the nap condition SWE of six naps each of 1.5 hours in duration distributed equally during a 24-hour period (TIB = 9 h) was calculated. In the baseline condition, overnight SWE was measured after 9 hours TIB. A paired t-test was used to compare nap and baseline conditions. A linear regression was used to examine whether SWE in nap and baseline conditions varied as a function of age.

**Results:** SWE was greater during baseline overnight than the nap condition (t(45) = 4.28; p < 0.0001). No association between age and SWE was found for either the baseline (r = 0.05; p = 0.78) or nap (r = −0.07; p = 0.66) conditions.

**Conclusion:** Our findings indicate that multiple naps throughout the day are not as effective at dissipating sleep pressure as a night of sleep. This is likely due to the influence of the circadian system, which staves off sleep during certain times of day.

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**0303**

**C-REACTIVE PROTEIN AND NAPPING IN A YOUNG ADULT POPULATION**

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**Introduction:** C-Reactive Protein (CRP) is a marker of systemic inflammation that is elevated after sleep deprivation. In those with disturbed sleep, elevated CRP is predictive of cognitive deficits. These reports suggest that sleep is protective against inflammation and its associated detrimental cognitive effects. Contrary to these reports, a large cohort study found that regularly-napping older adults have higher CRP levels than non-napping older adults, suggesting that napping habitually may be detrimental to health.

**Methods:** We aimed to replicate this finding in a younger population by examining whether napping predicted high-sensitivity CRP levels in the public Add Health Dataset from 720 young adults (29.0 ± 1.72 yrs). Those who reported not habitually napping were compared to those who reported napping a minimum of 1 or more days/week.

**Results:** Contrary to the older adult findings, young adults who reported napping had significantly lower CRP levels than those who did not nap when controlling for socioeconomic status, age, body mass index, ethnicity, depression, cigarette smoking, alcohol use, diastolic blood pressure, and self-reported snoring (β = −1.18, p = 0.018). CRP was again predictive of cognitive abilities (working memory: β = −0.008, p = 0.024), but napping was not found to be a mediating factor.

**Conclusion:** Although habitual naps in older adults predict higher CRP levels, our findings suggest that napping is related to decreased inflammation in a young adult population. We propose the existence of two distinct nap types. Recovery naps, which occur frequently in young adults in response to insufficient sleep, seem to be beneficial for physiological health. On the other hand, essential naps, which are seen in older adults, may occur in response to a sedentary lifestyle and body/brain degradation. Essential naps may be a marker of degraded health, as frequent napping has been tied to cognitive decline and mortality in older adults. Future work will explore the dissociation of these nap types.

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**0304**

**CAN ONE MODEL PREDICT AN INDIVIDUAL’S PERFORMANCE DURING BOTH TOTAL AND PARTIAL SLEEP LOSS?**

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**Introduction:** Current performance models can effectively predict neurobehavioral performance impairment during total sleep deprivation. However, because these models do not accurately represent the physiological processes inducing the slow changes in brain physiology during partial sleep loss [i.e., chronic sleep restriction (CSR)], their performance predictions for CSR are not very accurate. Given that most operational environments are predominantly characterized by CSR, there is a need for models that can accurately predict the effects of the continuum of sleep loss.

**Methods:** We developed a unified mathematical model that, given an individual's sleep/wake history, predicts performance impairment due to any sleep-loss condition. In the model, we hypothesized that an individual's capacity to recover during sleep is dependent on the individual's sleep debt, with the most recent sleep/wake history exerting the greatest influence on sleep recovery. We represented this mathematically by modulating the benefit of sleep as a function of sleep debt, with a larger sleep debt resulting in a smaller recovery during sleep.

**Results:** We used psychomotor vigilance task data from a two-arm laboratory study involving 15 subjects to develop and validate our model. In the first arm of the study, subjects were exposed to 64 hours of total sleep deprivation, and in the second, the same subjects were restricted to 3 hours of sleep per night for 7 consecutive nights. Our results showed that, on average, individual-specific unified models provided 29–35% improved prediction accuracy compared to group-average models. More importantly, we showed that once the model had been customized to an individual for either of the two conditions, it could be directly applied to predict the same individual's performance under the other sleep-loss condition.
0305 DIFFERENCES IN PLASMA LIPIDS DURING RESTED WAKEFULNESS AND SLEEP DEPRIVATION

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Introduction: Recent studies suggest that metabolite levels in plasma are regulated by the circadian clock and modulated by sleep deprivation. Here, we explored the feasibility of using metabolite profiling to identify biomarkers for circadian phase or sleep insufficiency.

Methods: Twenty ethnic-Chinese males (aged 21–28 years) were kept awake for 40 consecutive hours in a laboratory setting using constant routine procedures. Blood samples were collected every 4 hours and mass spectrometry techniques were used to analyze more than 250 lipid species in plasma. Using intraclass correlation analysis, differences in concentration levels were examined over time and across subjects for each lipid time series. Lipids that showed the most reliable time-since-wake variation were used to develop a model based on maximum likelihood estimation (MLE), with the aim of identifying blood samples that were collected during rested wakefulness versus sleep deprivation.

Results: Between-subject differences in concentrations for most lipid species were greater than variation that occurred with increasing time spent awake (ICC > 0.6 for 74% of lipids). Nonetheless, hierarchical agglomerative clustering revealed several different patterns of lipid profiles including those that increased over time (phosphatidylethanolamine), decreased over time (plasmalogen), or increased with a strong underlying circadian rhythm (triglycerides). Based on the 16 lipids that showed the most reliable time-since-wake variation across subjects, our MLE model identified blood samples that were collected during sleep deprivation (≥ 16 hours of wakefulness) with sensitivity of 74% and specificity of 70%.

Conclusion: Despite large between-subject differences in the concentrations of plasma lipids, a subset of metabolites showed reliable time-dependent variation during the sleep deprivation procedure. Lipid profiles differed substantially during rested wakefulness and sleep deprivation, raising the possibility that metabolomics based approaches can be used to establish a biomolecular signature of sleep loss.

Support (If Any): SingHealth Foundation (FG410P) and the Singapore National Research Foundation (CRP2007-04).

0306 THE NLRP3 INFLAMMASOME REGULATES SLEEP INDUCED BY BOTH WAKING ACTIVITY AND PATHOGENS

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Introduction: Inflammasomes are protein complexes that regulate inflammation. The inflammasome assembly activates caspase-1, which cleaves pro-interleukin-1 beta (IL1β) into its pro-inflammatory somnogenic mature active form. Extracellular adenosine tri-phosphate and pathogen associated molecular patterns, such as lipopolysaccharide, activate the inflammasome proteins nucleotide-binding domain leucine rich family pyrin containing 3 (NLRP3) and the apoptosis-associated speck-like protein containing a carboxyl-terminal caspase-recruitment domain (ASC) that is required for inflammasome activation. We aimed to determine the role of the NLRP3 inflammasome in sleep regulation.

Methods: Male mice lacking NLRP3 [NLRP3-knockout (KO)] and C57BL/6 wild-type controls (WT) were implanted with EEG and EMG electrodes and a cannula into the left ventricle. Sleep architecture was assessed during spontaneous sleep and after 6 h of sleep deprivation (SD) and intracerebralventricular injections of 0.9% NaCl vehicle, IL-1β, or lipopolysaccharide. Somatosensory cortex NLRP3, ASC, and IL1β mRNA expression and caspase-1 activity were determined after SD and spontaneous sleep.

Results: NLRP3-KO and WT mice exhibited diurnal rhythms in non-rapid eye movement sleep (NREMS) and rapid eye movement sleep (REMS) with greater values occurring during light vs dark periods. However, NLRP3-KO mice had reduced NREMS amounts in the first 6 h of the light period compared to WTs. NLRP3-KO mice demonstrated reduced enhancements in NREMS and slow-wave activity (SWA) after either SD or lipopolysaccharide compared to WTs. While SD led to increased expression of NLRP3, ASC, and IL1β mRNA and enhanced caspase-1 activity in WT mice, there was no increase in IL1β mRNA and caspase-1 activity in NLRP3-KO mice. Similar enhancements in NREMS and SWA were found in NLRP3-KO and WT mice after intracerebralventricular injections of IL1β, a molecule located downstream of inflammasome activation.

Conclusion: These data suggest that the NLRP3 inflammasome is a significant mechanism induced by both enhanced waking activity and pathogen regulating sleep.

Support (If Any): VA Medical Research Award, 5T32MH016259-35

0307 RECOVERY SLEEP FOLLOWING PERIODS OF PROLONGED WAKEFULNESS UPREGULATES NUCLEAR MITOCHONDRIAL GENE EXPRESSION IN THE BASAL FOREBRAIN OF RAT

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Introduction: Mitochondrial oxidative phosphorylation (OXPHOS) is the primary source of cellular ATP. Only 13 OXPHOS proteins are encoded by mitochondrial and > 90% proteins by nuclear genome. Previously we reported that in wakefulness-associated areas of rat brain, the cellular ATP level exhibits a surge at 10 am, when the rats mostly sleep. Preventing sleep (sleep deprivation, SD) from 7–10 am prevented the surge. To further understand the diurnal and SD-induced regulation, we examined the nuclear-coded OXPHOS -expression for diurnal, SD and recovery sleep (RS)-induced changes using a 84 gene-array.
**Introduction:** Homeostatic sleep regulation associates synaptic homeostatic plasticity. During waking period, synaptic strength is reinforced through synaptic plasticity and released in sleep durations. Arc is one of genes involved in synaptic plasticity that decrease synaptic spines when overexpression in neurons. Although basic Arc expression level is low in neurons, Arc expression is rapidly increased during sleep deprivation. However, Arc’s involvement in sleep homeostasis is unclear. Using wild type (WT) and Arc knockout (KO) mice, we observed the sleep-wake phenotype of Arc KO mice.

**Methods:** EEG/EMG electrodes were implanted on WT and KO mice aged older than 8-week. Data acquisition was performed over 4 days as follows 2 days baseline, 1 day sleep deprivation (SD), and 1 day recovery. SD was employed from ZT0-4.

**Results:** KO mice showed significant reduction of slow wave activity (SWA, 0.5–4.5 Hz) compared with WT (WT: 20.5 ± 2.0/h, KO: 12.14 ± 0.9/h). Also, KO mice indicated high amount of REM sleep. The mRNA levels of 64/84 genes showed > 2-fold increase at 10 am when compared to 7 am and other time points. 3 h SD (but not after 6 h SD) resulted in the upregulation of 6 Complex I, and downregulation of 2 Complex II, 2 Complex III, 2 Complex V, and carnitine/acylcarnitine- translocase genes. Following RS mRNA levels of 34/84 genes showed statistically significant increases when compared to time-of-day control.

**Conclusion:** The highest expression of the nuclear-coded mitochondrial genes parallels our previous observation on the ATP surge at 10 am (Dworak et al., 2010). The upregulation of complex I with concomitant downregulation of Complex II subunits after 3 h SD suggest a preference for Complex I mediated electron transport. The upregulation of OXPHOS genes following RS suggests restoration of ATP expended during SD, thus supports restorative function of sleep.

**Support (If Any):** VA Merit Grant, NINDS R21 NS079866, NIMH R01 MH039683

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**0308 INvolvement of Arc gene in sleep-wake regulation**

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**Introduction:** Involvement of Arc gene in sleep-wake regulation is still unknown. Whether pharmacologically enhancing sleep can significantly improve pain outcomes.

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pain, i.e. time until the cold sensation gets unbearable. Interleukin-6 (IL-6) expression, a potent sensitizer of the nociceptive system, was measured in monocytes before each CPT.

**Results:** As expected, participants in the sleep control condition habituated to the painful challenge over time, as indicated by tolerating the cold pain for increasingly longer time periods. However, subjects exposed to repeated sleep restriction were not able to habituate to the pain, not even during intermittent recovery sleep periods (p < 0.05 for interaction effect). Pain intensity ratings analyzed over the first 30 seconds of the CPT indicate a faster summation of pain in repeatedly sleep restricted participants. In parallel, interleukin-6 expression steadily increased across repeated sleep restriction, and did not return to baseline upon intermittent recovery sleep (p < 0.05).

**Conclusion:** Common pattern of repeatedly restricting and catching up on sleep may increase chronic pain vulnerability in the long term through a progressive failure to habituate to pain and a quicker summation of pain, which is likely inflammatory-related.

**Support:** NIH/NHLBI HL 105544, ULI RR02758 and M01-RR-01032 from the National Center for Research Resources to the Harvard Clinical and Translational Science Center

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**0311**

**ACUTE SLEEP DISRUPTION ALTERS NEURAL RESPONSES TO THREATENING AND AMBIGUOUS CUES**

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**Introduction:** Accurate threat detection is essential in military operational environments where sleep is often significantly disrupted. We examined the acute effects of 50% sleep restriction (SR) and total sleep deprivation (SD) relative to normal sleep (NS) on neural responses to threatening and potentially ambiguous cues.

**Methods:** 86 healthy sleepers (18–30 years old; 50% women) were randomized to NS (n = 30), SR (n = 29), or SD (n = 27). The evening following the randomization night, participants completed a gender identification task while implicitly viewing emotional faces during a 3T fMRI scan. BOLD activation in response to angry vs. neutral faces, and neutral faces vs. control stimuli (pictorial cues only), were compared across groups. Regions of interest (ROIs) were identified based on the entire group’s activation map during the same task prior to any sleep manipulation. These included the right and left inferior frontal gyrus (IFG) and amygdala. Analyses were conducted using SPM8.

**Results:** The SR and SD groups did not differ from each other, but both showed increased BOLD activation bilaterally in IFG in response to angry vs. neutral faces compared to the NS group (all p < 0.005). The NS group showed greater BOLD activation of the right IFG (p < 0.02) compared to the SR and SD groups in response to neutral faces vs. control stimuli. The NS group also showed greater amygdala response to the neutral faces vs. control condition than the SD group (p < 0.01).

**Conclusion:** Sleep disruption increases neural responses to threatening cues, but reduces neural responses to potentially ambiguous cues. These findings have important implications for high-risk occupations where sleep is often curtailed, including military service members and emergency responders.

**Support (If Any):** This work was supported by DoD Award #11293006 (W81XWH-12-2-0024; PI: Germain)

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**0312**

**IMPACT OF STRESS REACTIVITY ON AFFECT DURING TOTAL SLEEP DEPRIVATION**

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**Introduction:** Exposure to stressful stimuli increases physiological arousal through the hypothalamic-pituitary-adrenal (HPA) axis. An outstanding question is how acute sleep loss affects reactivity to stressful stimuli. We measured responses to psychosocial and physical stress in a laboratory-based total sleep deprivation (TSD) study and examined individual differences in affective reactivity.

**Methods:** Eleven healthy adults (ages 22–39; 6 females) completed a 5-day (4-night) in-laboratory study. After an adaptation day and a baseline day (each 10 h TIB; 22:00–08:00), subjects underwent 38 h TSD, which was followed by a recovery night. After 35 h TSD, subjects underwent the 10 min Maastricht Acute Stress Test (MAST). This task involved 5 cold pressor trials, requiring subjects to submerge their non-dominant hand in cold water (0°C) for 60–90 s. Between cold pressor trials, subjects performed a difficult mental arithmetic task, during which they received negative feedback for incorrect responses. Upon completion of the MAST, the Positive and Negative Affect Schedule (PANAS) was administered to measure subjective mood. Salivary cortisol, used as an index of HPA activation, was measured just before the MAST at 19:00 and after the MAST every 15 min from 19:15 until 20:15 and at 21:15. Saliva was obtained using cotton swabs (Sarstedt); samples were analyzed using high-sensitivity enzyme immunoassay (Salimetrics).

**Results:** Mixed-effects analysis of variance (ANOVA) indicated a significant change in cortisol level over time (F[6,59] = 9.11, P < 0.001), with significant increases from baseline beginning 15 min after MAST administration until returning to baseline by 2 h post-MAST. Subjects’ positive affect (M = 21.8, SD = 7.0) and negative affect (M = 17.2, SD = 6.3) on the PANAS after MAST administration were correlated with mean post-MAST salivary cortisol concentration, controlling for gender, age and pre-MAST salivary cortisol concentration. There was a significant correlation of mean post-MAST cortisol concentration with subjective negative affect (r = 0.78, p = 0.021) but not with positive affect (r = 0.04, p = 0.92).

**Conclusion:** Subjects varied in their reactivity to stressful stimuli during TSD. Greater HPA activation as measured by salivary cortisol was associated with greater negative mood after exposure to combined psychosocial and physical stress.

**Support (If Any):** ONR grant N00014-13-C-0063.

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**0313**

**INSUFFICIENT SLEEP INDUCED POSITIVE ENERGY BALANCE OCCURS RAPIDLY AND IS SUSTAINED WITH CHRONIC INSUFFICIENT SLEEP**

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**Introduction:** Findings from epidemiological studies show an association between insufficient sleep and obesity. We previously reported that either extended wakefulness during total sleep deprivation or insufficient sleep (5 h) increases total daily energy expenditure (EE).
A. Basic Sleep Science

XIII. Sleep Deprivation

2.8 ± 0.1, P = 0.0017 and 2.4 ± 0.09 vs. 3.0 ± 0.1, P = 0.0032) and physical activity-related EE (0.5 ± 0.1 vs. 1.8 ± 0.1, P = 0.003 and 0.7 ± 0.1 vs. 1.8 ± 0.2, P = 0.0062). After acute and chronic sleep deprivation, orexin-A failed to significantly increase physical activity (7.6 ± 1.8 vs. 16.6 ± 3.6, P = 0.14 and 4.7 ± 2.0 vs. 13.6 ± 4.4, P = 0.10), TEE (23.1 ± 0.1 vs. 26.1 ± 0.1, P = 0.23 and 26.1 ± 0.09 vs. 28.1 ± 0.1, P = 0.19) and physical activity-related EE (0.8 ± 0.2 vs. 1.2 ± 0.2, P = 0.38 and 0.6 ± 0.2 vs. 1.0 ± 0.2, P = 0.21).

Conclusion: Sleep deprivation may reduce the effectiveness of orexin-A to increase EE due to physical activity thus, leading to weight gain.

0315 SLEEP DEFICIENCY, OBSTRUCTIVE SLEEP APNEA AND OVERNIGHT SHIFT WORK ARE ASSOCIATED WITH AN INCREASED RISK OF ADVERSE CARDIOVASCULAR EVENTS: A PROSPECTIVE, MULTINATIONAL STUDY IN THE SOLID-TIMI 52 TRIAL


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Introduction: Patients hospitalized with an acute coronary syndrome (ACS) are at increased risk of recurrent cardiovascular events. It is unknown whether sleep deficiency and circadian disruption are associated with the risk of cardiovascular events in post-ACS patients. We therefore prospectively hypothesized that there would be an association between sleep deficiency, obstructive sleep apnea (OSA), overnight shift work and cardiovascular events in a large population of ACS patients.

Methods: SOLID-TIMI 52 was a multinational, double-blind, placebo-controlled trial that enrolled 13,026 patients within 30 days of hospitalization with ACS. At baseline, all patients were to complete the Berlin questionnaire to assess risk of OSA, and complete a sleep and shift work survey. Median follow-up was 2.5 years. Endpoints included major coronary events (MCE; CHD death, MI or urgent revascularization) and major adverse cardiovascular events (MACE; CV death, MI or stroke), all adjudicated by a blinded committee. Analyses were adjusted for baseline demographics, past medical history, traditional risk predictors and baseline lipids.

Results: After multivariable adjustment, elevated OSA risk status by Berlin questionnaire was associated with an increased risk of MCE and MACE (HR: 1.12, 95% CI: 1.00–1.24, P = 0.04; HR: 1.13, 1.01–1.27, P = 0.03, respectively). Individuals who reported < 6 hours sleep per night had a 29% higher risk of MCE (1.29, 1.12–1.49, P < 0.001). Long-term overnight shift work (≥ 3 night shifts/week for ≥ 1 year) was associated with a 15% higher risk of MCE (1.15, 1.03–1.29, P = 0.01) and 21% higher risk of MI (1.21, 1.04–1.39, P = 0.01).

Conclusion: Sleep deficiency and circadian disruption may be under-recognized as important predictors of adverse outcomes after ACS. Increased efforts should be made to identify, treat and educate patients about the importance of sleep for the potential prevention of cardiovascular events.

Support (If Any): The SOLID-TIMI 52 trial was funded by GlaxoSmithKline. The current analysis received no additional funding; statistical analysis was carried out by the TIMI Study Group.
THE EFFECTS OF REPETITIVE SLEEP RESTRICTION ON NEUROBEHAVIORAL OUTPUT OF HEALTHY ADULTS
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Introduction: This study examines the effect of repetitive cycles of sleep restriction (SR; 4 h sleep) and 8 h sleep on neurobehavioral output of healthy adults.

Methods: In a 22-day in-hospital protocol, forty-five healthy participants with normal sleep (age 31.9 ± 9.69 years) were randomly assigned to SR (permitted 4 h sleep/night for 3 nights followed by 1 night of 8 h sleep, repeated 4 times) or control (8 h sleep every night). At baseline and after every second night of SR, four 10-minute visual psychomotor vigilance tests (PVT) were administered 2 hours after wake up and spaced 4 hours apart throughout the day to measure participants’ neurobehavioral output. Night time SR PVT were omitted from analysis because there was no control group test equivalent. The reciprocal reaction time (RT) and median RT (ms) data were collected from n = 38 participants (20 control; 18 SR). A mixed linear statistical model was used to compare these metrics between SR and control conditions.

Results: Reciprocal RT decreased significantly in SR compared to control (SR rate −0.28 ms-l ± 0.08; control rate −0.06 ms-l ± 0.06; p < 0.05) following a step-wise pattern; decreasing in the first SR cycle, stabilizing in the second, decreasing in the third, and stabilizing in the fourth SR cycle. Median RT increased significantly in SR compared to the control condition (+25.6 ms ± 7.30 in SR; +5.22 ms ± 5.46 in control; p < 0.05) following the same step-wise pattern across cycles. Reciprocal RT and median RT showed impaired performance, compared to baseline, for each of the 4 SR cycles.

Conclusion: Repetitive sleep restriction produces a step-wise dose-dependent deficit on neurobehavioral output. Future studies are needed to determine the effect of varying SR bout length on cumulative neurobehavioral deficits.

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IMPACT OF RECOVERY SLEEP OPPORTUNITY ON NEUROBEHAVIORAL MEASURES FOLLOWING CHRONIC SLEEP RESTRICTION
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Introduction: Using a large cohort of experimentally sleep-restricted healthy adults, we examined whether recovery from sleep restriction (SR) differed among neurobehavioral measures given varying doses of recovery sleep opportunity.

Methods: N = 289 adults (21–50 y, 47% female) had 2 baseline laboratory sleeps (BL1-2; 10 h TIB), then randomization to either a control condition (10 h TIB on all nights; n = 23) or to 5 SR nights (SR1-5; 4 h TIB) followed by randomization to 1 of 7 single-night recovery sleep opportunity (R1; 0, 2, 4, 6, 8, 10, or 12 h TIB) conditions (n = 266). Performance outcomes (10 h–20 h daily) included the Psychomotor Vigilance Test (PVT), the Digit Symbol Substitution Task (DSST), and the Digit Span Test (DST). Subjective outcomes included the Karolinska Sleepiness Scale (KSS) and the fatigue subscale of the Profile of Mood States (POMS-F). Sleep physiology was recorded. Mann-Whitney U tests were used to compare changes in outcomes from baseline to post-recovery sleep dose (R1-BL2) between the sleep-restricted and control cohorts.

Results: After recovery sleep up to 6 h, SR subjects differed statistically from controls on all outcomes, as measured by change from baseline to post-recovery sleep. After 8 h TIB, SR subjects no longer differed from controls on KSS and POMS-F, as well as working memory (DST). SR subjects continued to exhibit significant impairments of vigilance attention (PVT) and cognitive speed (DSST) (p < 0.01). PVT performance recovered only after 12 h TIB, while DSST performance remained below that of the control group after 12 h TIB. Data on sleep physiology were evaluated relative to recovery responses.
Conclusion: There appears to be a premature perception of full recovery from sleep restriction evident in subjective ratings and working memory measures, despite continued deficits of attention and cognitive processing.

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0319
THE EFFECT OF 36 HOURS OF TOTAL SLEEP DEPRIVATION ON EXTINCTION LEARNING AND RECALL

A. Basic Sleep Science

Introduction: Fear conditioning is critical in the development and maintenance of posttraumatic stress disorder (PTSD), and extinction learning/retention is necessary for treatment response. Animal studies have shown sleep disruption interferes with consolidation of extinguished fear. In humans, research suggests disrupted sleep impairs extinction recall, though no studies have examined this experimentally using total sleep deprivation (TSD). Here, we examined the effect of 36 hours TSD on extinction learning and recall.

Methods: Thirty-one healthy control participants (age = 23.9 ± 4.6, 24F) underwent a laboratory paradigm to acquire conditioned fear to a visual cue (CS), which was paired with an unconditioned stimulus (US) 75% of the time. Twenty-four hours after fear conditioning, participants underwent an extinction learning session. Twenty-four hours after extinction learning, participants underwent an extinction recall session. Participants were randomized to three groups: 1) well-rested (Group 1; n = 18); 2) 36 h TSD before extinction learning (Group 2; n = 22); or 3) 36 h TSD before extinction recall (Group 3; n = 21). One-way ANOVAs were used to compare the groups on Blink EMG reactivity to the CS during extinction learning and recall. Follow-up t-tests compared Group 1 to Group 2 and Group 1 to Group 3.

Results: There were no differences among the three groups during extinction learning (Fs < 1, ns). During the extinction recall session, Group 2 demonstrated more reactivity to the CS than the Group 1 (t = −2.2, p < 0.04). There was no difference between Groups 1 and 3 during extinction recall (t = −1.26, ns).

Conclusion: This was the first study to examine the effect of TSD on extinction learning and recall in human subjects. Results indicated that sleep deprivation prior to extinction acquisition did not interfere with extinction learning, but instead interfered with retention of that learning. As extinction retention is necessary for recovery from PTSD, future research should examine the relationship between sleep disturbance and extinction recall in clinical populations.

Support (If Any): Defense Medical Research and Development Program (DMRDP)

0320
PREFRONTAL BRAIN RESPONSE TO NEUROBEHAVIORAL TESTING IS CORRELATED WITH COGNITIVE PERFORMANCE

A. Basic Sleep Science

Introduction: Shift workers are at elevated risk of sleepiness-related accidents due to sleep loss and circadian misalignment from extended work hours and shifting work schedules. Near-Infrared Spectroscopy (NIRS) quantifies hemodynamic changes in oxygenated (HbO2) and deoxygenated blood within the brain that reflect alterations in regional brain activity. We tested whether NIRS monitoring would effectively detect and eventually predict decreased objective performance due to sleep loss.

Methods: We used NIRS monitoring in 6 volunteers who participated in a 32-day study of the effects of chronic sleep restriction (CSR). The study protocol included 3 baseline days, 20 days of forced desynchrony (FD), and 4 recovery days. On FD days, participants received either: (i) 8.0 hrs sleep per 24 hrs (control condition), or (ii) 5.6 hrs sleep per 24 hrs (CSR condition). A 10-min psychomotor vigilance task (PVT) was administered every 2 hours. NIRS hemodynamic responses during each PVT session were analyzed using deconvolution to estimate the peak amplitude of the hemodynamic response function to the PVT stimulus.

Results: On FD and recovery days, PVT sessions with HbO2 peak amplitude less than that measured on baseline days were significantly more likely to contain PVT lapses, independent of condition (Fisher exact test p < 0.0001). When peak amplitude was below baseline (versus above baseline), the relative risk of PVT lapse was 2.0 (p < 0.0001).

Conclusion: Our findings suggest attentional failures associated with sleep deficiency are more likely when PFC brain activation is lower. Results demonstrate the effectiveness of NIRS-monitoring of regional brain activity associated with cognitive performance deficits induced by sleep deficiency. NIRS monitoring may be useful in identifying individuals who might be at increased risk of sleep-related errors and occupational injuries. The cost-effective and minimally intrusive NIRS assessment of regional brain activity may be applicable in personnel in safety-sensitive occupations, including pilots, health care providers, truck drivers and military personnel.


0321
MULTIMODAL NEUROIMAGING TO PREDICT RESISTANCE TO SLEEP DEPRIVATION

A. Basic Sleep Science

Introduction: Some individuals show greater resistance to the adverse cognitive effects of sleep deprivation (SD) than others. If we can understand the brain systems that confer the ability to sustain cognitive performance for exceptionally long periods, it may be possible to develop methods to enhance these capacities. Here, we used multimodal brain imaging with a novel data fusion technique to predict Resistance to SD.
**THE EFFECT OF ACUTE SLEEP DEPRIVATION ON SKIN CONDUCTANCE RESPONSE AND ITS CORRELATION TO FMRI DATA DURING FEAR CONDITIONING**

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**Introduction:** Acute sleep deprivation is known to elicit changes in the autonomic nervous system (ANS). Skin conductance response (SCR) reflects ANS activity in response to fear arousal. We examined SCR during an fMRI fear-conditioning task following a night of normal sleep (NS), sleep restriction (half-night; SR), or total sleep deprivation (SD) to examine how sleep alterations affect SCR and its correlation to neural activity during fear learning.

**Methods:** Seventy-one (mean age = 23.4 ± 3.2; 49% female) right-handed participants were randomized to NS (n = 23), SR (n = 25), or SD (n = 23). The following morning, SCR, recorded from the left hand, and fMRI data were collected simultaneously. Conditioned stimuli consisting of 2 colored lamps (CS+1 and CS+2) were paired at a 63% reinforcement rate with a right-handed finger shock (unconditioned stimulus, UCS). A third lamp color (CS-) was never associated with the UCS. Three-way ANOVAs compared mean SCRs across groups during CS+1, CS+2, CS-, UCS, and corresponding no-shock-expected periods following CS-. Brain activation during the shock, averaged over fear-associated regions, was correlated with mean SCR during CS+1 trials to examine how sleep alterations affect SCR and its correlation to neural activity during fear learning.

**Results:** ANOVAs revealed differences between SCRs during CS+1 (p = 0.01), CS+2 (p = 0.05), and the UCS (p = 0.002), with the SD group demonstrating lower SCRs than the NS or SR groups. No group differences were found during CS- (p = 0.13) and no-shock periods (p = 0.10). Significant positive correlations were found between SCR and fMRI data for the NS group in the middle frontal gyrus (MFG) (p = 0.017) and thalamus (p = 0.018), and for the SR group in the right amygdala (p < 0.0001), dorsal ACC (p = 0.001), MFG (p = 0.001), thalamus (p = 0.005), subgenual ACC (p = 0.006), and anterior insula (p = 0.001). No significant correlations were found for the SD group.

**Conclusion:** These results suggest that acute sleep deprivation affects SCR arousal and its coupling to activity in fear-related brain regions.

**Support (If Any):** DARPA-12-12-11-YFA11-FP-029

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**TOPOGRAPHICAL EEG DIFFERENCES AND BROAD BAND EEG POWER SPECTRA DURING INSUFFICIENT SLEEP**

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**Introduction:** Delta EEG activity increases during sleep after total sleep deprivation with largest changes observed in frontal brain sites. However, there is not agreement about changes in EEG activity during chronic insufficient sleep. Here we examined broad EEG band activity and topographical differences using a sensitive within-subjects design of 5 days insufficient sleep (5 h) and 5 days adequate sleep (9 h).

**Methods:** 16 (8 female) healthy (aged 22 ± 5 y; mean ± SD) participants completed a 14–15 day in-laboratory protocol. A three day in-lab baseline segment was preceded by one week of consistent 9 h sleep schedules prior to exposure to two experimental conditions, each with 5 days of either 5 h or 9 h sleep opportunities. Condition order was counterbalanced such that half started with the 5 h condition first. EEG power spectra on the last two nights of each condition were averaged and calculated with Fast Fourier Transform for NREM sleep epochs at frontal (F3-A2), central (C3-A2) and occipital (O1-A2) sites for the delta (0.75–4.25 Hz), theta (4.25–8.25 Hz), alpha (8.25–12.25 Hz), sigma (12.25–15.25 Hz) and beta (15.25–25.25 Hz) broad bands. EEG data were compiled into time bins representing 1/10th of corresponding NREM cycles and data were log transformed.

**Results:** Delta increased during 5 h versus 9 h sleep opportunities in NREM cycle1 and cycle2 at F3 and C3 (p < 0.05) (most robustly in NREM cycle2). Theta increased during 5 h for all three brain sites in NREM cycle1 and F3 and C3 in NREM cycle2 (p < 0.05). Alpha surprisingly increased during 5 h for all three brain sites in NREM cycle1 and NREM cycle3 (p < 0.05). Sigma decreased during 5 h for C3 and beta decreased during 5 h for F3 and C3 in NREM cycle2 (p < 0.05).

**Conclusion:** Insufficient sleep changes EEG activities across the entire 0.75–25.25 Hz range, especially in the frontal and central sites; changes observed may represent EEG signatures of increased homeostatic sleep drive.

**Support (If Any):** NIHRO1HL085705; IULIRR025780; P30DK048520
0324

AGE-RELATED CHANGES IN INTRA AND INTERHEMISPHERIC WAKING EEG COHERENT ACTIVITY AFTER A NIGHT OF TOTAL SLEEP DEPRIVATION

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Introduction: Waking EEG studies have shown enhanced intrahemispheric but decreased interhemispheric coherence after sleep deprivation. Compared to young adults, older individuals show smaller or similar effects of acute sleep loss on vigilance. However, no study has evaluated changes in cerebral connectivity after sleep loss in aging. This study compared intrahemispheric (INTRA) and interhemispheric (INTER) waking EEG coherence before and after sleep deprivation in young and middle-aged participants.

Methods: Thirteen young (6W; mean = 29.9 years, SD = 5.0) and 14 middle-aged (11W; mean = 51.3 years, SD = 5.0) healthy subjects participated in a 25-hour constant routine protocol. Two waking EEGs were recorded after habitual wake time; the first after one hour of wakefulness (BSL) and the second after 25-hours of wakefulness (PRIV). Magnitude squared coherence was computed in INTRA (F3-C3, F3-P3, F3-O1, C3-P3, C3-O1, P3-O1) and INTER (F3-F4, C3-C4, P3-P4, O1-O2) pairs of electrodes for delta, theta, alpha, and beta frequency bands. ANOVAs 2groups*2conditions were computed for each pair and frequency bands.

Results: Compared to BSL, young subjects showed higher INTRA alpha coherence for F3-O1 and C3-P3 in PRIV whereas no condition effect was found for the older participants. Furthermore, both age groups showed higher INTRA coherence in alpha for C3-O1 and in delta for F3-O1 in PRIV compared to BSL. In PRIV, both age groups showed higher INTER coherence in alpha for F3-F4 but lower INTER coherence in beta for C3-C4 and in delta/theta for P3-P4 and O1-O2.

Conclusion: Compared to the young, older subjects showed less prominent effects of the sleep deprivation on INTRA coherence supporting the hypothesis of lower effects of homeostatic sleep pressure on waking EEG connectivity in older participants. Sleep loss decreased INTER coherence in delta/theta in more posterior derivations but enhanced alpha coherence in frontal derivations similarly in both groups. Future studies should evaluate how cerebral waking EEG connectivity during sleep loss is linked with vigilance and performance deterioration during aging.

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0325

SLOW WAVE ACTIVITY AND VIGILANCE CHANGES AFTER ACUTE SLEEP DEPRIVATION AND CHRONIC SLEEP RESTRICTION

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Introduction: Acute sleep deprivation (aSD) and chronic sleep restriction (cSR) impair vigilance. Increased slow wave activity (SWA) during sleep is a well-established marker of sleep pressure resulting from prolonged wakefulness. We aimed at directly comparing the effects of aSD and cSR on vigilance, subjective sleepiness and SWA.

Methods: 6 male subjects underwent 40 hours of aSD and 7 nights of cSR (5 h instead of 8 h sleep/night). We compared the maximal change in first hour SWA (power density in the 1.25–4.5 Hz range, 128 EEG electrodes), during the recovery nights after aSD and cSR relative to a baseline night. We assessed vigilance in the afternoons before the respective nights, using the psychomotor vigilance task (PVT), i.e. speed and number of lapses (reaction times > 500 ms; transformed: √x+√(x+1)), and subjective sleepiness by the Stanford Sleepiness Scale.

Results: The maximal SWA increase after aSD (+102.0 ± 30.2%, mean ± SD) was significantly higher (p < 0.01) than after cSR (+37.0 ± 9.8%). Subjective sleepiness increased after aSD (+1.7 ± 1.2; p < 0.05) and cSR (+2.0 ± 1.3; p < 0.05), reaching equal levels (p = 0.58). In the PVT, speed was reduced to comparable values (p = 0.95) after aSD (−0.6 ± 0.4s; p < 0.05) and cSR (−0.4 ± 0.3s; p < 0.05). The increase in lapses was significant after aSD (±2.2 ± 1.6; p < 0.05), but not after cSR (±0.8 ± 1.6; p = 0.29), with a trend for more lapses after aSD (p = 0.08).

Conclusion: The higher impact of aSD on SWA and lapses in vigilance are contrasted by comparable effects of aSD and cSR on psychomotor speed and subjective sleepiness. Further data analysis in this ongoing study, i.e. topographical distribution of SWA changes, inter-individual differences, or the course of cSR might lead to novel insights in the underlying mechanisms of these seemingly discrepant findings.

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0326

EFFECTS OF SLEEP DEPRIVATION ON ALCOHOL CONSUMPTION: EVIDENCE FOR A BI-DIRECTIONAL RELATIONSHIP

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Introduction: The effects of alcohol on sleep have been heavily researched. However, little research has assessed the effects of sleep deprivation on subsequent alcohol consumption. Many people with alcohol use disorders report sleep disorders; if sleep deprivation does impact alcohol consumption then current research addresses half the issue. The present study seeks to test the effects of sleep deprivation on voluntary alcohol consumption in rodents.

Methods: The subjects, 14 adult male Sprague-Dawley rats, were first given free access to ethanol and a water (7% solution) for three weeks to achieve steady drinking behavior. Rats were then sleep deprived (SD) by a slowly rotating wheel for a small (18 hr), medium (20 hr), and large (22 hr) amount every day for one week. Individual rats were...
counterbalanced across conditions and had at least a week in between conditions (no SD). Additionally, a wheel control (WC) condition was used where the rat spent 18–22 hours a day in a non-rotating wheel.

**Results:** A Friedman test demonstrated a statistically significant difference in voluntary alcohol consumption on SD vs non-SD conditions, χ² (4) = 11.754, p = 0.019. Post hoc analysis on SD amount were conducted by running separate Wilcoxon signed-rank tests with a Bonferroni correction. No significant differences were found, but all conditions had moderate to large effect sizes when compared to no-SD weeks: 18 hr and No SD (d = 0.579), 20 hr and No SD (d = 0.545), 22 hr and No SD (d = 0.495), and WC and No SD (d = 0.397).

**Conclusion:** Voluntary alcohol consumption increased during all SD conditions supporting the idea that there is a bi-directional relationship between sleep and alcohol consumption. However, the WC condition was also significantly different from no SD, suggesting that this effect could be an artifact of home cage removal.

**0327**

**INTERACTIVE EFFECTS OF TOBACCO WITHDRAWAL AND SLEEP DEPRIVATION ON MOOD AND DRUG CRAVING**

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**Introduction:** Sleep disturbance experienced during tobacco withdrawal has been linked with an increased risk of relapse. We investigated the effect of a night of sleep deprivation and acute tobacco abstinence on measures of mood and tobacco craving previously associated with increased risk of relapse.

**Methods:** Regular tobacco smokers and non-smokers (n = 25, age 22.4 ± 3.8 years). Regular smokers were randomly assigned to an abstaining or active (ad libitum) smoking group. Participants spent one night sleeping in the laboratory and a second night completely deprived, each separated by 1 week. Abstaining smokers abstained for ≥ 14 hours on each study night. Participants completed the Profile of Mood States (POMS) and Brief Questionnaire of Smoking Urges (BQSU) both pre-and post-sleep, and across sleep deprivation (every 3 hrs). Mixed models ANOVA assessed these data for effects of sleep condition, time, and smoking group.

**Results:** Abstaining smokers reported greater overall mood disturbance on the POMS (mean ± SD; 47.33 ± 27.97) versus active (-23.53 ± 27.64) and non-smokers (24.47 ± 27.97) over sleep deprivation. All groups reported lower POMS mood disturbance over normal sleep (Abstaining: 3.64 ± 8.88; active smoking: 14.57 ± 25.76; non-smoking: 8.15 ± 21.88). A main effect of night as well as a night by time interaction effect on POMS mood were found to be significant (both p < 0.01) while a night x smoking group interaction effect on POMS mood approached significance (p = 0.06). All other POMS interactions were non-significant. Abstaining smokers reported greater craving on the QSUB versus active smokers over both sleep deprivation (41.77 ± 18.22 and 21.46 ± 6.4) and normal sleep (36.1 ± 16.9 and 24.5 ± 15.5). A main effect of time on QSUB craving was significant as was a time by group interaction, (both: p < 0.01).

**Conclusion:** These preliminary results suggest that sleep disturbance may further worsen nicotine withdrawal related changes in mood, or that sleep may be protective particularly given the negative independent effect of sleep deprivation on mood. Tobacco craving is known to escalate over the course of acute withdrawal, however it remains unclear whether sleep loss during times of withdrawal increases drug craving.

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**0328**

**THE ALCOHOL CLAMP METHOD: A NOVEL APPROACH FOR STUDYING THE COMBINED EFFECTS OF ALCOHOL AND SLEEP DEPRIVATION ON SIMULATED DRIVING PERFORMANCE**

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**Introduction:** Many alcohol-related vehicular accidents occur at night when individuals are partially sleep deprived, but few studies have examined the effects of combining alcohol and sleep loss on driving performance. We implemented the alcohol clamp method to examine the effects of a small dose of alcohol on simulated driving performance 2 hours after usual bedtime.

**Methods:** In a within-subjects study, healthy ethnic-Chinese males (n = 12, aged 22–29 years) were kept awake for 24 consecutive hours in a laboratory setting on 2 occasions. Subjects were administered alcohol or placebo during each visit, with the order randomized and counterbalanced. Starting at midnight, an alcohol solution (6% in saline) was delivered intravenously for 2 hours using a Computer-assisted Alcohol Infusion System. Blood alcohol content was clamped at 0.04 g/dL (half the legal limit for operating a vehicle in the USA), which was verified by taking frequent breathalyzer measurements. Participants completed 35-minute driving tasks 10 hours and 18 hours after their usual wake time using a PC-based simulator (DriveSim5; York Computer Technologies), as well as shorter 13-minute drives every 2–4 hours. Performance was assessed using the standard deviation of lane position (SDLP).

**Results:** The SDLP increased during sleep deprivation, and variability in lane position was nearly 3 times greater in the alcohol condition relative to placebo. Two hours after usual bedtime, the effects of alcohol on SDLP were equivalent to performance in the placebo condition after 22 h of sustained wakefulness.

**Conclusion:** A moderate amount of alcohol can substantially impair driving performance during the early part of the night. In future studies, it will be important to evaluate the interaction of blood alcohol and time spent awake on driving performance. Such information could be used to inform policies on safe driving practices.

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**0329**

**THE MODIFICATION EFFECT OF SLEEP IN THE ASSOCIATION BETWEEN FTO RS99396099 AND DIETARY PATTERN: AN FMRI STUDY**

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**Introduction:** FTO is highly expressed in brain regions controlling feeding and energy expenditure, such as the hypothalamus. However, little is known how FTO affect the brain to influence appetitive traits, and furthermore if sleep, which was proved to be close related to energy intake, can interact with FTO on food responsiveness. This study was design to investigate whether sleep modified the association FTO rs99396099 and food preference.

**Methods:** The study used a 3 (picture types: high-calories food HF, low-calories food LF, dining utensil) × 2 (sleep status: total sleep deprivation...
TSD, Normal sleep, NS) ×2 (FTO genotypes: AT, TT) within-subjects design. 26 normal-weight healthy female subjects were recruited and scheduled for two functional magnetic resonance imaging scanning visits: after a normal night sleep and after one night total sleep deprivation. The two scanning sessions were conducted 4 weeks apart and the order of scanning was counterbalanced across subject. On the morning after either total sleep deprivation or regular sleep, subjects rated their hunger on a scale from 0 (empty/want to throw-up) to 10 (full/want to throw-up) and evaluated sleepiness by Stanford Sleepiness Scale before fMRI scanning. fMRI during visual food presentation was performed. All participants were genotyped for FTO SNP rs9939609.

**Results:** The final sample consisted of 24 subjects (21.39 ± 1.92 years old), 5 subjects of those carried FTO rs9939609 AT risk allele carriers. Subjects reported significantly greater hunger (6.09 ± 2.60 vs. 3.18 ± 2.11, Z = −3.38, p = 0.001) and sleepiness (2.91 ± 1.31 vs. 1.95 ± 0.95, Z = −2.73, p = 0.006) after TSD than after NS. Compared to TT subjects, TA subjects was associated with a significantly greater activation in the bilateral Middle Occipital Gyrus, the left Superior Frontal Gyrus, Middle Frontal Gyrus, Medial Frontal Gyrus and Sub-Gyral, the right Cuneus in response to HF versus LF during NS condition. Besides, greater activation in the left Inferior Parietal Lobule (Supramarginal Gyrus, Angular Gyrus, Precunansanterior) were found in response to HF and LF images in the TA subjects after TSD compared with after NS.

**Conclusion:** Activation of brain regions known to regulate appetite, reward, and incentive motivation in FTO risk allele carriers may contribute to high caloric food preference and sleep might be able to modify the genetic determinant of obesity from FTO variation.

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### 0330

**INDIVIDUAL DIFFERENCES IN RESTED ACTIVATION OF THE VENTRAL STRIATUM PREDICTS OVEREATING DURING SLEEP DEPRIVATION**

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**Introduction:** Sleep loss has been shown to contribute to weight gain through several mechanisms, including alterations in appetite-regulating hormones, increased hunger, and increased fat and carbohydrate intake. In addition to altered physiological responses, sleep deprivation (SD) may also affect food intake by altering the functioning of the reward and behavioral control regions of the brain. Consistent with recent theories positing trait-like individual differences in vulnerability to sleep loss, we hypothesized that some people might show greater vulnerability to sleep loss-induced overeating that would be related to baseline differences in the functional responses of reward anticipation regions of the brain (e.g., ventral striatum).

**Methods:** At rested baseline, thirty healthy participants (15 males) aged 20–43 years completed a series of functional magnetic resonance imaging (fMRI) scans, including the multi-source interference test (MSIT) and n-back tasks, which measure executive functioning and working memory, respectively. Later that same week, each participant completed a 28-hour period of SD, during which they were given ad libitum access to 10,500 kcal of food to consume throughout the overnight SD session. FMRI brain responses were used to predict subsequent food consumption, appetite, and hunger ratings during each third of the session using SPMS (p < 0.001).

**Results:** Baseline functional activation within the ventral striatum, particularly the nucleus accumbens, was positively correlated with kcals consumed during the period of sleep deprivation, but only for the final third of the session (i.e., 6 am to noon). This was observed for the MSIT (R2 = 0.45) as well as the n-back task (R2 = 0.57).

**Conclusion:** Prior research suggests that SD is associated with downregulation of dopamine D2 receptors in the ventral striatum. Our findings suggest that individual differences in the responsiveness of the ventral striatum at baseline may confer some resistance to this downregulation during SD, leading to a greater propensity to overeat among such individuals.

**Support (If Any):** DARPA-12-12-11-YFA11-FP-029

### 0331

**EATING ON NIGHT SHIFT: A LARGE VS SMALL SNACK IMPAIRS GLUCOSE RESPONSE TO BREAKFAST**

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**Introduction:** Shift work is a risk factor for chronic diseases such as type 2 diabetes. Food choice may play a role, however, simply eating at night when the body is primed for sleep may have implications for health. This study examined the impact of consuming a large vs small snack at night on glucose metabolism.

**Methods:** N = 29 healthy subjects (21–35 y; 18F) participated in a simulated night shift laboratory study that included one baseline night of sleep (BL; 2200 h–0700 h) and one night awake with allocation to either a large snack (500 Kcal) or small snack (200 kcal) group. The snack was consumed between 0000–0030 h and consisted of low fat milk, a sandwich, chips and fruit (large snack) or half sandwich and fruit (small snack). Subjects ate an identical mixed meal breakfast (500 kcal) after BL sleep and simulated night shift at 0830 h. Interstitial glucose was measured continuously during the entire study using Medtronic Continual Glucose Monitors. Only subjects with identical breakfast consumption and complete data sets were analysed (N = 20).

**Results:** Pre-breakfast, glucose levels were not significantly different between BL and night shift, nor were they different between snack groups (p > 0.05). A snack group by day interaction effect was found (F1,17 5.36, p = 0.03) and post-hocs revealed that in the large snack group, AUC response to breakfast was significantly higher following night shift compared to baseline (p = 0.003). This translated to a 17.8% (SEM 6.7) increase. AUC was not significantly different between days in the small snack group.

**Conclusion:** Consuming a large snack at 0000 h impairs the glucose response to breakfast, compared to a smaller snack. Further research in this area will inform dietary advice for shift workers, which could include recommendations on how much to eat as well as content.

**Support (If Any):** University of South Australia DRPF Seeding Grant
sleep on energy expenditure in African American and Caucasian men and women.

Methods: Healthy adults (21–50 y) participated in a controlled laboratory study. After two baseline sleep nights, subjects were randomized to an experimental (n = 36; 4 h time-in-bed (TIB)/night for 5 nights followed by 1 night 12 h TIB recovery sleep) or a control condition (n = 11; 10 h TIB/night). Resting metabolic rate and respiratory quotient were measured using indirect calorimetry in the morning after overnight fasting.

Results: Resting metabolic rate—the largest component of energy expenditure—decreased after five nights of sleep restriction (−2.6%, p = 0.032) and returned to baseline levels after recovery sleep. No changes in resting metabolic rate were observed in control subjects. Relative to Caucasians (n = 14), African Americans (n = 22) exhibited comparable daily caloric intake but a lower resting metabolic rate (p = 0.043) and a higher respiratory quotient (p = 0.013) regardless of sleep duration.

Discussion: Adults who are chronically sleep restricted due to having habitual short sleep durations may need to compensate for decreased morning resting metabolic rate by reducing caloric intake or increasing physical activity to prevent weight gain.

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0333 NEW LIKELIHOOD RATIO METRIC FOR THE PSYCHOMOTOR VIGILANCE TEST AND IMPLICATIONS FOR THE CHOICE OF A PRIMARY PVT OUTCOME METRIC
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Introduction: The Psychomotor Vigilance Test (PVT) is a widely used assay of behavioral alertness sensitive to the effects of sleep loss and circadian misalignment. However, there is currently no accepted PVT outcome metric that captures response slowing, attentional lapses, as well as compensatory premature responses which are all typically observed concurrently in sleep-deprived subjects.

Methods: We developed a novel Likelihood Ratio Metric (LRM) based on relative frequency distributions in 50 categories of response times in alert and sleep-deprived subjects.

Results: LRM scored the second highest effect size (1.91; 95% confidence interval CI 1.53–2.63) in a 33-hour total sleep deprivation protocol (outranked only by response speed, effects size 1.93; 95% CI 1.55–2.65) and the highest effect size (1.22; 95% CI 0.98–1.57) in a 5 consecutive night, 4 hour time in bed sleep opportunity partial sleep restriction protocol (followed by response speed, effect size 1.21; 95% CI 0.94–1.59). Standardized LRM scores agreed well with standardized response speed scores (Pearson’s r = 0.999 for total and partial sleep restriction), and less well with 5 other common PVT outcome metrics (Pearson’s r = 0.824–0.990 for total sleep deprivation and r = 0.900–0.999 for partial sleep restriction) including mean and median response times, fastest 10% response times, false starts and lapses.

Conclusion: The new LRM is a sensitive PVT outcome metric with high statistical power that takes subtle sleep loss related changes in the distribution of response times (including false starts) into account, uses most of the available information, is not prone to outliers, and can easily be calculated and interpreted. Congruence between, and similar performance of, LRM and PVT response speed support the use of response speed as the primary, most sensitive, and most parsimonious PVT outcome metric.

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0334 SLEEP DEPRIVATION AND THE TEMPORAL DYNAMICS OF ACTION CONTROL
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Introduction: We are often faced with automatic response tendencies which conflict with higher-level goals. This study aims to clarify how total sleep deprivation (TSD) impacts various aspects of response selection under conditions of response conflict.

Methods: 22 healthy young adults (12 females) completed the Simon task at a sleep-rested and a sleep-deprived session; with one week in between, and order counterbalanced. The Simon task involved a red versus a green square mapped to two response alternatives (left versus right hand). Participants indicate stimulus color, which requires overriding an automatic tendency to respond based on stimulus location. Delta plots were used to reveal the temporal dynamics of automatic response capture and selective response suppression. Next, delta plots were analyzed as a function of whether the previous trial was congruent or incongruent to explore conflict adaptation. Mixed-effects models were used to probe the effects of sleep deprivation on relevant delta slopes.

Results: The negativity of the slowest slope of the delta plot is taken to reflect the efficiency of selective response suppression; there was a significant effect of session (F(1,20) = 6.1, p = 0.02). The fastest slope of the conditional accuracy function is taken to reflect the strength of automatic response capture; this was not impacted by fatigue. Further, sleep deprivation did not impact sequential congruency effects, i.e. delta plots as a function of the congruency of the previous trial.

Conclusion: Sleep deprivation impaired selective response suppression but automatic response capture. That is, fatigue impaired the ability to use cognitive control in order to suppress an automatic yet unwanted response. The flexibility of cognitive control in adapting to changing trial-by-trial demands (i.e., conflict adaptation), however, appears to be intact with fatigue as indicated by preserved sequential congruency effects.

0335 MODELING SLEEP DEPRIVATION AND THE ROLE OF PERSONAL AGENCY IN RISKY DECISION-MAKING
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Introduction: The current study examined the role of personal agency in risky decision-making during sleep deprivation. Personal agency involves the feeling of being personally responsible for a choice made and was operationally manipulated by whether or not participants had to make a motor response to register each decision.

Methods: Twenty-two healthy young participants (12 females) performed tasks at a sleep-rested (3:00 pm) and at a sleep-deprived session (at 4:00 am following 20 h of wake), with order counterbalanced and 7 d between sessions. Participants completed two variants of the Balloon Analogue Risk Task (BARTs). In the first version (classic-BART), participants manually pressed a button to progressively inflate a bal-
loon, while in a second version the computer auto-inflated the balloon (auto-BART). Each inflation is associated with more points, at the risk of a random explosion wiping out all gains for that balloon. Mixed-effects models examined the effects of fatigue and task version on each risky decision-making component estimated from a sequential decision-making model.

**Results:** Estimates of explosion probability (q), were > 90% accurate for both versions, with no effect of fatigue. In the sleep-rested session there was greater reward sensitivity (γ^++) for the auto-BART than for the classic-BART (1.61 vs. 1.30; F(1,60) = 15.2, p < 0.001) while in the sleep-deprived condition a significant modulation of reward sensitivity by task version was not observed (1.33 vs. 1.25; p = 0.43). There was further a main effect: reward sensitivity was lower for the sleep-deprived versus the sleep-rested session (F(1,140) = 7.2, p < 0.01).

**Conclusion:** Modeling behavioral choices on two variants of the Balloon Analogue Risk Task (BART) suggested that sleep deprivation produces distinct changes in underlying aspects of risky decision-making. Probability estimates were highly accurate both during rest and fatigue. During sleep deprivation, however, there was less reward sensitivity, and also less modulation of reward sensitivity as a function of personal agency.

### 0336 CAFFEINE MITIGATES PERFORMANCE IMPAIRMENTS ASSOCIATED WITH 50H SLEEP DEPRIVATION BUT NOT SUBJECTIVE SLEEPINESS

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**Introduction:** Caffeine is an effective fatigue countermeasure in sustained operations. However, there is limited evidence demonstrating the benefits of repeated caffeine consumption in maintaining performance and subjective sleepiness over extended wakefulness. The current study investigated the impact of multiple caffeine doses on performance and subjective sleepiness during 50 h extended wakefulness.

**Methods:** Twenty-four healthy participants were assigned to a caffeine (n = 12 [4F]), ages 22.5 ± 3.3 y) or placebo condition (n = 12 [5F], ages 22.5 ± 2.5 y). Following a 10 h baseline sleep, participants remained awake for 50 h (two nights). Each night at 01:00 h, 03:00 h, 05:00 h and 07:00 h participants were given 200 mg of caffeine or placebo gum. Neurobehavioral test batteries were administered every 3–4 h and included the psychomotor vigilance task (PVT), the digit symbol substitution task (DSST), and the Karolinska sleepiness scale (KSS). Mixed model ANOVA assessed the main and interaction effects of condition and hours of wakefulness on performance and subjective sleepiness.

**Results:** Compared to placebo, caffeine reduced the number of PVT lapses (F(1,22) = 15.9, p < 0.001) but did not affect DSST correct responses (F(1,22) = 2.1, p = 0.2) or KSS scores (F(1,22) = 0.7, p = 0.4). All measures worsened with increasing hours of wakefulness (PVT, F(8,176) = 20.8, p < 0.001; DSST, F(8,176) = 7.1, p < 0.001; KSS F(8,176) = 40.2, p < 0.001). Caffeine slowed the increase in PVT lapses (F(8,176) = 10.5, p < 0.001) and the decrease in DSST correct responses (F(8,176) = 3.7, p < 0.001) such that after 50 h of wakefulness performance was better following caffeine administration compared to placebo. Caffeine also slowed the increase in KSS scores (F(8,176) = 4.2, p < 0.001), but only during the first night.

**Conclusion:** Findings demonstrate that strategic caffeine use effectively mitigates performance impairments during 50 h wakefulness. While caffeine reduced subjective sleepiness during the first night, additional doses of caffeine did not improve subjective sleepiness. Results highlight the lack of congruence between subjective and objective measures. Individuals using caffeine as a fatigue countermeasure in sustained operations may miscalculate their ability to perform.

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### 0337 SLEEP LOSS AND RESPONSE INHIBITION ON AN EMOTIONAL GO-NO-GO TASK

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**Introduction:** Sleep deprivation is known to increase emotional reactivity to negative stimuli, however the underlying mechanisms are unclear. This study examined whether one night of total sleep deprivation impairs inhibitory control for emotional stimuli.

**Methods:** To date, N = 17 healthy participants (ages 25.2 ± 5.0 y, 5 female) completed an in-laboratory study. N = 8 subjects were randomized to a control sleep group (SC) and N = 9 subjects were randomized to a sleep deprivation group (SD). Participants completed an emotional Go/No-Go task, and the Positive Affect Negative Affect Schedule at 11:00 h at baseline and after a night of either sleep or sleep deprivation. The Go/No-go task involved responding to pictures of happy, fearful and neutral facial expressions. At different time points throughout the task, instructions were displayed stating which expressions were “go” items (requiring a response) and which were “no-go” items (requiring withholding of a response). False alarm rates (FA; incorrect no-go trials) and reaction time (RT) were recorded separately for each valence category. A 2 (group) x 2 (session) ANOVA was performed to examine the effect of sleep deprivation on Go/No-go performance, and t-tests were conducted to examine group differences in subjective affect.

**Results:** The SD group reported significantly lower levels of positive affect after sleep deprivation (t(15) = 2.93, p = 0.01). Preliminary analyses revealed a significant session x group interaction for overall FAs (F(1, 14) = 5.21; p = 0.039) and RT (F(1, 14) = 16.06; p = 0.001), such that the SD group had a higher FA rate and slower RTs after sleep deprivation. Post hoc analysis did not reveal any significant differences in performance between groups for any valence category.

**Conclusion:** Sleep deprivation led to a decrease in positive affect and impairment in response inhibition which was not specific to any valence category. These results suggest that sleep loss impedes inhibitory control mechanisms. Further research is needed to clarify the influence of sleep on emotion-related impulsivity.

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XIII. Sleep Deprivation

0338 PERFORMANCE DECLINE DURING CHRONIC SLEEP DEPRIVATION IS ASSOCIATED WITH DECREASING CEREBRAL OXYGEN LEVEL IN ADOLESCENTS UNDER REAL-LIFE SCHOOL CONDITIONS

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Introduction: Sufficient sleep is important for adolescent mental development. Chronic sleep deprivation (CSD) during school time can lead to low school performance. Psychomotor vigilance task (PVT) has proven to be a sensitive measure of sleep loss. Functional neuroimaging of adolescent brain activities during PVT under real-life school conditions will provide insights into the neuronal basis of how CSD influences cognitive function in adolescents.

Methods: 17 health high school students (m: 8, f: 9, age: 18–19) participated in a 4 nights CSD protocols at home. They were restricted to sleep 4 to 5 hours per night from Monday to Thursday controlled by actigraphy and phone calls from experimenters. Daily PVT sessions were performed each day between 4–5 pm from Monday (baseline measurement) to Friday (the last day of CSD) during school time. The HbO2, HHb, oxygen index (i.e., HbO2–HHb), blood volume (BV) and oxygen saturation (StO2) changes in left forehead were monitored using near-infrared spectroscopy (NIRS) in 8 volunteers during the first and last PVTs. The PVT reaction time (RT) was assessed (one-way repeated ANOVA, p < 0.05). The mean values and changing slopes of hemodynamic parameters during PVT sessions between Monday and Friday were compared (paired t-test, p < 0.05).

Results: The PVT performances (lapses, mean RT, median RT, mean 10% fastest and 10% slowest RT) decrease during sleep deprivation (all p < 0.05). Compared to baseline measurement on Monday, a significant decrease in mean cerebral HbO2 (p = 0.012), OI (p = 0.006) and StO2 (p = 0.006) while an increase in HHb (p = 0.005) are observed during PVT sessions on Friday. The changing slopes of hemodynamics during PVT sessions also decline after CSD (all p < 0.05).

Conclusion: Declining PVT performances after CSD are associated by a decreasing cerebral oxygen level and slower oxygenation response during PVT sessions in adolescents. Sleep loss may affect adolescents’ brain function by reducing cerebral oxygen supply.

Support (If Any): This work was supported by Scientific Foundation of Clinic Barmelweid.

0339 ITEM AND SOURCE MEMORY FOR AFFECTIVE WORDS UNDER TOTAL SLEEP DEPRIVATION

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Introduction: Considerable research has focused on consolidation of memory during sleep, but relatively little attention has been paid to memory for new information under total sleep deprivation (TSD). Memory is not a unitary ability, and TSD effects on cognitive performance are not uniform across domains. We investigated TSD effects on two related but dissociable memory systems: item memory (recognition of stimuli) and source memory (memory for the context in which stimuli occurred). Stimuli consisted of affectively positive, negative, or neutral words (items) spoken in either a female or male voice (source).

Methods: N = 69 healthy adults (ages 22–40, 35 males) spent 3 consecutive 24 h days in the laboratory. After a baseline night (10 h time in bed (TIB)), subjects were randomly assigned to a 38 h TSD (n = 37) or control (10 h TIB) condition, followed by a recovery night (10 h TIB). The item and source memory task was administered once at baseline (14:00) and once 24 h later during TSD. Stimuli were presented through headphones, with half of the words in each affective valence category spoken by a female and half by a male. Recognition memory was tested with foils and targets of each valence category. For words correctly identified as previously heard, source memory was tested by subjects indicating whether the word was spoken by a female or male. Hits and false alarms were calculated for item recognition. Total number of correct source identifications, conditional on correct item memory, was calculated for source memory.

Results: Repeated-measures ANOVA revealed significant Condition by Session interactions for item hits [F(1,67) = 8.55, p < 0.01, η2 = 0.11], item false alarms [F(1,67) = 25.04, p < 0.001, η2 = 0.27], and source memory [F(1,66) = 7.48, p < 0.01, η2 = 0.10], with TSD causing reduced item and source memory across all word valences. There were no significant Condition by Valence interactions for either item or source memory.

Conclusion: TSD degraded item and source memory regardless of affective valence. Our findings suggest that sleep deprived individuals may experience both item and source memory errors which, in natural settings, could lead to, e.g., false identifications in eyewitness situations.

Support (If Any): NIH grant R21CA167691

0340 EFFECTS OF TOTAL SLEEP DEPRIVATION ON SIMPLE REACTION TIME, VIGILANCE, AND VISUAL ATTENTION IN COLLEGE STUDENTS

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Introduction: College students often engage in total sleep deprivation (TSD) known as “all-nighters”. TSD has a negative effect on multiple cognitive domains, including simple attention, complex attention and working memory. Subjective reports on TSD in college students indicate that TSD contributes to decreased academic performance and lower GPA. The present study extended previous work by considering the effects of TSD on college students’ cognitive performance using objective actigraphy and computer-based cognitive tests of simple reaction time/vigilance and visual attention rather than self-report measures of academic performance and other cognitive domains. We hypothesized students’ performance on simple reaction time/vigilance and visual attention tasks would be worse after a period of TSD than when awake.

Method: As part of a larger study, 25 college students aged 18–26 years (M = 22.99, SD = 2.64, 68% female) completed the psychomotor vigilance test (PVT, a measure of simple reaction time and vigilance) and the useful field of view (UFOV) test (measure of visual attention) twice, once the morning after sufficient sleep (> 7 hours, verified with actigraphy) and once after a monitored “all-nighter” (also verified with actigraphy).

Results: In paired-samples t-tests, PVT mean reaction time, PVT lapse count, and UFOV total scores differed across conditions (t23) = 4.55, p < 0.001; t(23) = 4.08, p < 0.001, and t(19) = 3.19, p = 0.005, respectively. Students had slower mean reaction time, higher lapse count, and poorer UFOV performance when sleepy.

Conclusion: As hypothesized, TSD had a deleterious effect on college students’ simple reaction time/vigilance and visual attention. This is especially concerning among college students since that population commonly engages in “all-nighters” to complete school work. Future
A. Basic Sleep Science

0341
ALTERED NEURONAL RESPONSE TO A WORKING MEMORY/ATTENTION TASK IN ADOLESCENTS UNDER CHRONIC SLEEP RESTRICTION
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Introduction: Chronic sleep restriction (SR) is common among adolescents on school nights. SR diminishes the ability to maintain attention and actively hold and mentally manipulate multiple pieces of information at once (working memory). This study used functional magnetic resonance imaging to probe brain circuits associated with working memory and attention and their dependence on teen sleep regimen.

Methods: 32 healthy adolescents aged 14–16 years underwent 5 consecutive nights of SR (6.5 hours in bed) versus 5 nights of healthy duration (HD; 10 hours in bed) in randomly counterbalanced order, separated by a 2-night washout. Adherence to the sleep regimen was verified by actigraphy. Imaging was performed the morning after each sleep condition during an n-back working-memory task. Group-level voxel-by-voxel analysis was performed over all subjects for summed response in two regions of interest: (a) task positive (TP) frontal and parietal regions that are commonly activated in response to attention demands, (b) task negative (TN) regions that are often less active in response to attention demands (e.g., “default mode” regions). ANOVA was performed for effects of sleep condition and for difficulty level of n-back. Paired T-tests compared HD and SR conditions.

Results: The ANOVA found significant main effects of both n-back difficulty and sleep state in both TP and TN networks. Follow-up paired T-tests showed significant or trending decreases in activation in left inferior/mid frontal and parietal TP regions during SR, but only at the most difficult level of working-memory demands. TN response was not different across sleep states, according to paired T-tests.

Conclusion: TP and TN responses systematically varied according to level of difficulty of the working memory task. Sleep state affected activation only for the most difficult level of working-memory/attention. There may be a cognitive challenge threshold for network breakdown due to chronic SR in adolescents.

Support (If Any): National Institutes of Health (R01 HL092149, UL1 RR026314)

0342
THE IMPACT OF SLEEP DEPRIVATION ON THE TRUSTWORTHINESS VISUAL REPRESENTATION
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Introduction: The impact of sleep deprivation (SD) on implicit social judgments and their associated perceptual mechanisms remains relatively unknown. The goal of this study is to evaluate if SD alters visual representations of trustworthiness for faces.

Methods: Nine participants (7W; 18–27 years old) completed a reverse correlation task, before and after a 36-hour SD. This task is designed to reveal the visual representations of any visual category, which is a trustworthy face in this case. On each trial (N = 700 pre- and post-SD), two stimuli were created by adding a visual noise pattern and its inverse on a base face (i.e. morph of 32 faces judged as neutral on the level of trustworthiness). The two stimuli were simultaneously presented on a computer monitor and participants had to decide which one seems most trustworthy. Classification images (CIs) depicting the visual representation of a trustworthy face were computed for each participant, before and after SD, by averaging the noise patterns of the stimuli selected as most trustworthy. Subsequently, the CIs were averaged across participants for each condition, thus resulting in two CIs, one pre- and one post-SD. The two CIs, each overlaid on the base face, were presented to 49 independent non-SD participants, who were asked to decide which face appeared the most trustworthy.

Results: A sign test revealed that the pre-SD CI was chosen as the most trustworthy more often than the post-SD CI (Frequency = 33; p = 0.021).

Conclusion: This study is the first to show that SD can change the visual representation of trustworthiness for faces by making it appear less trustworthy. One notable change in the visual representation post-SD was in the eye area: they were more slanted than in the pre-SD visual representation. This result is consistent with the literature showing that the eye area conveys crucial information for the trustworthiness judgment.

XIII. Sleep Deprivation

0343
REDUCED RISK AVERSION AFTER CHRONIC SLEEP RESTRICTION BUT NOT AFTER ACUTE SLEEP DEPRIVATION
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Introduction: Various studies have shown an effect of acute sleep deprivation (aSD) on risky decision making. Chronic sleep restriction (cSR) mirrors everyday life better than aSD. It is not yet clear if and how chronic sleep restriction (cSR) affects decision making behavior. Such sleep restriction particularly affects people in positions with vast responsibilities including managers, scientists, or politicians, where risky decisions could have far-reaching consequences. Our study investigates the influence of both aSD and cSR on decision making under conditions of risk and uncertainty.

Methods: We studied decision making behavior under risk in nine healthy males. Their risk preferences were assessed prior to and after cSR (reduction of sleep duration from 8 h/night to 5 h/night over the period of one week) as well as prior to and after aSD (one night of total sleep deprivation). The risk task allows the measurement of the model-free risk aversion ratio (%(chosen safe options)/%(chosen risk options)). A paired samples t-test was performed with p < 0.05 considered as significant.

Results: The risk aversion ratio significantly decreased after cSR (mean ± SD: −32.9% ± 23.7%, p < 0.05). Meanwhile, no significant effects could be assessed for aSD (13.7% ± 46.09%, p = 0.789).

Conclusion: Preliminary results of our ongoing study indicate that risk aversive behavior is notably decreased after cSR. Therefore, cSR and aSD might have distinct effects on risk aversion. These findings are a first step towards understanding risk taking behavior under cSR.

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A123
0344
FEASIBILITY OF A 5-WEEK, RANDOMIZED CROSS-OVER ADOLESCENT SLEEP EXTENSION TRIAL DURING THE SCHOOL YEAR
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Introduction: Multi-night experimental sleep restriction protocols have shown effects on adolescents’ attention, mood regulation, learning, and dietary intake. However, for ethics reasons these protocols have mostly been limited to the summer months. Also, the longest experimental condition has been 5 nights, which may limit sensitivity to cumulative effects. Here we report on the feasibility of a longer, school-year-based experimental sleep extension trial.

Methods: Healthy 14–17-year-olds who regularly sleep 5–7 hours on school nights were enrolled in a 5-week protocol. Week 1 was a baseline to confirm typical sleep patterns. Subsequently, participants entered 2-week sleep conditions in randomly counterbalanced order: Prescribed Typical Sleep (TYP; school-night schedule matching baseline) versus Sleep Extension (EXT; 1.5 hours more time in bed on school nights). Weekend bedtimes were teen-selected, with weekend rise within 1 hour of school days. We prohibited naps and limited caffeine intake. All sleep occurred at home, monitored via sleep diary and objective actigraphy.

Results: Of 12 enrolled adolescents, 3 dropped out (1 before randomization, 2 after). Actigraphy showed that the remaining 9 (75%) averaged 55 minutes more sleep on school nights during EXT than during TYP (p < 0.001, range = 31–88). Average school night sleep during TYP (6.49 hr) was similar to baseline (6.32 hr); both were significantly shorter than during EXT (7.41 hr), p < 0.001. This was due to earlier sleep onset during EXT (p = 0.001); rise time differed minimally (p > 0.05). Sleep onset, offset, and duration did not differ across the two weeks within either experimental sleep condition (p > 0.10). On a previously-validated questionnaire, adolescents reported less daytime sleepiness during EXT than TYP (p = 0.008).

Conclusion: It appears feasible to conduct a protracted sleep extension trial with short-sleeping adolescents that can be ethically conducted during the school year and incorporates an experimental, cross-over design to allow for causal inference and examination of practice or carry-over effects.


0346
VITAMIN E INTAKE ASSOCIATES WITH SPATIAL MEMORY PERFORMANCE DURING SLEEP RESTRICTION IN HEALTHY WOMEN
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Introduction: A previous study using a rodent model found that vitamin E administration attenuated sleep deprivation-induced spatial memory impairment. The current study assessed if ad libitum vitamin E intake associated with memory performance in healthy adults undergoing sleep restriction.

Method: Forty-one healthy adults (18 females, 21–50 y) participated in one of two laboratory protocols and experienced two nights of baseline sleep (BL1-2, 10 h/night, 2200–0800) followed by five nights of sleep restriction (SR1-5, 4 h/night, 0400–0800). Subjects completed the Visual Object Learning Task (VOLT), a spatial working memory assessment, as part of a larger test battery each morning. Performance on the VOLT was assessed using a standard score that accounted for the accuracy and speed of responses. Food/drink intake was ad libitum and was recorded by trained monitors. Intake data were entered into a food processing program to obtain vitamin E consumption.

Results: Performance on the VOLT varied significantly across protocol days (p < 0.001). Subjects displayed improvement on the VOLT from BL2 to SR2 and then a decline in performance from SR2 to SR5. During baseline, vitamin E intake was not related to VOLT performance in men or women (ps > 0.21). During sleep restriction (mean SR1-SR5), vitamin E intake was positively correlated with VOLT performance in women (r = 0.46, p = 0.053), but not in men (r = 0.14, p = 0.51). A median split based on vitamin E intake during sleep restriction was then conducted among women. Those who consumed higher levels of vitamin E performed significantly better on the VOLT during sleep restriction than women who consumed lower levels of vitamin E (p = 0.029, Cohen’s d = 1.13).
A. Basic Sleep Science

**Conclusion:** Ingestion of vitamin E, an antioxidant substance, may improve spatial memory performance during sleep restriction in women. Future research is needed to replicate these findings in a larger sample and to assess whether other nutrients or vitamins are related to memory performance during sleep restriction.

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**0347**

**SEX DIFFERENCES IN THE ASSOCIATION BETWEEN PERSONALITY AND RESISTANCE TO SLEEP DEPRIVATION**

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**Introduction:** The role of personality traits as a component of individual differences in vulnerability to the adverse effects of sleep deprivation continues to be debated. In particular, the trait of extraversion has been associated with decreased performance on behavioral tasks during sleep deprivation in a number of studies. Other aspects of personality (i.e., agreeableness, conscientiousness, openness) may also contribute, although the available evidence is limited. The present study examined the relationship between the effects of sleep deprivation and the five facets of personality and whether these associations differ between men and women.

**Methods:** Forty-six healthy individuals (males = 23, M age = 25, range = 20–43) completed the NEO Personality Inventory, Revised (NEO PI-R), followed by a series of Psychomotor Vigilance Tasks (PVT) every hour from 19:00 to 12:00 over a 30-hour sleep deprivation period. A bivariate Pearson's correlation was used to examine the relationships between mean change in performance on the PVT (i.e., speed) and the different subscales of the NEO PI-R.

**Results:** Average PVT speed post baseline was negatively associated with the extraversion (r = −0.331, p = 0.028) and agreeableness (r = −0.402, p = 0.007) subscales of the NEO PI-R. This relationship was found to be driven by females for both the extraversion (r = −0.470, p = 0.032) and agreeableness (r = −0.509, p = 0.019) subscales. Males showed no significant correlations between different facets of personality and neurocognitive performance throughout the sleep deprivation period.

**Conclusion:** Higher extraversion was correlated with poorer PVT speed throughout a single night of total sleep deprivation, but only among females. Higher agreeableness was also correlated with slower PVT throughout the sleep deprivation session. Findings are consistent with theories of personality functioning that posit lower basal cortical arousal and reduced sympathetic nervous system activation among such individuals. The observation of a gender difference raises a potential role for sex-related hormones that should be explored in future research.

**Support (If Any):** DARPA-12-12-11-YFA11-FP-029

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**0349**

**STABILITY OF TRAIT-LIKE VULNERABILITY TO TOTAL SLEEP DEPRIVATION AND CHRONIC SLEEP RESTRICTION IN THE SAME PROTOCOL**

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**Introduction:** Exposure to different types of sleep loss separated by 2–4 weeks reveals similar trait-like differential neurobehavioral vulnerability. We determined whether such trait-like responses are obtained after one bout of chronic sleep restriction (SR) and one bout of acute total sleep deprivation (TSD) separated by recovery sleep in the same protocol.

**Methods:** Sixty-three healthy adults (ages 21–50 y; 31f) completed 2 baseline (10 and 12 h time in bed, TIB) nights followed by either 5 SR nights (4 h TIB) or 36 hrs of acute TSD. Subjects then received 4 recovery (12 h TIB) nights followed by either 5 SR nights or 36 hrs of acute TSD, in a counterbalanced manner to the initial sleep loss condition. Neurobehavioral testing included the 10-min Psychomotor Vigilance Test (PVT), Digit Span (DS), Digit Symbol Substitution Test (DSST), Karolinska Sleepiness Scale (KSS), and Profile of Mood States (POMS) every 2 h during wakefulness. The intraclass correlation coefficient (ICC) for each measure was computed as the ratio of between-subjects variance to the sum of the between- and within-subjects variances using data from 0800 h/1000 h to 2000 h after the fifth night of SR and data from 2200 h/0000 h to 2000 h of TSD.

**Results:** Subjects who displayed vulnerability to SR also displayed vulnerability to TSD, as evident by high ICCs: PVT lapses + false starts, ICC = 0.741; PVT response speed, ICC = 0.892; DSST correct, ICC = 0.913; DS correct, ICC = 0.938; POMS fatigue, ICC = 0.763; and KSS, ICC = 0.828. Sleep loss order did not affect ICCs.
**Conclusion:** Neurobehavioral vulnerability to SR and TSD, separated by 4 nights of recovery, showed trait-like stability in performance and subjective measures, as evident in the stability of substantial inter-individual variance (74%-94% across measures). These data confirm the stability of phenotypic neurobehavioral responses to SR and TSD regardless of the order of sleep loss configuration and are critical for understanding individual neurobehavioral responses across different forms of commonly experienced sleep loss.

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**0350**

**RESISTANCE TO SLEEP DEPRIVATION INVOLVES greater functional activation AND WHITE MATTER CONNECTIVITY WITHIN A FRONTO-PARIETAL NETWORK**


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**Introduction:** Sleep deprivation (SD) can impair attention and vigilance, but some individuals appear much more vulnerable to the effects of SD than others. Prior work suggests that individual differences in baseline responsiveness of a fronto-parietal attention and working memory (WM) system may be associated with the capacity to sustain vigilance during SD. The neurocircuitry underlying this resistance capacity remains virtually unexplored. Here, we combined functional magnetic resonance imaging (fMRI) and diffusion tensor imaging (DTI) to investigate the association between the microstructure of the axonal tracts connecting frontal and parietal regions associated with sustained vigilance and individual resistance to SD.

**Methods:** Thirty healthy participants (15 males) aged 20–43 years underwent fMRI and DTI (3T) at rested wakefulness. Between one to 4 days after the scan, participants then underwent a 28-hour period of SD, with hourly assessment of vigilance using the psychomotor vigilance test (PVT). Resistance to sleep deprivation was determined by calculating the mean PVT speed (as percent of baseline) during SD. Task-related (Sternberg WM Task) fronto-parietal fMRI activation clusters that correlated with Resistance were localized and used as seed regions of interest. Task-related (Stroop Test) fronto-parietal fMRI activation clusters that correlated with Vigilance were localized and used as seed regions of interest. The mean fractional anisotropy of the axonal tracts connecting the seed regions was calculated and correlated with Resistance to sleep deprivation.

**Results:** fMRI activation in the left inferior parietal lobule (IPL) and dorsolateral prefrontal cortex (DLPFC) positively correlated with Resistance capacity. Higher fractional anisotropy of the left superior longitudinal fasciculus comprising the primary axons connecting IPL and DLPFC was also associated with better Resistance.

**Conclusion:** These findings suggest that individual differences in Resistance to SD are associated with greater functional responsiveness of a fronto-parietal attention system and greater structural integrity of the microstructural properties of the axonal interconnections between these regions. Future work may focus on methods to enhance Resistance by manipulating this network.

**Support (If Any):** DARPA-12-12-11-YFA11-FP-029

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**0351**

**PREFRONTAL GABA PREDICTS RESISTANCE TO SLEEP DEPRIVATION**

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**Introduction:** There appear to be consistent trait-like individual differences in the ability to resist the degrading cognitive and behavioral effects of sleep deprivation, but few if any reliable biomarkers for this capacity have been identified. Recent studies have focused on identifying the neurobiological correlates associated with this resistance capacity. The inhibitory neurotransmitter gamma-aminobutyric acid (GABA) has been implicated in sleep regulation, with patients diagnosed with primary insomnia demonstrating significant GABA alterations. The objective of this study was to use magnetic resonance spectroscopy (MRS) to examine brain GABA as a potential predictor of resistance to sleep deprivation.

**Methods:** Proton metabolite data were acquired using MEGAPRESS at 3T from the medial prefrontal cortex (MPFC), dorsolateral prefrontal cortex (DLPFC), and occipital lobe (OCC), in healthy adult men (n = 20) and women (n = 20). MRS and cognitive functioning data were acquired prior to a 30-hour sleep deprivation challenge. Resistance to sleep deprivation was determined using a 10-minute Psychomotor Vigilance Test (PVT), acquired hourly during the deprivation challenge. PVT data were analyzed as speed [(1/RT)*1000], normalized as a percentage of baseline from the first three administrations.

**Results:** Participants demonstrated a significant decline in PVT performance during sleep deprivation, with similar decrements observed across sexes: men performed at 86.5% and women at 84.9% of baseline (pre-deprivation) levels. While no sex differences were observed in OCC GABA, women had higher frontal lobe GABA, in both MPFC and DLPFC, relative to men. However, in men, higher MPFC GABA significantly predicted greater resistance to sleep deprivation on the PVT (p < 0.05).

**Conclusion:** These findings suggest frontal lobe GABA, specifically in MPFC, plays an important role in the ability to resist sleep deprivation in men. Assessment of neurochemistry may therefore be useful in predicting and discriminating vulnerable individuals from those who are more resilient to sleep deprivation. Further exploration of sex differences is warranted.

**Support (If Any):** D12AP00241 (WDK)

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**0352**

**PHYSICAL EXERCISE MAY CONTRIBUTE TO VULNERABILITY TO SLEEP DEPRIVATION**

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**Introduction:** Evidence suggests that there are stable trait-like individual differences in the vulnerability or resistance to sleep deprivation (SD). Little is known about the degree to which behavioral factors, such as physical activity, may contribute to these differences. Physical exercise is endorsed as a non-pharmacological intervention for individuals with sleep disorders as it increases fatigue, promotes the thermoregulatory response, and can phase shift the circadian rhythm. We hypothesized that individuals who exercise more frequently would show greater vulnerability to SD in comparison to individuals who exercise less frequently.

**Methods:** Forty-six healthy adults (23 male, 23 female; age: 20–43 years) underwent a 30-hour SD session, with hourly performance...
monitoring (psychomotor vigilance test; PVT) across the SD session as a measure of performance. Participants reported their total weekly exercise in minutes and were divided into three groups: non-exercisers, low exercisers (under 180 minutes), and high exercisers (over 180 minutes). A mixed ANOVA was used to analyze PVT percent change in performance compared to baseline across the three exercise groups during the overnight SD (1 am to 6 am).

**Results:** Performance on the PVT decreased for all subjects during the SD (F(3, 113) = 23.55, p < 0.0001). There was a significant interaction between PVT performance and the type of exercise (F(5, 113) = 2.50, p = 0.03). High exercise individuals showed the greatest decline in performance on the PVT in comparison to individuals in the low and no exercise groups, in particular during the early hours of the morning (3 am–6 am).

**Conclusion:** Higher levels of regular self-reported physical exercise were associated with greater declines in alertness during a period of overnight SD. This may be explained by greater needs for energy conservation and tissue restoration among highly active individuals. Future work should examine the role of circadian factors and other contributors to physical health in resistance capacity.

**Support (If Any):** DARPA-12-12-11-YFA11-FP-029

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**0353 AN EVALUATION OF PERSONAL CHARACTERISTICS AS PREDICTORS OF VULNERABILITY TO SUSTAINED PARTIAL SLEEP LOSS**

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**Introduction:** Experiments have documented that there are stable phenotypic differences among individuals in vulnerability to the neurobehavioral effects of sustained partial sleep restriction (SR). This has prompted questions about the predictability of this inter-individual vulnerability, based on personal characteristics of people. We addressed these questions relative to a number of demographic, personality, and sleep-wake measures, to evaluate the hypotheses that certain demographics, other acquired and sleep-wake characteristics can help predict these neurobehavioral responses to sleep restriction.

**Methods:** In a controlled laboratory environment, N = 51 healthy, ethnically-diverse subjects (n = 23 females, age M = 33 y, education M = 14 y) received 2 nights of baseline sleep (B; 10 h TIB) followed by 5 nights of SR (4 h TIB). During wakefulness each day (08 h, 10 h, 12 h, 16 h, 18 h, 20 h), behavioral alertness was assessed using the Psychomotor Vigilance Test (PVT), a well-established measure of the cumulative neurobehavioral effects of SR. The average hourly increases from B days to SR days for PVT performance outcomes were evaluated relative to 4 pre-lab sleep measures: sleep quality (PSQI), morningness–eveningness (MEQ), sleep duration (actigraphy), and daytime sleepiness (ESS) as well as 6 pre-SR characteristics of subjects: age, gender, ethnicity, education, reading IQ, and personality (EPI).

**Results:** Subjects were ranked for the effects of SR on 8 PVT outcome variables. For each outcome, the median was used to separate those who had a larger PVT deficit to sleep restriction from those who had a smaller PVT deficit to sleep restriction. Independent t-tests were conducted between these two groups for all pre-lab sleep and all personality characteristics (N = 104 t-tests). None of the 10 personal or sleep characteristics reliably (p < 0.05) differed between the two phenotypic groups.

**Conclusion:** None of the demographic, personality, or sleep-wake measures evaluated prior to sleep restriction predicted PVT responses to 5 nights of sustained sleep restriction (4 h/night). Analyses are continuing to evaluate other outcomes affected by SR.

**Support (If Any):** National Institutes of Health grant R01 NR-004281 and NIH CTRC UL1TR000003.

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**0354 EMOTIONAL RESILIENCE IS NOT ASSOCIATED WITH INCREASED EMOTIONAL RESISTANCE TO SLEEP DEPRIVATION**

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**Introduction:** Sleep difficulties are commonly co-morbid with a range of emotional disorders, and acute sleep deprivation is associated with an increase in sub-clinical symptoms of psychopathology in healthy individuals. It is therefore crucial to identify possible protective factors against the negative impacts of sleep loss on mood. We hypothesized that higher levels of emotional resilience would be associated with greater emotional stability during sleep deprivation.

**Methods:** Thirty-six healthy 20–42 year olds (50% females, M age = 25.42,) completed the Connor-Davidson Resilience Scale (CD-RISC) as a measure of emotional resilience. Participants then underwent a 30-hour sleep deprivation session during which they reported on their mood (e.g., happy, sad, afraid, angry, tense) using a Visual Analog Mood Scale, and completed the Psychomotor Vigilance Test (PVT) every hour.

**Results:** Self-reported positive mood scores, and performance on the PVT decreased during the sleep deprivation for all subjects. Emotional resilience did not correlate with changes in PVT or negative mood during the sleep deprivation. However, contrary to expectations, greater emotional resilience scores (CD-RISC scores) were correlated with decreased positive mood throughout the night (r = −0.40, p = 0.02). This effect was significant for males (r = −0.60, p = 0.009), but not for females (r = −0.30, p = 0.21).

**Conclusion:** Contrary to what was hypothesized, emotional resilience was not a protective factor against the negative impact of sleep deprivation on mood and attention. In fact, greater emotional resilience at baseline predicted decreases in positive mood during sleep deprivation, especially in males. Considering the importance of emotional resilience in protecting against the development of psychopathology and prior evidence of the antidepressant effects of sleep deprivation in depressed individuals, this finding might have important implications for understanding the directionality of the association between sleep deprivation and psychopathology, as well as the mechanisms underlying the antidepressant effects of sleep deprivation.

**Support (If Any):** DARPA-12-12-11-YFA11-FP-029
completed 15 crossings in a virtual reality pedestrian environment, the Useful Field of Vision task (UFOV) to assess visual awareness, and Conners’ Continuous Performance Test (CPT) to assess attention. CPT attention was assessed via both hit reaction time (average speed for correct responses) and response speed variability. Attention during street-crossings was measured via the number of missed safe crossing opportunities. Pedestrian safety was measured by the number of hits or close calls while crossing. Participants self-reported the number of “all-nighters”, or times per month they stay awake all night.

Results: Regression analyses were completed with the number of all-nighters per month as an independent variable and UFOV scores ($F(1,19) = 11.74$, $p < 0.01$, $R^2 = 0.38$), CPT hit response time ($F(1,22) = 8.20$, $p < 0.01$, $R^2 = 0.27$) and variability ($F(1,21) = 4.91$, $p < 0.05$, $R^2 = 0.19$), missed opportunities ($F(1,23) = 5.10$, $p < 0.05$, $R^2 = 0.18$), and hits/close calls ($F(1,23) = 0.05$, ns, $R^2 = 0.002$) as dependent variables. All-nighters per month were significantly associated with all variables except pedestrian hits/close calls, which did match the hypothesized direction (sleep deprived $M = 0.84$, $SD = 1.21$ versus rested $M = 0.68$, $SD = 0.90$).

Conclusions: As seen in adults, sleep deprivation significantly reduces cognitive function, impairment that may increase college students’ risk of physical injury when engaging in tasks requiring significant cognitive load such as crossing streets.

0356
SLEEP DEPRIVED PHYSICIANS HAVE A HIGHER RATE OF SUCCESS IN RESIDENCY EXAM IN BRAZIL
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Introduction: Sleep seems to be essential to cognitive performance. It is reported that sleep restriction leads to a number of consequences including, neurocognitive impairment, poor psychomotor function, attention deficits, memory loss, anxiety, damage to quality of life, also interfering with motor skills and the process of making decisions. Many or all of the reported consequences of insufficient sleep are important to medical performance, what has been of concern around the world. Objective: To evaluate if sleep deprivation interferes with the performance of candidates in the exam to access residency program in Brazil.

Methods: On the examination day, candidates filled a sleep diary reporting how many hours they slept the 3 nights before the exam. We analyzed the median TST only for the night before the exam. The candidates were dived into two groups: ≥ 390 minutes and ≤ 390 minutes (sleep deprived).

Results: There were 4,123 physicians participating in this research. The mean TST in the night before the exam was 300 minutes (6 hours) and the median 390 minutes (6 hours and 30 minutes). There were 2,119 sleep deprived physicians where 833 (39.31%) candidates were approved and 1,286 (60.69%) did not succeed. The not sleep deprived group comprised 2,004 candidates, where 581 (29%) were approved and 1,423 (71%) were not ($p < 0.000$), showing a higher proportion of success in the exam for the sleep deprived group.

Conclusion: The success rate in the exam of those candidates in the group of sleep deprived (that slept less than 6 hours and 30 minutes before the exam) was higher than in the group that slept more, what was unexpected. It is possible that the most prepared candidates have some degree of anxiety that reduces the TST at a point that does not impair cognitive performance.

Support (If Any): Institutional grants from CAPES, CNPq.
0359 INTER-INDIVIDUAL DIFFERENCES IN THE EFFECTS OF AIRCRAFT NOISE ON SLEEP FRAGMENTATION

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Introduction: Environmental noise exposure has been shown to disturb sleep and impair recuperation, and may contribute to the increased risk for (cardiovascular) disease. Noise policy and regulation are usually based on average responses, although substantial inter-individual differences in the effects of traffic noise on sleep have been demonstrated in relatively homogeneous and healthy populations. In this analysis, we investigated what percentage of the total variance in noise-induced awakening reactions can be explained by stable inter-individual differences.

Methods: The analyses are based on 72 healthy subjects (age range 18–71 years, 32 male) who participated in a polysomnographic laboratory study on the effects of traffic noise on sleep and were investigated for 11 consecutive nights. This analysis concentrates on 4 exposure nights where subjects were exposed to 80 noise events from air, road, and/or rail traffic noise with maximum sound pressure levels varying between 45 and 65 dB(A).

Results: Mixed-effects models of variance controlling for age, gender, study phase, study night, noise exposure in the previous night, and awakening probability in noise-free nights showed that 53.7% of the total variance was explained by inter-individual differences. The results thus demonstrate that a considerable amount of the variance observed in noise-induced sleep disturbance can be explained by inter-individual differences that cannot be explained by age, gender, or specific study design aspects.

Conclusion: The results demonstrate that it will be important to identify those at higher risk for noise induced sleep disturbance. Furthermore, the custom to base noise policy and legislation on average responses should be re-assessed based on these findings.

Support (If Any): The study was internally funded by the German Aerospace Center (DLR).

0360 POOR SLEEP QUALITY ASSOCIATED WITH LOWER WORK PERFORMANCE AND GREATER HEALTHCARE COSTS: LONGITUDINAL DATA FROM KANSAS STATE EMPLOYEE WELLNESS PROGRAMS

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Introduction: Several studies show sleep disorders and poor sleep quality to be associated with adverse occupational outcomes. Few studies, though, have examined whether worsening of sleep over time leads to worsening of outcomes. In particular, few studies examine sleep quality and its change relative to healthcare expenditures.

Methods: Data from the Kansas State Employee Wellness Program from 2008 (N = 11,698) and 2009 (N = 5,636) were used. Sleep quality was assessed as “Trouble Sleeping” with categories of “Never,” “Seldom,” “Sometimes,” “Often,” or “Always.” Absenteeism was recorded as full or partial workdays missed. Work performance over the past 4 weeks was rated in a 10-point scale and applied to both the self and typical workers in that position (relative performance was [self]-[others]). Healthcare costs were evaluated objectively in dollars. Analyses were adjusted for age, sex, race/ethnicity, education, income, and overall health.

Results: Poor sleep quality was cross-sectionally and longitudinally associated with absenteeism, poor work performance, and increased healthcare costs. For example, poor sleep “Always” (vs “Never”) was associated with greater likelihood of missing 7 or more full days (OR = 5.58, p < 0.0005), partial days (OR = 5.37, p = 0.004), and total days (OR = 6.02, p < 0.0005), lower self-rated performance (B = −0.36, p < 0.0005), lower relative performance (B = −0.24, p = 0.004), and higher healthcare costs (B = $3,461.89, p < 0.0005). Longitudinally, each 1-category worsening of sleep quality over 1 year was associated with a further increase in daily days (B = 0.07, p = 0.007), partial days (B = 0.09, p = 0.002), and total days (B = 0.15, p < 0.0005), lower self-rated performance (B = −0.05, p = 0.006), lower relative performance (B = −0.08, p = 0.001), and $189.46 more healthcare expenditures (p = 0.041).

Conclusion: Poor sleep quality was associated with greater absenteeism, worse work performance, and increased healthcare expenditures. Further, worsening sleep over 1 year led to exacerbations in these domains. Workplace health interventions should address problems of poor sleep quality, which may not only improve health but also improve work productivity and reduce costs.

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0361 ADOLESCENT SLEEP RESTRICTION AND PERFORMANCE IN A DRIVING SIMULATOR

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Introduction: We have previously shown that experimentally-induced sleep restriction (SR) impairs adolescents’ attention. Given the importance of attention to driving, SR may similarly contribute to high rates of adolescent driving accidents. Correlational and quasi-experimental
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studies support this possibility, but cannot prove causation. Here, we examine the impact of experimental SR on adolescents in a driving simulator, considering whether that impact is moderated by the nature of the drive (urban/suburban vs. rural) or how vulnerable each adolescent is to attentional decline after SR.

Methods: 17 healthy 16–18-year-old licensed drivers completed, in randomly counterbalanced order, two 5-night sleep conditions: SR (6.5 hours in bed) vs. Healthy Sleep (HS; 10 hours in bed). At the end of each, adolescents completed rural and urban/suburban courses in a driving simulator, and parents rated adolescents on a validated attention questionnaire. Vulnerability to SR was computed as raw score difference in those parent ratings across the sleep conditions. Outcome variables included mean speed, standard deviation of speed, standard deviation of lateral lane position (SDLP) and crashes. Separate multivariate models examined the main and interaction effects of sleep condition, type of drive, and vulnerability to SR, covarying for months licensed.

Results: Adolescents averaged 2 hours more sleep during HS than SR, p = 0.001. Although effects for the other driving outcomes were non-significant, there were 3-way interactions (sleep-by-drive-by-vulnerability) for mean speed and SDLP (p < 0.02). During the rural drive, adolescents had less consistent lateral vehicle control in SR than HS, despite slower driving among those reported to be vulnerable to SR. During the urban/suburban drive, SR worsened SDLP only among adolescents reported to be vulnerable to SR.

Conclusion: Even a moderate degree of SR appears to be a modifiable contributor to adolescent driving problems. This impact is widely present during boring rural drives, and in a subgroup during interesting urban/suburban drives.

Support (If Any): Cincinnati Children’s Research Foundation and the National Institutes of Health Grants T32HP10027 and R01 HL092149.

DO 10MIN NAPS BEFORE THE COMMUTE HOME FROM A NIGHT SHIFT CAUSE SLEEP INERTIA?

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Introduction: Driving home after a night shift is associated with increased risk of road accidents. Napping may be used as a sleepiness countermeasure before the commute. The potential for sleep inertia after a pre-commute nap, however, has not been investigated.

Methods: Twenty-one healthy subjects (21–35 y; 12F) participated in a 3-day laboratory study including one baseline sleep opportunity (2200 h–0700 h) and one experimental night involving randomization to one of two conditions: total sleep deprivation (NO-NAP), or a 10 min nap ending at 0400 h plus a 10 min nap ending at 0710 h (10-NAP). This analysis focussed on performance following the 10 min nap ending at 0710 h, simulating a pre-commute nap. Nap sleep was recorded using polysomnography. A 40 min York monotonous highway driving task was performed at 0715 h. The standard deviations of road position and speed were analysed. Further, a 3 min psychomotor vigilance task (PVT) was administered pre-nap (0630 h), post-nap (0712 h), and post-drive (0755 h). PVT mean reciprocal response times (MRRT) were analysed.

Results: Total nap sleep time (mean ± SD) was 9.1 ± 1.2 min, with 1.3 ± 1.9 min spent in slow wave sleep. Mixed-effects ANOVA revealed a significant condition*time interaction (F1,10 = 6.86; p = 0.017) for PVT MRRT. There was no difference pre- to post-nap in the NO-NAP condition. However, post-nap performance in the 10-NAP condition was significantly worse than pre-nap, and worse than the NO-NAP condition post-nap. Driving performance did not differ significantly between conditions. There were also no differences between conditions for PVT MRRT post-drive.

Conclusion: There were no group differences in PVT MRRT before the pre-commute nap (0630 h), which suggests that there were no significant carry-over effects of the 10 min nap at 0400 h. However, the PVT administered after the pre-commute nap detected signs of sleep inertia. The 40 min driving task that started immediately following, and the PVT administered right after, did not show evidence of sleep inertia—nor did they show benefits from the pre-commute nap.

Support (If Any): University of South Australia DRPF Seeding Grant.

0362

A COMPARISON OF SLEEP AND PERFORMANCE OF US NAVY SAILORS ON FOUR DIFFERENT SHIFTWORK SCHEDULES

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Introduction: The naval environment is characterized by sleep problems, sleep deprivation and elevated fatigue. The daily work and rest schedules for crewmembers is under the control of the ship’s commanding officer and consequently, varies from ship to ship. In this naturalistic experiment, we examined the sleep patterns and psychomotor vigilance performance of sailors on 4 different work and rest schedules.

Methods: Crewmembers on DDG-109 were observed for two weeks on either a “3 hrs-on/9 hrs-off” (n = 24) or a “6 hrs-on/6 hrs-off” (n = 9, Operations Department). Crewmembers (n = 34) on DDG-65 were observed for one week on a backward-rotating “6 hrs-on/18 hrs-off” schedule. On CNV-68, 77 crewmembers (Nuclear Reactor department) were observed for two weeks on a “5 hrs-on/10 hrs-off” schedule. Each sailor wore an actigraph, completed an activity log, and performed a 3-minute psychomotor vigilance test (PVT) before and after standing watch. A between-subjects comparison assessed differences in daily sleep and PVT performance among the watchstanding schedules.

Results: Crewmembers on the 5 hrs-on/10 hrs-off received significantly more daily sleep (6.88 ± 0.89 hours) than those on the modified 6-on/18-off (5.65 ± 1.63 hours) and those on the 6 hrs-on/6 hrs-off (5.90 ± 0.90 hours) schedules (all comparisons, p < 0.05). Their sleep was comparable to sailors working the 3 hrs-on/9 hrs-off (6.54 ± 0.8 hours). However, sleep on the 5 hrs-on/10 hrs-off schedule occurs in irregular, circadian-misaligned times of the day. Over an entire 3-day rotation circle, a crew member on the 5 hrs-on/10 hrs-off encounters two 20-hour periods of sustained wakefulness and one night of short sleep (< 4 hours). The 5 hrs-on/10 hrs-off schedule was associated with the worst PVT performance (mean reaction time and 355 ms lapses) followed by the 6 hrs-on/6 hrs-off. The best performance was seen in the 3 hrs-on/9 hrs-off followed by the 6 hrs-on/18 hrs-off. PVT performance for both schedules was significantly better than the 5 hrs-on/10 hrs-off (p < 0.05).

Conclusion: The 5 hrs-on/10 hrs-off results in lower quality sleep than other schedules. In particular, the 3 hrs-on/9 hrs-off schedule yielded better sleep hygiene and better performance. The surface navy community should consider revising its watchstanding practices. This study suggests that watchstanding schedules based on sound human performance and ergonomics principles may lead to better performance in the operational environment.

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**0364**

**SHORT SLEEP DURATION, INSOMNIA, AND SNORING ASSOCIATED WITH DROWSY DRIVING**


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**Introduction:** Numerous studies have shown that sleep apnea and sleep loss are associated with motor vehicle accidents. Less well documented is whether habitual short sleep duration, insomnia, and/or loud snoring also constitute risk factors for drowsy driving. These associations are evaluated in the present study.

**Methods:** Data from the Sleep and Healthy Activity, Diet, Environment and Socialization (SHADES) study was used. SHADES is a survey of adults age 22–60 in southeastern Pennsylvania (N = 1007). Sleep duration was assessed with the NHANES item (typical weeknight sleep) and categorized as very short (≤ 4 h), short (5–6 h), normal (7–8 h, reference), and long (≥ 9 h). Drowsy driving in the past 30 days was self-reported using an item from an established national database (BRFSS). Insomnia was assessed with the Insomnia Severity Index (ISI) and categorized as none (reference), mild, moderate, or severe. Loud Snoring was assessed using the Multivariable Apnea Prediction (MAP) questionnaire item, as 0 (“Never”, reference) to 4 (“Always”). Covariates included obesity (BMI ≥ 30), age, sex, education, and race/ethnicity. Logistic regression analyses evaluated each sleep factor alone and after adjustment for the others (all included covariates).

**Results:** Both very short (OR = 3.99; p < 0.0001) and short (OR = 2.14; p = 0.002) sleep duration were associated with drowsy driving, as was mild (OR = 2.31; p = 0.005), moderate (OR = 3.14; p < 0.0001), and severe (OR = 6.61; p < 0.0001) insomnia and snoring “Rarely” (OR = 1.98; p = 0.020), “Frequently” (OR = 2.15; p = 0.04) or “Always” (OR = 4.59; p < 0.0001). When sleep factors were adjusted for each other, unique effects were found for very short (OR = 2.26; p = 0.034) and short (OR = 1.70; p = 0.045) sleep, mild (OR = 1.97; p = 0.032), moderate (OR = 2.21; p = 0.024), and severe (OR = 3.42; p = 0.010) insomnia, and loud snoring “Rarely” (OR = 1.92; p = 0.028) and “Always” (OR = 3.62; p = 0.001).

**Conclusion:** All 3 sleep risk factors were associated with drowsy driving. Notably, the effects of sleep duration overlapped with those of insomnia, attenuating results. These results show that short sleep, insomnia, and loud snoring are all independent risk factors for drowsy driving.

**Support (If Any):** The SHADES study was funded by R21ES022931. Dr. Grandner is also supported by K23HL110216.

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**0365**

**DRIVING HOME FROM THE NIGHT SHIFT: A BRIGHT LIGHT INTERVENTION STUDY**

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**Introduction:** Sleep deprivation (SD) interacts with time of day (circadian phase) to impair psychomotor vigilance and increase the risk of driving accidents during the commute home after night work. Bright light (BL) can enhance alertness and cognitive performance. We examined the effects of BL at the end of a simulated night shift on driving performance.

**Methods:** Participants (22.8 ± 4 ya; N = 19; 5 female) were prescreened for chronotype, sleep disorders and motion sickness in the driving simulator. A repeated measures, cross-over balanced design was used, with no less than 1 week between the following 3 conditions: 1. No SD, 2. Overnight SD with 45 min dim light (DL) exposure (~50 lux), and 3. Overnight SD with 45 min BL exposure (~5600 lux). During SD, subjects remained awake in the laboratory from their usual bedtime for 6:00 hrs in ~50 lux light, with 1 or 2 research assistants. Body temperature and psychomotor vigilance (PVT) data were collected at 30 min intervals. Subjects then received the light treatment, followed by a 45 min driving test in a high-fidelity simulator. Saliva was collected before and after light treatment for melatonin assay.

**Results:** Temperature, subjective alertness and PVT performance decreased significantly across the night (repeated measures ANOVA). BL significantly suppressed melatonin, but did not improve subjective alertness or PVT performance. SD markedly increased incidents, accidents, and standard deviation of lane position. These measures worsened with time on task. BL compared to DL did not improve performance during the first 22 min circuit, but across the 2 circuits BL significantly attenuated the effect of time on task on incidents and accidents.

**Conclusion:** Bright light at the end of a night shift may have potential as a countermeasure to improve driving performance following night work, particularly for low light work environments and commutes that occur before dawn.

**Support (If Any):** Natural Sciences and Engineering Research Council (Canada)

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**0366**

**SLEEP DEPRIVATION AND RECOVERY IN AN EXPEDITION ADVENTURE RACE**

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**Introduction:** Sleep deprivation, defined as either suboptimal, fragmented or a complete lack of sleep, has significant consequences for cognitive function, attention and operant memory along with a vast array of other health implications. Whilst there have been a number of well documented cases of prolonged sleep deprivation within controlled studies, the consequences of sleep deprivation as they pertain to athletic performance and recovery from endurance sports, in particular adventure racing, remain largely uncharacterised. Expedition adventure racing is a multi-disciplinary team sport involving wilderness navigation with races anywhere up to two weeks in length. As the clock does not stop during a race, teams will normally push through all hours, often forgoing sleep completely with sleep deprivation perceived as staple consequence of the sport. This pilot study provides the first objective data of sleep patterns in the period leading up to, during and following an expedition adventure race.

**Methods:** Four participants (3 male, 1 female) comprising a single team at the 2014 GODZone Adventure Race in New Zealand collected activity and light exposure data via actigraphy over a 10 day pre-race, 5 day race and 2 weeks post-race period. Data was analysed to determine objective 24-hour sleep/wake parameters, physical activity intensity, and ambient light levels.

**Results:** The longest period of wakefulness observed was 40 hours and 28 minutes, with total sleep time averaging 3 hours per day across the 5 days or racing. Individual differences were observed in post-race recovery despite the original degree of sleep deprivation effectively being determined by a tethered group decision.

**Conclusion:** The current study represents a real world sleep deprivation model where sleep loss, performance goals and risk management are self-regulated. Findings of this pilot study indicate that adventure racers form an excellent novel ecological model for examining the relationship between sleep deprivation, performance and recovery.
0367
SLEEP 24 HOURS PRIOR TO TOP OF DESCENT AS A PREDICTOR OF SLEEPINESS, FATIGUE, AND PERFORMANCE ON TWO GUAM-BASED FLIGHTS
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Introduction: Top of descent (TOD) is a critical phase of flight in which the pilot initiates the descent to landing. The first flight studied (Island Hopper) originates in Guam with 5 stops in Micronesia and the Marshall Islands before finishing in Honolulu. After a layover, the reverse route is flown back to Guam. The second flight studied (Triangle) originates in Guam, stops in Manila, then Koror, and finishes back in Guam (without a layover). We looked at whether the amount of time a pilot sleeps in the 24 hours prior to final TOD, into Honolulu or Guam, was a useful indicator of fatigue, sleepiness, and/or performance.

Methods: Each pilot contributed one pair of data points (n = 87) for the three flight segments studied: outbound Island Hopper, inbound Island Hopper, and Triangle. Sleep 24 hours prior to TOD was correlated to each metric (S/P, KSS, and PVT mean speed) using Pearson’s R. Pilot’s sleep 24 hours prior to TOD was measured in pilots using sleep/wake history scored by actigraphy along with self-report in a sleep/work diary. Self-reported fatigue was measured using the Samn-Perelli Fatigue Scale (S/P) and self-reported sleepiness was measured using the Karolinska Sleepiness Scale (KSS). Pilot performance was measured using the 5-minute psychomotor vigilance task (PVT).

Results: A positive correlation was statistically significant between sleep 24 hours prior to TOD and the S/P scores (r² = 0.058, df = 1, p = 0.019). There was a positive correlation between sleep 24 hours prior to TOD and the KSS scores that was statistically significant (r² = 0.046, df = 1, p = 0.033). No significant correlation was found between sleep 24 hours prior to TOD and PVT mean speed.

Conclusion: Results suggest that total sleep in the 24 hours prior to TOD is useful in predicting fatigue and sleepiness at final TOD in long duration, multi-segment flights.

Support (If Any): The study was supported by United Airlines.

0368
A COMPARISON OF A LONG-DURATION, MULTI-SEGMENT FLIGHT AND AN OVERNIGHT FLIGHT ON PILOT FATIGUE, SLEEPINESS, AND PERFORMANCE
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Introduction: The Island Hopper flight originates in Guam, makes four stops before Majuro, and lands in Honolulu for a layover, before returning to Guam by the reverse route. Two crews fly the route; each crew consists of one Captain and one First Officer. On the Outbound flight, Crew A flies from Guam to Majuro. Crew B flies from Majuro to Honolulu. On the Inbound flight, Crew A flies Honolulu to Majuro and Crew B flies Majuro to Guam. This Island Hopper flight was compared to an overnight flight (Triangle) that originates in Guam, stops in Manila and Koror, and returns to Guam. This comparison was designated by the Federal Aviation Administration (FAA) for data collection under a Fatigue Risk Management System (FRMS).

Methods: 29 pilots participated (Crew A - n = 10; Crew B - n = 19) in this study. Flights were compared by operation (Island Hopper vs. Triangle) and flight type (outbound vs. inbound), for Crew A and Crew B at final top of descent (TOD). Sleep in the 24 hours prior to final TOD (S24P) was measured with actigraphy and self-report. Performance was measured as speed on the psychomotor vigilance task (PVT). Self-reported fatigue and sleepiness were measured with the Samn-Perelli Fatigue Scale and Karolinska Sleepiness Scale, respectively. We used fitted models and paired comparisons to test for differences and the two, one-sided test to test for equivalence.

Results: For Crew A Outbound vs. Triangle, we found more S24P and less sleepiness. For Crew A Inbound vs. Triangle, Crew B Outbound vs. Triangle, and Crew B Inbound vs. Triangle we found more S24P, greater speed on the PVT, and less fatigue and sleepiness. All data was significant.

Conclusion: The evidence showed that pilots flying the Island Hopper were better in terms of sleep, performance, fatigue and sleepiness.

Support (If Any): The study was supported by United Airlines.

0369
SLEEP DEPRIVATION PRECIPITATES THE DEVELOPMENT OF AMPHETAMINE-INDUCED CONDITIONED PLACE PREFERENCE IN RATS
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Introduction: Rationale: Sleep deprivation (SD) and amphetamine use are commonly associated conditions at late-night parties or due to excessive sleepiness caused by excessive work load. SD shares similar neurobiological effects with psychostimulants, playing an important role in the development of and recovery from drug addiction, especially through conditioning manipulations. Objectives: The aim of the present study was to investigate the effects of SD on the development of conditioned place preference (CPP) in a protocol with a reduced number of conditioning sessions challenged with amphetamine.

Methods: Male adult rats were submitted to 4 conditioning sessions (2 sessions a day) in the CPP apparatus, half with saline (non-drug-paired compartment) and half with 2 mg/kg amphetamine (drug-paired compartment) after control (home-cage maintained) or sleep deprivation (gentle handling method for 6 h) conditions.

Results: Control animals did not express a preference for the amphetamine-paired compartment, showing that 2 conditioning sessions with the drug was not enough to establish a CPP. On the other hand, animals submitted to SD during the conditioning trials expressed a preference for the amphetamine-paired compartment maintained across the entire test session.

Conclusion: SD strengthens the rewarding properties of amphetamine, thereby precipitating the development of CPP. By showing that lack of sleep might contribute for the establishment of a conditioning between the drug effect and environmental cues, our data provide relevant insights to psychostimulant abuse prevention campaigns.

Support (If Any): AFIP, CAPES, CNPq and FAPESP.

0370
ACUTE SLEEP DEBT AND GAMBLING TASK IN MICE: IT DEPENDS ON WHEN IT ARRIVES AND IT AMPLIFIES SOME PRE-EXISTING INDIVIDUAL BEHAVIORAL Profiles!
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Introduction: Acute sleep debt with total sleep deprivation (TSD) is responsible for many cognitive dysfunctions in healthy humans (Chee...
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and Chuah 2008) such as taking more risk (Killgore et al., 2006). Neither studies have focused on individual differences in such effects nor developing a validated animal model in order to understand the biological substrates.

Methods: We have developed and validated a Mouse version of the Iowa Gambling task (MGT, Pittaras et al., 2013), which takes place in a 4-arm maze and last 5 days (D1 to D5). We have induced an acute sleep debt (ASD) of 24 hours using a programmed moving platform (Chauveau et al., 2014). ASD was applied either just at the end of the task (D5-D6, n = 22) or just after 2 days (D2-D3, n = 16). We have also included control groups (n = 16 and n = 23).

Results: ASD applied at D5-D6 did not change mice preference for advantageous choices (T-Test: p > 0.001) as control mice did (MW: p > 0.59). But sleep deprived mice were faster to make their choices (MW: p < 0.05). When ASD was applied at D2-D3, mice did not change their choice preferences towards advantageous ones (T-Test: p > 0.46) as control mice did but stayed faster to make their choices (MW: p < 0.05). Moreover, individual behavioral profiles that exist in control mice (“safe”, “risky” and “intermediate” mice) were amplified after ASD for “risky” and “safe” mice.

Conclusions: ASD seems to reduce the latency of behavioral response of mice in this gambling taking but its deleterious effect on decision-making processes seemed to be related to a time-dependent effect. Moreover, ASD seems to amplify pre-existing individual behavioral profiles through a behavioral rigidity.

Support (If Any): This research was financially support by grants from French Government (DGA, Contract # PDH-1-SMO-2-0505/12ca706).

0371
EFFECTS OF SLEEP DISRUPTION AND OVERNUTRITION ON INFLAMMATION AND GLYCEMIC CONTROL
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Introduction: Peripheral inflammation following chronic insufficient sleep or overnutrition is associated with impaired glycemic control and metabolic disease. Overnutrition also induces metabolic deficits in part via hypothalamic inflammation. It remains unknown whether neuroinflammation elicited by insufficient sleep impairs energy regulation. We tested the hypothesis that neuroinflammation contributes to deficits in energy regulation following insufficient sleep and overnutrition.

Methods: Adult male C57BL/6J mice were housed in novel sleep disruption devices and assigned to one of four groups: undisturbed sleep and chow diet; undisturbed sleep and high-fat diet (HFD); 18-h sleep fragmentation (SF) and chow diet; or 18-h SF and HFD. After 3 or 9 days’ exposure to these conditions, blood samples and metabolic tissues were collected and analyzed for selected cytokines using a Lumixen bead-based assay (n = 7–8/group). Plasma corticosterone concentrations were measured via enzyme immunoassay. Glucose tolerance tests were performed to assess glycemic control in a separate set of mice (n = 4/group).

Results: A trend towards impaired glucose tolerance was observed after 3 days of SF (p = 0.08), whereas 9 days of SF or HFD significantly impaired glucose tolerance (p < 0.05). Three days of SF significantly elevated levels of pro-inflammatory cytokines in the hypothalamus and brainstem, altered cytokine signaling in plasma, and elevated plasma corticosterone levels (p < 0.05). After 9 days, pro-inflammatory responses to SF largely subsided, but elevations in brainstem interleukin-6 and reductions in plasma corticosterone were observed in response to HFD (p < 0.05). At both time points, plasma leptin concentrations increased with HFD and decreased with SF (p < 0.05).

Conclusion: Prolonged SF or HFD impairs glycemic control and exposure to both factors results in even greater impairment. SF induces a more rapid pro-inflammatory response than does HFD, however the functional effects of these responses remain unclear as they do not correspond well with patterns of glucose intolerance.

Support (If Any): This work was supported by the University of Washington Dept. of Anesthesiology and Pain Medicine and by NIH grants 1F32DK103491-01 and 2T32DK007247.

0372
MECHANICALLY CONTROLLED REM SLEEP DEPRIVATION SELECTIVELY ACTIVATES REM SLEEP-RELATED BRAIN STRUCTURES UNDER A STRESS-FREE CONDITION IN MICE
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Introduction: Experimental sleep deprivation is often performed to challenge homeostatic sleep-wake regulation. Compared with total sleep deprivation, selective REM sleep deprivation (RSD) is more difficult to conduct. So far, the inverted flower-pot method is used to achieve RSD. However, this method is principally stressful and eliminates a significant amount of non-REM sleep. To minimize stress response to RSD, we designed new automated machinery and used it to detect REM sleep-activated brain structures.

Methods: C57BL/6N mice, implanted with EEG/EMG electrodes, underwent RSD from light onset for 36 or 48 hours. A few hours before RSD the mice were placed into a rotating wheel connected to a computer-controlled motor system which activated the wheel when the mice fell into REM sleep. Half of them were continuously under recordings during and after 36-h RSD, while the others were sacrificed immediately or 10 h after RSD for c-Fos staining. To determine the corticosterone response, another group of mice was used for blood sampling before and after 48-h RSD.

Results: RSD eliminated 95.7% of REM sleep on average, while > 80% of non-REM sleep was preserved in comparison with baseline. Right after RSD, mice stayed awake for a few hours, then REM sleep predominated during Zeitgeber time 19–24 (234.9% versus baseline). Although non-REM sleep episodes became fragmented during RSD, the amount of non-REM sleep returned to the baseline level during recovery. C-Fos-positive cells were barely found in the paraventricular nucleus, while in amygdaloid structures more c-Fos activation occurred than in the brainstem when accumulation of REM sleep appeared. Plasma corticosterone stayed at a basal level even after 48-h RSD.

Conclusion: Our theta activity-based RSD method achieved selective sleep deprivation without eliciting stress responses. The results encourage its potential use for studying REM sleep homeostasis and related brain structures separately from those representing stress impacts.

Support (If Any): Max Planck Society

0373
CHRONIC SLEEP RESTRICTION INCREASES MICROGLIAL IBA1 IMMUNOREACTIVITY IN THE RAT BRAIN
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Introduction: Microglia are the primary mediators of the neuroinflammation that occurs in the central nervous system in response to injury, neurodegeneration, and chronic stress. Recent evidence also suggests a role of microglia in neural circuitry modeling and synaptic pruning. To determine whether chronic sleep restriction (CSR) induces changes in microglia, we examined the immunoreactivity for ionized calcium-binding adaptor molecule 1 (Iba1), a marker for microglia, in the rat brain during and after the ‘3/1’ protocol of CSR (continuous...
cycles of 3 h of sleep deprivation [using slowly rotating wheels] followed by 1 h of sleep opportunity) for 99 h.

**Methods:** Eight groups of adult male Wistar rats were used (n = 4–9/group). Three sleep-restricted groups were housed in motorized activity wheels, and underwent the 3/1 protocol for 3, 27, or 99 h. A recovery group was housed in motorized activity wheels and underwent the 3/1 protocol for 99 h, followed by 6 days of unrestricted sleep in locked wheels. Four time-matched control groups were housed in locked wheels. Following perfusion at the end of the experiment, brains were processed immunohistochemically for Iba1. Counts of Iba1+ cell bodies and the density of Iba1 immunoreactivity (including both cell bodies and associated processes) were obtained in several sleep/wake-related and limbic regions.

**Results:** The number of Iba1+ microglia and the density of Iba1 immunoreactivity did not differ between the four time-matched control groups in any of the regions studied. However, in the prelimental cortex, the number of Iba1+ cells and the density of Iba1 immunoreactivity increased after 27 and 99 h of CSR, and tended to remain elevated after 6 days of recovery, relative to the control conditions. In the perifornical lateral hypothalamic area, the number of Iba1+ cells was increased only after 99 h of CSR, and was at control levels after 6 recovery days; the density of Iba1 immunoreactivity was unchanged. No significant changes were found in the dentate gyrus of the hippocampus or the locus coeruleus after CSR. The examination of additional brain regions is underway.

**Conclusion:** The 3/1 CSR protocol for 99 h induced region-specific and duration-dependent changes in the number of Iba1+ microglia and the density of Iba1 immunoreactivity. These microglial changes could contribute to neuroinflammation and synaptic remodeling as a result of CSR. Morphological analyses of immunoreactive microglia and additional immunostaining with markers of functional activation are in progress to address these possibilities.

**Support (If Any):** CIHR

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**0374**

**CHRONIC ALCOHOL CONSUMPTION IMPAIRS RECOVERY SLEEP AFTER SLEEP DEPRIVATION IN RATS**

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**Introduction:** Sleep disturbances are common among alcoholic patients, which may persist for years after abstinence and contribute to relapse. How chronic alcohol disturbs sleep remains unclear. This study examined effects of chronic alcohol consumption on recovery sleep after sleep deprivation in rats.

**Methods:** We instrumented male Sprague-Dawley rats (n = 15 for Alcohol; n = 12 for Control) with EEG/EMG electrodes for sleep recording. We used a pair-feeding model (8-week, 6% alcohol in liquid diet). After acclimation, we acquired 24-hour data before and after sleep deprivation sessions (6-hour), which were performed by gentle handling from ZT 0 (lights-on). Rats had continuous access to alcohol throughout experiments. Sleep recordings (10-second epochs) were manually scored as wake, NREM or REM sleep. Statistical analyses include two-tailed T-test and two-way repeated-measures ANOVA (Tukey post-hoc).

**Results:** Chronic alcohol changed the structure of recovery sleep during the 24 hours after sleep deprivation without affecting total wake/NREM/REM time. During the first 6-hour recovery in the light, alcohol-treated rats exhibited: more wake time; unaltered NREM time, due to more number of, but shorter duration NREM bouts; and less REM time caused by shorter REM bout duration. During later recovery (subsequent dark period), the Alcohol Group showed: fewer but longer wake and NREM bouts; and increased REM bout duration, leading to more REM time. Chronic alcohol also increased latency to long NREM (≥ 5 min) and long REM (≥ 1 min) episodes after sleep deprivation.

**Conclusion:** Chronic alcohol exposure increased sleep latency and fragmented NREM/REM sleep during the first 6-hour recovery in the light, indicating destabilized sleep states. These changes were later compensated during the dark period. Our findings demonstrate that chronic alcohol consumption impairs recovery sleep after sleep deprivation by altering the stability of sleep states.
0375
PC AND SMARTPHONE PLATFORMS FOR NEUROBEHAVIORAL PERFORMANCE TESTING AND PREDICTION
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Introduction: Currently, reaction time (RT) tests are largely performed using commercially available devices [e.g., the psychomotor vigilance task (PVT)-192]. However, such devices are costly, not user-friendly, and require many manual steps to export the collected performance data. Importantly, these devices do not allow for the integration of data analysis software. Nor do they allow for the tracking and prediction of performance levels in real time as tests are being taken.

Methods: We developed two standalone platforms to measure RT and predict performance at an individual level: 1) the personal computer (PC)-PVT and 2) the smartphone 2B-Alert app. Realizing that the key element of PVT testing is the accurate measurement of RT to a visual stimulus, we incorporated key features of the PVT-192 into each platform and characterized the various hardware and software delays associated with these platforms. We then incorporated software modules that 1) allow user inputs of sleep-wake history and caffeine usage, 2) compute PVT performance statistics, 3) customize mathematical models of performance to the individual, and 4) display the customized model predictions for any desired horizon, all in real time.

Results: The PC-PVT and 2B-Alert app were capable of measuring RTs with an average delay of less than 10 ms and 30 ms, respectively. The PC-PVT software has been downloaded 263 times from users across five continents since March 2014, and it is freely available from our Web site (http://bhsi.org/downloads/pc-pvt/). The 2B-Alert app is undergoing verification and validation tests, and should be available by January 2015.

Conclusion: With the integration of real-time, individual-specific performance prediction models into the PVT testing software, the PC-PVT and the smartphone 2B-Alert app provide powerful tools for laboratory study and personal fatigue management.

0376
OPTIMIZING COST VERSUS ACCURACY FOR SUBJECT-SPECIFIC ESTIMATION OF SLEEP PARAMETERS
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Introduction: Due to night-to-night variability, multiple sleep recordings are needed for accurate estimation of subject-specific sleep parameters. Polysomnography (PSG) is considered a gold standard for estimating sleep parameters, but PSG recordings are costly. Wrist actigraphy provides a less expensive alternative for estimation of certain sleep parameters, but results tend to be biased. We applied a Bayesian technique to combine PSG and actigraphy estimates to benefit from the advantages of each, and developed a method to optimize for cost versus accuracy. We illustrate the method with wakefulness after sleep onset (WASO) measurements.

Methods: N = 33 healthy subjects (ages 22–38; 15 females) spent between 6 and 13 nights and days in a laboratory. Time in bed was 22:00–08:00 each day, and sleep was recorded with both PSG and actigraphy. WASO, defined here by 30 s waking epochs between sleep onset and final awakening, was estimated from each of the PSG records (WASOp) and actigraphy records (WASOa). A bivariate Bayesian random intercept model was used to represent subjects’ WASOp and WASOa measurements across nights, and a bivariate normal Bayesian prior distribution for WASOp and WASOa was estimated.

Results: The between-subject standard deviations for WASOp and WASOa were Da = 21 min and correlation was R = 0.69. The corresponding within-subject standard deviations (night-to-night variabilities) were Sp = 32 min and Sa = 21 min. Given the Bayesian prior distribution, the number of WASOp and WASOa measurements, Mp and Ma, that yield a fixed average level of accuracy E (square root of the Bayesian mean squared error) with minimal cost is given by:

\[ MP = \frac{Sp}{\sqrt{1-R^2}} \]

\[ MA = \frac{Sa}{\sqrt{1-R^2}} \]

where C represents the cost ratio of PSG versus actigraphy recordings. To illustrate this result, for C = 25, an average subject-specific WASOp estimation accuracy of ± 14 min could be achieved cost-effectively with 1 night of PSG and 8 nights of actigraphy. For comparison, to achieve the same accuracy with PSG alone would require 3 nights of recording, at more than twice the cost.

Conclusion: We derived novel equations for optimizing cost versus accuracy in bivariate estimation of subject-specific sleep parameters. We showed that estimation using both PSG and actigraphy may improve accuracy and/or reduce cost.


0377
QUANTIFICATION OF SLEEP STATE DEPENDENT ELECTROENCEPHALOGRAPHIC AND CEREBRAL METABOLIC PARAMETERS USING A SEMI-AUTOMATED APPROACH
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Introduction: Rodent sleep research uses electroencephalography (EEG) and electromyography (EMG) to determine the sleep state of an animal at any given time. Automated state classification reduces the burden associated with classifying sleep states.

Methods: We developed a novel semi-automated state classification procedure. Principal Component Analysis (PCA) was used to convert EEG spectral power in the delta (1–4 Hz), theta (5–9 Hz), low beta (10–20 Hz), high beta (30–40 Hz) bands and integrated EMG to a 3-dimensional principal component space. Native Bayes classification was then used to determine sleep states of un-scored epochs based on their position within this 3-D space relative to manually scored epochs. We validated this algorithm against manually-scored sleep state classification of data from C57BL/6J (n = 11) and BALB/CJ (n = 11) mice using 10-second epochs. To quantify the temporal dynamics of EEG slow wave (1–4 Hz) activity and lactate concentration measured in the cerebral cortex by an indwelling enzymatic biosensor, we used a general homeostatic model (Process S).

Results: Time of day-specific strain differences in time spent awake were detected with the automated method (F1,20 = 5.3, P < 0.001) or the manual classification method (F1,20 = 5.3, P < 0.001). Both methods yielded strain differences in wake as a percentage of time in hours 5, 9, 10, 19 and 24 of recording (Fisher’s PLSD). Frequency-specific strain differences in EEG power spectral profiles during slow
wave sleep were detected as effectively with the automated method (F19,380 = 7.8, P < 0.001) as with the manual classification method (F19,380 = 7.9, P < 0.001). Error associated with mathematical modeling of lactate concentration (F1,20 = 5.3, P = 0.032) but not EEG slow wave activity was significantly reduced with automated state classification relative to manual classification.

**Conclusion:** Automated scoring is an efficient and equally effective alternative to visual inspection in studies on the temporal dynamics of sleep and sleep-related physiological parameters.

**Support (If Any):** This work is supported by NINDS RO1NS078498 and NIDA R21DA037708.

**0378**

**DAILY SLEEP VARIABILITY QUANTIFIED: A RELIABLE AND FLEXIBLE APPROACH**

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**Introduction:** Sleep is frequently assessed over multiple days. Night-to-night variability in sleep timing, duration, and quality is common, and can be clinically meaningful. A reliable and flexible quantitative method for estimating variability in sleep parameters is a stepping-stone in better understanding the nature and correlates of daily sleep variability. We present a novel Bayesian variability model (VM) for quantifying variability and using variability as a predictor. Compared to other commonly used variability methods (e.g., individual standard deviations; ISD), the VM accounts for measurement error, flexibly adjusts for systematic time-related changes, and could be valid for relatively small number of repeated measurements.

**Methods:** A simulation study was conducted to compare the performance of the VM against the ISD. Simulated datasets (8,000) of a generic sleep parameter tested conditions where the following varied (a) the number of nights of sleep data (5, 14), (b) sample sizes (80, 250), (c) individual differences in sleep variability (low, high), and (d) effect sizes (small 0.20, large 0.50) of variability in a regression controlling for the mean. Datasets were simulated so that the true effect of variability in the regression was known, allowing estimated values using the VM and ISD to be compared against true values.

**Results:** The VM resulted in less biased (i.e., more accurate) estimates than did the ISD across all conditions (average percent bias 3.5% vs. 17.1%, respectively). Across conditions, the ISD consistently underestimated the true effect (negative bias), whereas the VM produced both (small) positive and negative bias. Differences in power between the two were small, with the VM always having slightly higher power. For a small effect, average power increased 0.47 for 250 versus 80 participants, relative to only 0.06 for 14 versus 5 nights of sleep. For a large effect all conditions had high power > 0.95.

**Conclusion:** The VM yields substantially more accurate results and slightly higher power than the ISD. Because the ISD consistently yielded too small effects, literature reporting relations of sleep variability to outcomes based on the ISD are likely smaller than in reality. Power depended more on sample size than on the number of nights of sleep simulated. The VM can be a useful method to reliably and flexibly examine the role of daily sleep variability in relation to outcomes of interest.

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**Support (If Any):** This work is supported by NINDS RO1NS078498 and NIDA R21DA037708.

**0379**

**SCREENING OBSURCTIVE SLEEP APNEA PATIENTS USING SNORE SOUND ANALYSIS: ALGORITHMS AND A TOOLBOX**

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**Introduction:** Almost all obstructive sleep apnea (OSA) patients snore (high sensitivity), but not all snorers have OSA (low specificity). Snore sound analysis is not currently used in diagnosing OSA, but if successful, can provide a convenient way to screen and monitor the disease. In this paper we propose mathematical algorithms and graphical software tools to analyse snoring sounds as well as breathing to screen OSA. Our techniques can use bedside microphones (including smartphones) requiring no physical contact with a patient. The analysis is fully automated.

**Method:** Breathing sounds were recorded with a bedside microphone (RODE, Model NT3) from 91 subjects (56 males and 35 females) undergoing routine Type-1 polysomnography. Snore sounds were automatically identified using a mathematical algorithm and mathematical features of snores were computed. We then trained a machine classifier to diagnose OSA, considering polysomnography-based clinical diagnosis as the reference standard. We trained two models, one each for males and females, and evaluated the performance using a 10-fold cross validation technique. We also developed alternative technology that does not require identifying snore sounds and can operate on sound streams including breathing sounds acquired with a smartphone (Samsung Galaxy). We developed a software tool complete with a graphical user interface to analyse sounds.

**Results:** When RDI = 15 was used as the OSA diagnosis threshold, the proposed technique achieved a sensitivity of 98% at a specificity of 91% in the male group. Corresponding numbers for the female group was 94% and 95%. At the threshold RDI = 30, we obtained a sensitivity of 94% (specificity: 91%) for males and a sensitivity of 100% (specificity: 96%) for females. Accuracy of the automated snore detection algorithm was 88% (sensitivity = 84%; specificity = 92%).

**Conclusion:** Snore sound analysis holds potential as a tool for population screening of OSA in an unattended environment. Sounds can be acquired from bedside microphones, including smartphones. The method provides a way to screen OSA and also monitor it over an extended time period.

**0380**

**MULTIPLE CLASSIFIER SYSTEMS FOR AUTOMATIC SLEEP SCORING IN MICE**

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**Introduction:** Electroencephalogram (EEG) and electromyogram (EMG) recordings are used to study sleep architecture and sleep-associated neural activity in rodents. These recordings must be scored by a researcher to label what sleep/wake stage the animal is in at each time point. Scoring is time-consuming and subjective, and can be excessively burdensome for large sample sizes and multi-day recordings, such as in genomic studies and compound screens. Previously, machine-learning classifier algorithms have been used to automate sleep scoring. Here, we improve on that process by employing multiple classifier systems (MCS), which uses multiple classifiers at once to score the recording.

**Methods:** Mouse EEG/EMG recordings (n = 18), each 24–48 h, were divided into 10-second epochs and scored by human experts into Wake,
NREM, and REM categories. Classifiers were trained on 720 scored epochs and then automatically scored the rest of the recording based on training scores. We first tested five base classifiers: naïve Bayes, linear discriminant analysis, k-nearest neighbors, support vector machine, and decision tree. These base classifiers were used to create two types of MCS: ensemble classifiers using random subspace and bootstrap aggregating, and hybrid classifiers using majority vote and stacking.

Results: The most accurate MCS used a combination of ensemble and hybrid techniques, and reduced errors over the best single base classifier by 19.7% (95.7% agreement with human). We also tested criteria for scoring with rejections, and found that errors could be reduced 53% (98% agreement) at the cost of manually scoring 8% of the recording.

Conclusion: Multiple classifier systems are an effective and efficient way to improve accuracy of automated sleep scoring, and semi-automated scoring can increase scoring speed dramatically while maintaining high accuracy. This approach opens up new possibilities for scoring many days (e.g. 10–20 days) in many animals (e.g. 100–1000) and should prove useful for many types of studies.

0381
FEATURE-BASED AUTOMATIC REM DETECTION USING WAVELET TRANSFORM, AMPLITUDE, SLOPE AND CROSS-CORRELATION
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Introduction: Rapid eye movements (REMs) are a defining feature of REM sleep. The number of discrete REMs over time, or REM density, has been investigated as a measure of sleep need (Aserinsky et al., 1969), marker of mental illness (Sitaram et al., 1981) and memory consolidation (Smith, 2004). Human detection of REMs is a time-consuming and biased process. Therefore, reliable, automated REM detection software is a valuable research tool.

Methods: We developed an automatic REM detection algorithm utilizing a parallel, union combination of extracted features (amplitude, slope, cross-correlation, and Discrete Wavelet Transform) from electrodes attached at the right and left outer canthi (right superior; left inferior). The REM sleep data set consisted of 110 minutes of poly-somnography data collected from 5 subjects during a nap study. 55% percent of the data were considered for training and the remaining data were used to test performance. Algorithm performance measures of specificity (true positive rate), sensitivity (true negative rate) and accuracy (correct detection rate) were calculated and compared to human detection by three expert sleep researchers. Fleiss’ Kappa was used as a measure of inter-rater-agreement between humans and human vs algorithm.

Results: The algorithm performance (83% sensitivity, 97% specificity, 96% accuracy) was comparable with the average human detection performance (80% sensitivity, 98% specificity, 97% accuracy). The algorithm agreed with human detection (0.74, Fleiss’ Kappa) and was comparable to the agreement level between humans (0.81, Fleiss’ Kappa).

Conclusion: The automatic detection algorithm presented is a viable and efficient method of REM detection as it reliably matches the performance of expert human sleep scorers. Further investigation on feature extraction and use of feature combination algorithms, such as artificial neural networks, is required to increase detection performance.

0382
NEW METHODS FOR DEFINING NREM/REM SLEEP CYCLES IN HUMAN SLEEP EPISODES
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Introduction: Current methods for analyzing NREM/REM sleep cycles were developed using sleep at habitual circadian phase in young, healthy individuals. In other situations, especially those with Wake within a sleep episode, these methods may not be appropriate. Better characterization of NREM/REM cycles will allow more accurate comparisons of metrics across sleep episodes. We present new methods for defining NREM/REM sleep cycles. These aim to summarize overall sleep structure using a minimal number of episodes of different arousal states while accurately matching the underlying hypnogram.

Methods: We compared three methods for defining NREM and REM episodes (together comprising NREM/REM cycles): (1) ‘Traditional’, from Feinberg and Floyd (1979), (2) ‘Extended’, which extends the Traditional definition by allowing iterative merging of adjacent states, and (3) ‘Change-point’, which applies change-point detection, a time-series analysis method. Data were from 128 healthy individuals studied in inpatient protocols with sleep at all circadian phases. For each method, we compared (i) the number of episodes, (ii) the percent of computed NREM episodes with > 90% NREM epochs, and (iii) the percent of computed REM episodes with > 90% REM epochs.

Results: The Traditional method defined 9,203 NREM episodes with 72% having > 90% agreement, and 8,083 REM episodes with 24% having > 90% agreement. The Extended method defined 14,493 NREM episodes with 72% having > 90% agreement, and 10,872 REM episodes with 48% having > 90% agreement. The Change-point method defined 13,814 NREM episodes with 89% having > 90% agreement, and 10,461 REM episodes with 44% having > 90% agreement.

Conclusion: The Extended method performed similarly to the Traditional method on NREM and better on REM episodes, at the cost of defining additional episodes. The Change-point method had the best trade-off between percent agreement and number of episodes. Our software package is created in R and available upon request.

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0383
VARIABILITY OF SLEEP-DEBT DISSIPATION ACROSS SEVERAL NIGHTS USING EEG-BASED SLOW-WAVE ACTIVITY
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Introduction: In the two-process model of sleep regulation, slow-wave activity (SWA, i.e. the EEG power in the 0.5–4 Hz frequency band) is considered a direct indicator of sleep-debt. SWA builds up during NREM sleep, declines before the onset of REM sleep, remains low during REM and the level of increase in successive NREM episodes gets progressively lower. According to a sleep regulation model, the instantaneous rate of decrease in sleep-debt S(t) is related to the SWA as: dS(t)/dt = −γSWA(t) where γ is the decay rate. Thus, the sleep-need after “t” minutes of sleep is: S(t) = S0 − γCSWA(t), where S0 is the sleep-need at the time of sleep-onset and CSWA is the cumulative SWA (integral of the SWA) from sleep onset (time 0) up to time “t”. The goal
in this research was to assess the variability across several nights of S(t). To increase the ecological validity of the results, the recordings were performed at home using an EEG wireless device with 2 EEG and 1 EEG (FPz location) channels.

Methods: The EEG and EOG data collected from 7 subjects (3 nights per subject) was manually scored into sleep stages and segmented into sleep cycles. The SWA was calculated for each 6-second long epoch of NREM. The SWA of epochs in REM, WAKE, and N1 was set to 0. The epochs containing artifacts were discarded. For each subject, the maximum difference in sleep duration across nights was less than 15 minutes. To estimate the values of S0 and γ, two boundary conditions were used: 1) the final S(t) was set to 0 and 2) S(t) coincides with SWA(t) at the time in the first sleep cycle where SWA is maximum (as suggested in literature).

Results: The variability of γ across nights is in average 12.7% (range: 0 to 30%). The variability of S0 across nights is in average 19.2% (range: 1 to 50%). As expected a higher variability exists across subjects (35% for γ and 62% for S0).

Conclusion: Sleep-debt dissipation is often evaluated in sleep deprivation and other sleep interventions (e.g. medication). Given the variability (> 10%) in γ and S0, it is necessary to collect the data from several nights (> 5 for 80% statistical power) to accurately assess the effect of any sleep intervention.

0384

Efficacy of a Smart Textile Shirt: Developing a Sleep Health Screening Tool for Military Populations

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Introduction: Sleep disturbance is frequently reported amongst active duty military and has myriad health and warfighter readiness implications. Current standards of sleep health evaluation require overnight inpatient studies using polysomnography (PSG), which is expensive and inconvenient. Our aim is to develop an accurate sleep screening tool for large-scale implementation, improving access to diagnostic services and significantly reducing costs. We are piloting the use of a new smart textile shirt (STS) that monitors heart rate, activity, and respiratory measures in the home.

Methods: In-lab participants (n = 6) wore the STS with concurrent PSG during an overnight sleep opportunity. In-home participants wore both the STS and actigraph (Actiwatch Spectrum) for 2–5 continuous days (n = 8). Initial technology-specific automated analyses of sleep metrics were derived, including total sleep time (TST) and sleep efficiency. Participants also completed a questionnaire assessing STS comfort and ease of use.

Results: Preliminary data suggest higher agreement between the STS and PSG than actigraphy. Paired t-tests revealed no difference between the STS and PSG on either sleep efficiency or TST (both p > 0.43). While TST did not differ between the STS and actigraphy (p = 0.47), STS sleep efficiency was significantly higher (p < 0.05). In addition, 85% of participants were able to don/off the shirt independently in <1 minute (versus 90 min with technician for PSG), and 100% reported the shirt was somewhat (38%) or very (62%) comfortable. Development of algorithms for sleep and detecting irregularities using the STS are currently underway. Future analyses will include additional subjects and sleep metrics.

Conclusions: The STS shows promise as an alternative for sleep assessment as compared to standard PSG and/or actigraphy. Additional analyses and testing in patient populations will be necessary in order to further determine the utility of this new technology for studying sleep in both clinical and research settings.

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0385

Fatigue Detection in the Military: A Systematic Overview of Oculomotor Tests Based on Saccadic Velocity

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Introduction: Inadequate sleep and extended hours of duty are common among military personnel. Therefore, fatigue has been recognized as a major contributing factor to operational errors. The development of sensitive fatigue detection tests (FDT) is critical to prevent catastrophes and accidents. In the last decades, FDT based on saccadic metrics are becoming popular among human factors experts, with saccadic velocity (SV) one of the most reliable indices to assess fatigue. However, its sensitivity in the military is not clear yet.

Methods: We carried out a systematic review of empirical studies involving military personnel (people trained to deal with fatigue) and analyzing SV as a fatigue index. We selected papers and reports published after 1995; the year of commercialization of the first PMI Impairment screener (PMI-FIT, http://pmifit.com/) by using the Google Scholar, Scopus, WOS, OpenGrey, and OAIster search engines. Key terms were: “saccadic velocity”, “fatigue”, “sleepiness”, “military**”.

Results: We retrieved 250 publications, and reviewed 21 that fulfilled inclusion/exclusion criteria. Most of the studies (n = 13) used sleep deprivation protocols (16–60 h) to induce fatigue. The others investigated the effects of fatigue produced by work (n = 37) and sleep (n = 4) schedules, and time-on-duty (40 min–3 h) (n = 3). PMI-FIT was used in most of the studies (n = 15). The others used commercial eye-trackers. Twelve studies found that SV decreased with increased fatigue level (only one showed the opposite trend). Three studies did not find significant effects. We were unable to retrieve valid results from five studies (because they were not reported or poorly reported).

Conclusion: Evidence agrees on the sensitivity of FDT based on SV. SV seems to be capable of detecting warfighter fatigue due to inadequate sleep over long periods of time (> 24 h). This result might offer military medical departments a valid biomarker of warfighter physiological state for screening and training programs.

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0386
CONSTRUCT VALIDITY AND FACTOR STRUCTURE OF THE PITTSBURGH SLEEP QUALITY INDEX IN A COHORT OF PERUVIAN PREGNANT WOMEN
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Introduction: We sought to evaluate the construct validity and factor structure of the Spanish-language version of the Pittsburgh Sleep Quality Index (PSQI) among pregnant Peruvian women.

Methods: A cohort of 642 women was interviewed at ≤ 16 weeks of gestation. During interview, we ascertained information about lifestyle, demographics, sleep characteristics, and mood symptoms. Stress induced sleep disturbance, depressive symptoms, and anxiety symptoms were evaluated using the Ford Insomnia Response to Stress Test (FIRST), Patient Health Questionnaire-9 (PHQ-9), and Generalized Anxiety Disorder-7 (GAD-7) assessment scales respectively. Consistency indices, exploratory and confirmatory factor analyses, correlations, and logistic regressions were used.

Results: Both exploratory and confirmatory factor analyses indicated a three-factor solution: sleep quality, sleep efficiency, and sleep medication. We observed significantly positive correlations of the PSQI with the FIRST (0.42), the PHQ-9 (0.49), and the GAD-7 (0.46). Poor sleepers (PSQI global score > 5) had significantly increased odds of experiencing stress induced sleep disturbance (odds ratio, OR = 3.64; 95% confidence interval, CI: 2.48, 5.35), depression (OR = 5.72; 95% CI: 3.79, 8.65), and probable generalized anxiety disorder (OR = 4.51; 95% CI: 3.09, 6.60).

Conclusion: The Spanish-language version of the PSQI instrument was found to have good construct validity among pregnant Peruvian women. Consistent with some other studies, the PSQI was found to have a three-factor structure. Further assessment and validation studies are needed to determine whether the three factor-specific scoring of the PSQI is favored over the PSQI global score in diverse populations.

0387
GREATER DECLINE IN REACTION TIME PERFORMANCE ON A SMARTPHONE APPLICATION DURING SLEEP DEPRIVATION IS LINKED TO EXTRAVersion
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Introduction: There is accumulating evidence that extraversion is one of the personality traits that confers a certain vulnerability to sleep deprivation (SD). Sleep-2-Peak (S2P), a new smartphone application designed to measure vigilance with reaction times (RTs), was used in this study in order to examine its ability to measure the vulnerability of extraverts to SD.

Methods: 16 subjects (18–27 y) completed a personality test (NEO-PI III) and underwent 35-hours of SD during which, every 2 hours (from 8 am on day 1 to 6 pm on day 2), they performed a 3 min version of S2P and the classic PVT-192 in a counterbalanced way. The subjects were separated in 2 equal groups of highest and lowest T scores on the Extraversion Scale of the Neo-PI III. T-tests were computed between the High Extroverts and Low Extroverts groups, on the total RTs increases throughout SD, first for the S2P, and then for the PVT-192.

Results: Results regarding S2P revealed a significant difference in RT increases between each group (t(16) = −2.21, p < 0.05). Greater increases in RTs were found in the High Extroverts throughout SD (mean increase of 45.12 ms) compared to the Low Extroverts (mean increase of 24.96 ms). However, no significant difference was found between the High and Low Extroverts for RT increases on the PVT-192 (t(16) = −0.25, n.s.), these increases being very similar in both groups (39.52 ms vs 36.59 ms, respectively).

Conclusion: These results confirm that the S2P smartphone application was able to distinguish the High Extroverts from the Low Extroverts during the SD protocol. These results also suggest that in a context of a relatively short period of SD, S2P may be more sensitive than the classic PVT-192 to identify those who are more vulnerable to SD. Intrinsic characteristics differences in those two RT tests could explain the results obtained.

0388
PREDICTIONS OF SLEEP DISTURBANCE FOR DIFFERENT NIGHTTIME AIRPORT OPERATION STRATEGIES USING A NEW MARKOV STATE TRANSITION SLEEP MODEL
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Introduction: To balance benefits and costs of potential airport operation changes such as noise curfews, changes in flight schedules, or flight paths, models are needed which can predict the time varying nature of the effects of aircraft noise on sleep. While a Markov transition model has previously been developed which predicts the transitions between 6 sleep stages throughout the night (Wake, S1, S2, S3, S4, and REM), it has two limitations. The Markov model was developed based on data from a laboratory study, in which a greater probability of aircraft noise-induced awakenings was found compared to field studies. In addition, the model predicts the same probability of awakening for all aircraft events, regardless of the noise level.

Methods: To overcome the two limitations of the previous model, a new Markov transition model was developed using data from a total of 483 nights from 63 subjects who participated in a polysomnographic field study that was conducted around Cologne-Bonn Airport. Similar to the previous Markov model, transition probabilities between sleep stages were calculated using 1st-order autoregressive multinomial logistic regression models. In addition to elapsed sleep time, the maximum noise level has been added to the model as an explanatory variable.

Results: The Markov model was used to predict the number of awakenings and the time spent in each sleep stage for different nighttime noise mitigation strategies including different timing of events and flight patterns. The model predicts a decrease in slow wave sleep and an increase in time spent awake due to noise exposure which is dependent on the number, noise level, and distribution of the aircraft events during the night.

Conclusion: With further validation, this Markov model could be a useful tool for optimizing nighttime traffic patterns to reduce the impact of noise on sleep in communities.

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0389  
CAN A MATHEMATICAL MODEL PREDICT COGNITIVE PERFORMANCE FOR DIFFERENT SLEEP-STUDY CONDITIONS FROM DIFFERENT LABORATORIES?  
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Introduction: Historically, mathematical models developed on performance data in one sleep study were limited to predicting performance in similar studies. To make predictions in other studies, involving different sleep-loss conditions, the model parameters were often recalibrated to fit the new study data, thereby limiting its practical utility. We recently developed a unified model that predicts the effects of the continuum of sleep loss, from chronic sleep restriction (CSR) to total sleep deprivation (TSD) conditions. However, the model was developed and validated on data from only two sleep-loss conditions, obtained from one laboratory. Here, we investigated whether this model can accurately predict performance for other sleep-loss conditions in studies performed in different laboratories.

Methods: We obtained psychomotor vigilance task (PVT) data from six different sleep studies from four different laboratories, and validated the unified model’s ability to predict performance in these studies. Specifically, we fitted the model to PVT lapse data from a study that encompassed four different CSR conditions (7 days of 3, 5, 7, and 9 h of sleep/night) and predicted performance in the five remaining studies, which included different combinations of the following sleep/wake schedules: 1) TSD (40 to 88 h), 2) CSR (2 to 6 h of sleep/night), 3) chronic sleep extension (8 to 10 h of sleep/night), and 4) naps (nocturnal and diurnal).

Results: Overall, the unified model accurately predicted the temporal dynamics of PVT performance across 14 different sleep-loss conditions, yielding root mean squared errors smaller than 4.16 lapses. Importantly, the model inherently captured the effects of different sleep-loss conditions regardless of the time and duration of the sleep episodes.

Conclusion: The unified model can serve as a useful tool to help design sleep studies and to predict cognitive performance impairment due to a wide range of sleep-loss conditions.

Support (If Any): Disclaimer: The opinions and assertions contained herein are the private views of the authors and are not to be construed as official or as reflecting the views of the U.S. Army or of the U.S. Department of Defense. This abstract has been approved for public release with unlimited distribution.

0390  
OPTOGENETIC LIGHT DELIVERY AND SIMULTANEOUS ELECTROPHYSIOLOGICAL RECORDING USING A TURN-KEY SYSTEM  
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Introduction: Optogenetics harnesses a combination of genetic and optical techniques to directly control specific nervous system cells. We designed, developed and tested a combination turn-key optogenetic LED light delivery system with simultaneous recordings of sleep and movement activity for rodents.

Methods: System design involved development of a highly accurate timing mechanism for controlling LED pulses and synchronizing with EEG and video recordings. In vivo testing used transgenic (Tg) mice modified to express channelrhodopsin in Thy1 brain cells (Cg-Tg(Thy1-COP4/eYFP)9Gfng/J) along with normal controls (C57). All animal procedures were approved by the University of Kansas IACUC. Mice were implanted with EEG recording electrodes and a cortical cannula for LED fiber probe implantation. Following a baseline recording period, mice were sleep-deprived for six hours beginning at lights-out followed by a recovery period. During stimulated periods, the first three hours of recovery sleep was accompanied by a blue light (470 nm) pulse (10 Hz, 80 ms, 10–15 mW/mm2) using Pinnacle’s Optogenetic Interface Module. During non-stimulated recovery periods, no light was administered.

Results: Tg mice receiving optical stimulation demonstrated greater increases in recovery delta (0.5–4.0 Hz) power / NREM epoch in the stimulated hemisphere as compared to a recovery period without optical stimulation (128 ± 6.2% vs. 117 ± 2.0%; P = 0.06). Delta power in the non-stimulated hemisphere did not show a measurable difference (118 ± 3.4% vs. 115 ± 2.2%; P = 0.41). Tg animals had less NREM sleep during optical stimulation as compared to recovery without stimulation (31.8 ± 1.5 min vs. 36.2 ± 1.0 min; P < 0.05). Control mice did not demonstrate significant changes on any of these parameters. Total movement and cage exploration, measured by X-Y tracking, was greater in the Tg mice during stimulation as compared to comparable, non-stimulated periods.

Conclusion: The effects on recovery sleep and overall activity demonstrate that this platform can be used to successfully alter and record multiple physiological parameters.

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THE IMPACT OF SLEEP APNEA ON WHITE MATTER HYPERINTENSITIES AMONG INDIVIDUALS WITH HEART FAILURE
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Introduction: Cognitive impairment is a significant problem among individuals with heart failure (HF). White matter hyperintensities (WMH) of presumed vascular origin are associated with impaired cognitive function in later life with healthy aging. For example, vascular risk factors, such as lower cardiac output and high blood pressure were found to be associated with higher WMH burden. OSA is another factor that contributes to changes in the brain. Although 25%–75% of HF patients have OSA, there is a dearth of research that explores how OSA contributes to WMH within the HF population. Thus, purpose of this investigation is to examine the impact of OSA on WMH in a HF sample.

Methods: 13 HF patients with untreated OSA and 12 HF patients without OSA (mean age = 68.2 SD = 6.1, male = 16 (64%)) underwent T-1 weighted and high resolution T-2 weighted fluid attenuated inversion recovery magnetic resonance (FLAIR) imaging and neuropsychological testing. OSA was evaluated using portable multichannel sleep monitoring device with AHI cutoff point 10. Total volume of WMH was calculated using the Lesion Segmentation Tool version 1.2.2. in Statistical Parametric Mapping 8. T-1 13 HF patients with untreated OSA and 12 HF patients without OSA (mean age = 68.2 SD = 6.1, male = 16 (64%)) underwent T-1 weighted and T-2 weighted fluid attenuated inversion recovery magnetic resonance (FLAIR) imaging. OSA was evaluated using portable multichannel sleep monitoring device with AHI cutoff point 10. Total volume of WMH was calculated using the Lesion Segmentation Tool version 1.2.2. in Statistical Parametric Mapping 8. T-1 Weighted and T2 FLAIR images acquired with a GE 3T MRI were used for lesion segmentation. The total volume WMH was divided by intracranial volume to calculate WMH ratio (WMHr). A log transformation was applied to WMH ratio value to normalize the distribution.

Results: Regression analyses adjusting for age, sex, left ventricular ejection fraction revealed that the presence of OSA was not associated with WMHr. However, the combination of untreated OSA and lower LVEF was associated with higher WMHr (p = 0.04).

Conclusion: Individuals who have reduced cardiac function and untreated OSA are more likely to have higher WMH burden than those without OSA. There is a need for prospective studies to determine the effect of OSA on WMH burden among individuals with HF.

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0392
DYNAMIC CHANGES IN GENE EXPRESSION DURING SLEEP IN OSA
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Introduction: We hypothesize that in individual patients with OSA gene expression in circulating cells will change dynamically in relation to events during sleep.

Methods: OSA patients and controls underwent a polysomnogram (10 pm–8 am) with blood collected every 2 hours (6 pm to noon). 4 OSA severity measures (ODI4, AHI, SaO2 < 90% and SaO2 nadir) were assessed in 1 hour bins. Expression of 18 genes on WBCs using PCR at each time point was normalized to the housekeeping genes.

Change in expression compared to pre-sleep measures (6 pm–10 pm) was assessed (denoted ΔΔCT). Linear mixed models were used to assess the relationship between the four OSA severity measures and ΔΔCT for expression of each gene measured up to 12 hours later. 216 comparisons (12 temporal associations for 18 genes) were assessed for each OSA severity measure. A Bonferroni correction of p < 2.315x10-4 (i.e., 0.05/216) is statistical significant; p < 0.0028 (0.05 corrected for 18 genes) is suggestive; p < 0.05 is nominally significant.

Results: 19 subjects were analyzed in this study. Across all temporal associations between ΔΔCT and the 4 OSA severity measures (n = 864 total), we observed 91 (10.5%) nominally significant associations: 13 for AHI, 18 for ODI4, 40 for hypoxia time, and 20 for SaO2 nadir. ICAM1 (adhesion molecule) (n = 13), SLC2A1 (glucose transporter 1) (n = 11) and NRF2 (nuclear respiratory factor 2) (n = 10) showed the largest number of associations (n), with increased transcription in response to higher OSA severity, specifically after 5–11 hours following hypoxia. In contrast, CYBB (a key subunit of NADPH oxidase) showed a delayed decreased transcription in response to higher OSA severity; this will be protective.

Conclusion: We observed temporal associations between expression of a number of genes and measures of OSA severity. The majority of associations was with hypoxia and were delayed. This strategy identifies a novel response pattern in patients with OSA.

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0393
EXPERIENCE OF DAYTIME SYMPTOMS FROM SLEEP APNEA AND INSOMNIA IS SIMILAR BETWEEN BLACK AND WHITES
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Introduction: Emerging evidence suggests that obstructive sleep apnea (OSA) and insomnia often co-occur. While studies have examined the overlap of symptoms in comorbid OSA and insomnia, little is known about racial differences in subjective reports of two commonly reported symptoms, sleepiness and fatigue. As such, this study examined racial differences in the association of OSA and insomnia with fatigue and sleepiness.

Methods: Veterans (92.4% male; 199 blacks, 286 whites; mean age = 51.7, SD = 13.5) diagnosed with OSA at the Miami VA Sleep Clinic completed the Insomnia Severity Index (mean = 18.1; 64.7% had a score ≥ 15), the Epworth Sleepiness Scale (ESS; mean = 12.5), and the Fatigue Severity Scale (FSS; mean = 39.4) prior to CPAP use. Multiple-group structural equation modeling with latent variables was used to determine whether race moderated the relationship of OSA with fatigue and sleepiness, and insomnia with fatigue and sleepiness.

Results: Fit indices indicated a good fitting baseline model [χ²(440) = 667.31, p < 0.001, CFI = 0.965, TLI = 0.960, RMSEA = 0.046 (90% CI 0.039, 0.053), p = 0.81, SRMR = 0.052]. Fatigue (FSS) was not associated with OSA in whites (b = −0.007, p = 0.13) and blacks (b = −0.008, p = 0.25); however, it was related to insomnia in whites (b = −0.399, p < 0.001) and blacks (b = −0.384, p < 0.001). Additionally, sleepiness (ESS) was associated with insomnia in whites (b = −0.241, p < 0.001), but not blacks (b = −0.062, p = 0.38). No relationship was observed between sleepiness and OSA in both whites (b = 0.002, p = 0.53) and blacks (b = −0.006, p = 0.17). Significant differences in these relationships by race, however, were not observed.
I. Sleep Disordered Breathing

Conclusion: These findings suggest that the relationship of OSA and insomnia with fatigue and sleepiness do not vary by race in those with untreated OSA. Given that racial/ethnic differences in CPAP use have been shown to emerge after OSA treatment begins, more research is needed to determine what factors, such as insomnia symptoms, contribute to differences in CPAP utilization.

0394
SENSORY NERVOUS LESIONS IN THE PALATE WORSENS OVER TIME IN UNTREATED SNORERS BUT NOT IN TREATED OSA-PATIENTS

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Introduction: Hypothesis: Snoring damages the neurons of the upper airway over time, thereby increasing the risk for sleep apnea. Cold detection threshold (CDT) testing could reveal this, as it is a routine neurophysiological method to detect nervous lesions.

Methods: 43 subjects, who were initially tested in 2008 for their ability to discern cold in the palate, were retested in 2014. Of these, 18 were non-snoring controls, 11 untreated snorers and 14 had received CPAP-treatment. Quantitative cold sensory testing was performed using the method of limits at the soft palate and the lip by a Medoc TSA-2001 equipment with an intra-oral thermode.

Results: For the non-snorers there were no significant changes in AHI (mean values 2 and 2.5, respectively) but the cold detection thresholds (CDT) increased from 2008 to 2014 (3.3°C to 5.8°C; p = 0.001). In the untreated snorers group AHI increased from 5 to 9, in average, and CDT:s had worsened from 5.1°C to 16.0°C (p = 0.003). Two subjects had completely lost their cold sensitivity in the palate, whereas it was normal on their lips. The CPAP-treated group had much higher AHI in 2008 than the two other groups, in average 29, which did not significantly change. Neither did their CDT:s; mean value 2008 was 5.5°C and 6.4°C in 2014. The change of CDT:s was significantly higher in the untreated snorers group than in the other two groups (p = 0.03).

Conclusion: There was a worsening in cold detection ability in the non-snoring group that could be attributed to increased age, but it was still within normal range. The untreated snorers group worsened much more, which shows that this group risks developing very poor sensitivity to cold in the upper airway in a couple of years of habitual snoring. This could contribute to sleep apnea, since the reflex that initiates contraction of the dilating upper airway muscles is triggered by the sensation of cold in the inspired air. In contrast, it seems that efficient treatment of OSA protects the sensory innervation, since the CPAP-treated group did not change their CDT:s.

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0395
PILOT STUDY OF BIOMARKERS FOR PREDICTING OSA AND EFFECTIVENESS OF CPAP TREATMENT -CORRELATION WITH GLUCOSE REGULATION

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Introduction: Obstructive sleep apnea (OSA) affects majority of the population and is associated with hypertension, obesity, diabetes, and an increased risk of heart attack and stroke. The overall objective of this study is to identify biomarkers with measurable biochemical characteristics associated with the severity of OSA, and to evaluate the effect of continuous positive airway pressure (CPAP) on these variables. Of particular interest are candidate biomarkers involved in the regulation of glucose.

Methods: We identified and diagnosed patients with OSA and determined the prevalence of metabolic syndrome (MS) at initial diagnosis and after CPAP using one of the following diagnostic criteria: IDF criterion: Waist Circumference ≥ 94 cm in men or ≥ 80 cm in women plus two or more below: -Low HDL = HDL < 40 mg/dl in males / < 50 mg/dl in females, or specific treatment for this lipid abnormality -Hypertension = SBP ≥ 130 mmHg or DBP ≥ 85 mmHg, or treatment for previously diagnosed hypertension -Dysglycaemia = FPG ≥ 100 mg/dl, or previously diagnosed type 2 diabetes NCEP ATP III criterion: At least three of the following criteria: Abdominal Obesity = Waist Circumference > 102 cm in men and 88 cm in women -Hypertriglyceridaemia = TG ≥ 150 mg/dl -Low HDL = HDL < 40 mg/dl in men and < 50 mg/dl in women -Hypertension = BP ≥ 130/85 mmHg -Dysglycaemia = FPG ≥ 110 mg/dl

Results: Approximately 10% of all new patients that presented to the center last year were diagnosed with OSA (~240 patients). Forty-two patients with OSA were included for analysis. Improvement of OSA symptoms was seen in ~61.9% after CPAP treatment. Baseline glucose and AIC expression were significantly lower in patients with high CPAP compliance than in those with low compliance. MS based on the diagnostic criteria set above was significantly improved with CPAP treatment. The mean scores of Epworth Sleepiness Scale (ESS) at baseline and after CPAP correlated with the degree of MS in these patients.

Conclusion: OSA is associated with MS and we hypothesize that dysregulation of glucose metabolism correlates with severity of the apnea. Effective CPAP treatment correlates with improved glucose and AIC levels and is associated with CPAP compliance and ESS. Identification and changes in expression of biomarkers that regulate glucose metabolism may possibly lead to early identification of OSA and provide an assessment of effective treatment with CPAP.

0396
WAKING ELECTROENCEPHALOGRAPHIC FUNCTIONAL CONNECTIVITY IN OLDER SUBJECTS WITH OBSTRUCTIVE SLEEP APNEA


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Introduction: Neuroanatomical changes and more specifically a decrease in grey matter density and white matter fiber integrity in the frontal lobes have been reported in individuals with obstructive sleep apnea (OSA). This study aimed at investigating whether OSA is associated with altered electroencephalographic (EEG) connectivity at rest, a measure of interaction between brain structures. We hypothesized that frontal regions would show severe connectivity disruption in OSA subjects in comparison to healthy controls.

Methods: Twenty-six OSA subjects (age: 63.8 ± 6.7 years; 4 females; apnea-hypopnea index (AHI): 36.9 ± 14.5) and 26 control subjects (age: 64.3 ± 6.4 years; 9 females; apnea-hypopnea index (AHI): 5.2 ± 3.0)
participated in a full-night polysomnography followed by a waking EEG recording. Artifact-free sections of the waking EEG were selected for a total of 118.8 ± 8.8 minutes per subject. Imaginary coherence values were derived for F3 and F4, where both electrodes were paired together then paired respectively with 12 other electrodes, for each frequency band, namely delta (1–4 Hz), theta (5–7 Hz), alpha (8–14 Hz), and beta (15–29 Hz). Groups were compared using Groups X Electrode pairs ANOVAs for each frequency band.

**Results:** No Groups X Electrode pairs interaction was observed for any of the 4 ANOVAs. However, a trend for a group effect showed decreased coherence in OSA subjects compared to control subjects in the theta band (F (1,50) = 4.01, p = 0.05). No other group effects were observed for beta, alpha and delta frequency bands.

**Conclusion:** Our results suggest a disruption of the frontal EEG functional connectivity measured at rest in the theta band in older individuals with OSA in comparison to control subjects. Whether this abnormal functional connectivity is associated with clinical variables or with neuropsychological decline among older OSA individuals should be investigated.

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**0397**

**ELEVATED PLASMA LEVELS OF SOLUBLE (PRO)RENIN RECEPTOR IN PATIENTS WITH OBSTRUCTIVE SLEEP APNEA SYNDROME - ASSOCIATION WITH POLYSOMNOGRAPHIC PARAMETERS**

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**Introduction:** (Pro)renin receptor (s(P)RR) is a specific receptor for both renin and its precursor prorenin. (P)RR was shown to be involved in pathophysiology of cardiovascular and renal diseases. Soluble (pro)renin receptor (s(P)RR), which is generated by furin from full length (P)RR, is present in blood.

**Objective:** The aim of the present study is to clarify the association of plasma s(P)RR levels and the severity of OSAS.

**Method:** Plasma levels of s(P)RR were measured by ELISA in 58 male patients diagnosed as OSAS based on PSG, and 14 age-matched male control subjects. Blood samples were obtained at 6:00 am just after overnight polysomnography.

**Results:** Plasma s(P)RR levels were significantly higher in patients with OSAS (9.0 ± 2.0 ng/mL, mean ± SD) than in control subjects (7.4 ± 1.5 ng/mL) (P = 0.0026). Plasma s(P)RR levels showed a significant negative correlation with % stage REM sleep (r = −0.377, p < 0.005), and significant positive correlations with % stage 1 (r = 0.374, p < 0.005), arousal index (r = 0.341, p < 0.01), AH1 (r = 0.352, p < 0.01) and desaturation index (r = 0.302, p < 0.05).

**Conclusions:** The present study has shown for the first time elevated plasma s(P)RR levels in patients with OSAS. Plasma s(P)RR levels were associated with the severity of OSAS. Soluble (P)RR may serve as a plasma marker reflecting the severity of OSAS.

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**0398**

**OBSTRUCTIVE SLEEP APNEA IS ASSOCIATED WITH LOW GABA AND HIGH GLUTAMATE IN THE INSULAR CORTEX**

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**Introduction:** The insular cortex is injured in obstructive sleep apnea (OSA), and responds inappropriately to autonomic challenges, as identified with neuroimaging measures. The mechanisms underlying the injury and dysfunction are unclear. The objective was to assess two neurotransmitters, γ-aminobutyric acid (GABA) and glutamate, within the insular cortex in OSA patients, relative to healthy controls. We hypothesize elevated glutamate based on evidence of hypoxia-induced excitotoxic conditions, and altered GABA based on impaired insular action and weaker cardiovascular reactivity in OSA.

**Methods:** We analyzed insular GABA and glutamate levels in 11 OSA (mean age ± SD: 54.6 ± 10.6 years; AH1: 35.0 ± 19.4; SAO2min: 83 %) patients and 13 healthy participants (50.7 ± 8.5 years) using a recently-developed non-uniform undersampled (NUS) compressed sensing based four dimensional echo-planar J-resolved spectroscopic imaging (4D-EP-JRESI), which enables evaluation of more metabolites than traditional 1D MRS/MRSI. We localized the anterior insular cortex with high-resolution anatomical scans. Acquired data were post-processed with a custom MATLAB-based program and metabolite ratios with respect to creatine peak were calculated using a modified prior knowledge fitting (Profit) algorithm. “Glx” (Glx = glutamine+glutamate) was used as a more sensitive indicator of glutamate. Analysis of covariance was used to assess OSA-control differences.

**Results:** In the right insular cortex, the OSA group showed decreased GABA (OSA: 0.28 ± 0.10, Control: 0.60 ± 0.14; p < 0.05), and no significant difference in Glx (OSA: 1.68 ± 0.40, Control: 1.51 ± 0.59). In the left insular cortex, the OSA group showed increased Glx (OSA: 1.78 ± 0.18, Control: 1.06 ± 0.48; p < 0.05) and no significant difference in GABA (OSA: 0.36 ± 0.07, Control: 0.55 ± 0.23; p < 0.05).

**Conclusion:** The anterior insular cortex in OSA shows altered levels of GABA and glutamate, consistent with the lateralized altered function of the structure; presumably, reduced GABA reflects a weaker functional role of the anterior insular, especially on the right side (preferentially sympathetic). The increased glutamate in the left insular cortex (preferentially parasympathetic) may reflect excitotoxic processes, which over time may contribute to the structural alterations found with structural imaging.

**Support (if any):** NIH National Institute of Nursing Research NR013693

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**0399**

**ASSESSMENT OF GENIOGLOSSUS FATIGUE USING DIFFERENT CONTRACTION TASKS**

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**Introduction:** The development of early genioglossus muscle fatigue following a repetitive protrusion task is a characteristic feature of sleep apnea patients. The tongue is involved in different movements but the influence of the direction of contraction task on genioglossus mechanical failure has not been assessed.
I. Sleep Disordered Breathing

Canadian Institutes of Health Research, Grant

B. Clinical Sleep Science

Methods: Genioglossus muscle fatigue was assessed in sleep apnea patients and control subjects. Investigated tasks were tongue protrusion (TP) and tongue elevation (TE) against the palate that were completed in random order. Contractile force was measured with pressure dedicated transducers. For each task, maximal voluntary contraction pressure (MVCP) was measured before and during recovery of a fatigue protocol. This one consisted in repetitive (1 every 5 sec) short (2 sec) contractions to reach 70% of baseline MVCP with completion of a MVCP every 60 sec. Endurance was assessed by the time elapsed from the beginning of the fatigue protocol to the moment subjects were not able to develop 80% of baseline MVCP. Time for recovery consisted in the time it took for MVCP to reach 90% of the pre fatigue value.

Results: Eight sleep apnea subjects (6 M, age 47 ± 13 y, BMI: 26.9 ± 1.8 kg/m², AHI: 20.2 ± 7.6/h) and 5 control subjects (4 M, age 44 ± 12, BMI: 27.6 ± 1.8 kg/m², AHI: 7 ± 3/h) participated in the study. There was no difference in baseline MVCP between the two groups for each contraction task. In sleep apnea patients, endurance was shorter with TE (6.3 ± 2.7 min) than TP (8.5 ± 3.6 min) and time for recovery was longer with TE (7.5 ± 5.4 min) than TP (3.8 ± 2.0 min). Such differences were not seen in control subjects (endurance TE 7.4 ± 3.5 min, TP 6.8 ± 2.0 min, time for recovery TE 4.0 ± 2.5 min, TP 2.6 ± 3.0 min).

Conclusion: Contractor tasks influence endurance and fatigue recovery features in sleep apnea patients but such pattern is not observed in control subjects.

Support (If Any): Canadian Institutes of Health Research, Grant 89985

NEW INSIGHTS ON THE PATHOPHYSIOLOGY OF INSPIRATORY FLOW LIMITATION DURING SLEEP

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Introduction: Inspiratory flow limitation (IFL) is defined as a “flattened shape” of the inspiratory airflow contour detected by nasal cannula pressure during sleep and can indicate increased upper airway resistance especially in mild Sleep Related Breathing Disorders (SRBD). The objective of this study was to investigate the association between upper airway abnormalities and IFL in patients with mild SRBD.

Methods: This study was derived from a general population study of 1,042 individuals. Were selected individuals without symptoms (with no significant pulmonary disease and no smoking) and with apnea-hypopnea index (AHI) below 5 events/hour of sleep, considered a “normal” group and individuals with symptoms and AHI between 5 and 15 events/hour considered as having mild Obstructive Sleep Apnea Syndrome (OSAS). 754 individuals were divided into 4 groups: group 1: AHI < 5/hour and < 30% of total sleep time (TST) with IFL (515 individuals), group 2: AHI < 5/hour and > 30% of TST with IFL (46 individuals), group 3: AHI: 5–15/hour and < 30% of TST with IFL (168 individuals) and group 4: AHI: 5–15/hour and > 30% of TST with IFL (25 individuals).

Results: Individuals with complain of oral breathing demonstrated chance 2.7 folds larger of having mild OSAS with > 30% TST with IFL compared to mild OSAS with < 30% of TST with IFL. Abnormal nasal structure increased chances of having mild OSAS with IFL > 30% 3.2 folds in comparison to normal with < 30% of TST with IFL. Those ones that had voluminous lateral wall demonstrated chance 4.2 folds larger of having mild OSAS with > 30% of TST with IFL compared to mild OSAS with < 30% of TST with IFL.

Conclusion: More than 30% of TST with IFL detected in polysomnography was associated with nasal and palatal anatomical abnormalities in mild SRBD patients. IFL may be an additional parameter for evaluating upper airway obstruction in mild OSAS patients.

Support (If Any): This work was supported by grants from AFIP, FAPESP and CNPq.
upper airway dilator muscle activity on return to sleep precipitating further airway collapse. However, studies have not found reduced dilator muscle activity following arousal; although many did not measure CO2 or assess respiratory arousals. We aimed to determine whether low CO2 following spontaneous respiratory arousal in OSA is associated with reduced genioglossus activity on return to sleep.

Methods: 32 OSA patients slept untreated with measurement of: EEG, EOG, submental EMG, airflow, end-tidal CO2 and intramuscular genioglossus EMG. Post-study, NREM respiratory arousals were identified and designated a CO2 change value, which was CO2 on the last breath of arousal (before return to sleep), relative to an individual’s waking CO2. Univariate ANOVA was used to determine whether there was an association between the CO2 change at arousal and genioglossus activity on each of the first five breaths following return to sleep.

Results: 1137 arousals across 24 participants were analysed. The median change in CO2 on the last breath of arousal from wakefulness was $-0.7$ mmHg (IQR = $-2.5$ to $1.3$ mmHg, range = $-8.8$ mmHg to $11.5$ mmHg). There was a significant nonlinear negative association that approximated an exponential function between CO2 change and peak genioglossus activity on the five breaths of return to sleep (all P-values < 0.05, except breath four = NS). A 1 mmHg decrease in CO2 at arousal corresponded to a 2–3% increase in peak genioglossus activity above wakefulness levels (dependent on magnitude of CO2 decrease) following return to sleep.

Conclusion: Low CO2 at arousal was not associated with low genioglossus activity following return to sleep. Rather, the lower the CO2 at arousal, the greater the genioglossus activity following return to sleep. This suggests arousal is not detrimental to airway patency, and may instead protect against further airway collapse.

0403

GROWTH RETARDATION FOLLOWING UPPER AIRWAY OBSTRUCTION AND SLEEP LOSS INDUCES EARLY BONE DEVELOPMENT: ROLE OF GHRELIN ON BONE METABOLISM IN RATS

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Introduction: There is no clear mechanism explaining growth retardation in pediatric obstructive sleep apnea and upper airway obstruction (UAO) in rats. We explore the effect of UAO on sleep, growth, and bone metabolism.

Methods: The trachea of 22-day-old male rats were obstructed and animals were followed for 7 weeks. Sleep, growth, and bone morphology were evaluated.

Results: UAO animals were awake for 24% more time, had 13% and 47% less SWS and paradoxical sleep duration, respectively. UAO animals demonstrated growth retardation; body weight, tibia, and tail length gains were all significantly reduced while food intake was elevated by 22% accompanied by 18% increase in intestinal/body length ratio. Serum ghrelin was elevated by 300% at both light on and light off phases while leptin decreased by 60%. Epiphyseal growth plate (EGP) Masson’s trichrome and Safranin O staining showed shorter and less functional EGP in the UAO. Total EGP proliferative and hypertrophic zones were reduced in UAO animals. A 2.5 fold increase in EGP OXR1 expression was shown in UAO. This finding was accompanied by a 92% decrease in ghrelin receptor associated with reduction of PPARγ and Sox9. Proliferative zone extra cellular matrix (ECM), collagen II, and aggrecan were reduced in UAO, while hypertrophic zone ECM collagen X decreased and metalloproteinase 13 increased. On the other hand, hypertrophic chondrocyte maturation markers Runx2 and VEGF, which indicate the efficacy of the endochondral ossification process, were unchanged in UAO.

Conclusion: UAO leads to sleep loss associated with impairment of energy and bone metabolism. The robust decrease in EGP ghrelin receptor inhibited key chondrogenic factors such as Sox9, IGF-I, and PPARγ, all associated with osteoblast differentiation and function and over-expression of OXR1. This study present evidence that growth retardation is related to suppression of EGP early development.

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0404

ASSOCIATION BETWEEN CEPHALOMETRIC MEASUREMENTS AND SEVERITY OF OBSTRUCTIVE SLEEP APNEA IN CHILDREN AND ADULTS

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Introduction: Previous studies revealed major differences in aetiology, manifestation and consequences between childhood and adulthood obstructive sleep apnoea (OSA) However, the possible differential effects of cephalometry on the two conditions have never been assessed. This study examined the association between cephalometric measurements and OSA severity in children and adults.

Methods: Children aged between 6 and 18 years who attended our paediatric sleep disorder clinic with symptoms suggestive of OSA were invited to undergo nocturnal polysomnography (PSG). Controls without habitual snoring were recruited from a concurrent population-based epidemiological study. Both parents and siblings (if any) of each participant were also invited to undergo nocturnal PSG. Partial correlation was used to assess the association between cephalometric measurements and log-transformed obstructive apnea hypopnea index (logOAHI) while controlling for age, gender and body mass index. Pediatric (< 18 y) and adult (≥ 18 y) subjects were analyzed separately.

Results: A total of 152 children (81 male) and 220 adults (110 male) were recruited. LogOAHI was associated with measures that indicated a lower position of hyoid bone (MP-H, Gn-Go-H and MP-H/Go-Gn) in both pediatric (r = 0.367, 0.408 and 0.395, respectively, all p < 0.001) and adult male subjects (r = 0.244, 0.210 and 0.256, respectively, all p < 0.05) but not in female subjects. However, the length of soft palate (r = 0.223, p = 0.018) and the inclination of mandible (r = 0.203, p = 0.031) were positively correlated with logOAHI only in adult male but not pediatric male subjects. Retrognathic mandible was significantly associated with logOAHI only in pediatric females (r = 0.323, p = 0.005) and adult males (r = 0.230, p = 0.015).

Conclusion: This preliminary analysis suggested that a lower position of hyoid bone was associated with more severe OSA in both adult and children males. But the contribution of the length of soft palate, inclination of mandible and retrognathic mandible on OSA severity may be different among paediatric and adult subjects.

Support (If Any): This study was funded by the Research Grants Council of the Hong Kong Special Administrative Region, China [CUHK471210].
0405 GENDER DIFFERENCES IN THE ASSOCIATION OF INFLAMMATION, SLEEP APNEA, AND HYPERTENSION

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Introduction: Many studies over the last decade have established associations between sleep apnea, inflammation, and cardiovascular outcomes. However, none have explored potential gender differences in these associations. Our aim was to differentially assess inflammatory markers in sleep apnea and comorbid hypertension in men and women.

Methods: A sample of 120 middle-aged, predominantly non-obese mild-to-moderate sleep apneics (AHI ≥ 5) and controls (51.7% male; mean age = 54.67 ± 0.54) underwent a clinical history, physical examination, and 8-hour polysomnography study. A single fasting blood draw was performed at 7:00 and assayed for IL-6, TNFR1, and CRP via ELISA. Two-tailed independent samples t-tests compared demographic, PSG, and biomarker variables between-gender. Increasing apnea severity (i.e. AHI < 5, 5 ≤ AHI < 15, and AHI ≥ 15) and the presence of hypertension (i.e. controls without hypertension, sleep apneics without hypertension, and sleep apneics with hypertension) were examined within-gender via ANCOVA, controlling for age and BMI.

Results: Men with sleep apnea had higher concentrations of plasma TNFR1 (1.13 ng/mL vs. 0.97 ng/mL; p = 0.04), CRP (1.56 ng/mL vs. 0.90 ng/mL; p = 0.06) and IL-6 (1.14 pg/mL vs. 0.82 pg/mL; p = 0.11) relative to controls. In women, only CRP was elevated with sleep apnea (2.81 ng/mL vs. 1.83 ng/mL; p = 0.04). A CRP dose-response was observed with increasing apnea severity (p-linear = 0.04 in both genders). A CRP dose-response was also observed between controls, apneics without hypertension, and apneics with hypertension; however, smaller elevations in CRP are observed. Our findings suggest that inflammatory markers should be analyzed and interpreted separately in men and women. Furthermore, a single measure of plasma CRP may be a clinically-useful marker of apnea severity and cardiovascular morbidity.

Support (If Any): NIH R01 HL 64415

0406 NOCTURNAL NON-DIPPING BLOOD PRESSURE IN PATIENTS WITH SUSPECTED OBSTRUCTIVE SLEEP APNEA

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Introduction: Obstructive sleep apnea (OSA) is associated with nocturnal non-dipping of blood pressure (NNDbp), which predicts cardiovascular disease. However, factors that lead to NNDbp in suspected OSA are poorly understood. We examined NNDbp with 24-hour ambulatory BP monitoring (ABPM) in a sleep clinic population.

Methods: Single-center, prospective study of patients referred for evaluation of OSA (n = 31). Baseline data included ABPM, Epworth Sleepiness Scale (ESS), medical history and active medications. Patients with structural heart disease, arrhythmia and heart failure were excluded. Hypertension was defined by self-report or use of antihypertensives. All participants completed in-laboratory polysomnography and hypopneas were scored with 3% oxygen desaturation or arousal.

Results: Participants were middle-aged (mean ± SD: years = 47.8 ± 11.7), sleepiness (ESS = 12.3 ± 5.9), and had high prevalence of obesity (body mass index; BMI = 38.0 ± 9.0) and hypertension (77%). 5 had AHI < 5 per hour, 9 had AHI = 5–15 per hour, and 17 had AHI > 15 per hour. Multivariable regression was performed to test the relationship of age, BMI, ESS, and AHI with NNDbp (average awake BP -average sleep BP/average awake BP) across the entire sample. AHI was the only significant predictor, where increasing AHI was associated with less dipping (mean BP: t-statistic = −2.11, p = 0.04, systolic BP: t-statistic = −2.19, p = 0.04, diastolic BP: t-statistic = −2.25, p = 0.03). When self-reported usual sleep time was added as a predictor to the model, these trends persisted: mean BP: t-statistic = −2.05, p = 0.05, systolic BP: t-statistic = −2.14, p = 0.04, diastolic BP: t-statistic = −2.25, p = 0.03.

Conclusion: In patients with suspected OSA, AHI as a continuous measure of sleep disordered breathing is associated with NNDbp. Larger studies are needed to fully characterize predictors of nocturnal hypertension in OSA.

0407 PLASMA GLUCAGON-LIKE PEPTIDE-1 IN PATIENTS WITH OBSTRUCTIVE SLEEP APNEA SYNDROME: ASSOCIATION WITH IMPAIRED GLUCOSE TOLERANCE

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Introduction: The role of GLP-1 is to stimulate the secretion of insulin. In healthy person, postprandial hyperglycemia increases the secretion of GLP-1 and it decrease from peak after 30 minute. Previous paper show that the patients with Obstructive sleep apnea (OSAS) have insulin resistance, but the relationship between GLP-1 and the severity of OSAS has nevert suggested. In this study, we investigated the time variation of pGLP-1 levels in patients with OSAS.

Methods: We enrolled 41 subjects with OSAS who has HbA1c < 6.2% and HOMA-R < 2.5. The OSAS patients were then grouped into 2 by the severity of OSAS (Group A: AHI ≥ 30, n = 19 and Group B: AHI < 30, n = 22). We conducted the glucose tolerance test and measured plasma glucose, serum insulin and pGLP-1 levels before and after 30, 60 and 120 minutes of load. pGLP-1 levels were measured by the ELISA method following the manufacturer’s protocols in the Division of Behavioral Sleep Medicine, Iwate Medical University.

Results: Before glucose load tests, pGLP-1 levels had no significant difference between the A group and the B group. After 30 minutes, pGLP-1 levels were significantly higher than before load in both groups and there were no significant difference between the A group and the B group. After 60 minutes, pGLP-1 levels of the B group (5.0 ± 2.0 pmol/L) showed a downward trend (no significant), but pGLP-1 levels of the A group (10.6 ± 14.7 pmol/L) did not decrease than after 30 minutes. Furthermore, after 120 minutes, pGLP-1 levels of the B group was significantly lower than the A group (5.4 ± 0.7 vs 9.1 ± 1.5 pmol/L, p = 0.01).

Conclusion: In this study, pGLP-1 of severe OSAS without insulin resistance and glucose tolerance was prolonged after 120 minutes glucose load. This study may suggest that severe OSAS has potential pancreatic β cell functional disorder and GLP-1 resistance.
B. Clinical Sleep Science

0408
HIGH PLASMA LEVELS OF SOLUBLE (PRO) RENIN RECEPTOR WERE IMPROVED BY CONTINUOUS POSITIVE AIRWAY PRESSURE TREATMENT IN PATIENTS WITH SEVERE OBRUPTIVE SLEEP APNEA SYNDROME

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Introduction: We have previously shown that plasma levels of soluble (pro)renin receptor, a neuropeptide with an apnea hypopnea index, were increased in parallel with the severity of the disease in patients with obstructive sleep apnea hypopnea syndrome (OSAS). To clarify effects of continuous positive airway pressure (CPAP) treatment on plasma levels of soluble (pro)renin receptor in patients with this syndrome.

Methods: Sleep tests and blood samples collection were conducted at the sleep related disorders clinic and the sleep laboratory of the Iwate Medical University Hospital. We studied 12 patients with OSAHS (apnea hypopnea index: AHI ≥ 20 by polysomnography) who were treated with nasal CPAP for 3 months. Plasma s(P)RR levels were measured by the ELISA method (Immuno-Biological Laboratories Co., Ltd., Fujikawa, Japan) following the manufacturer’s protocols in the Department of Endocrinology and Applied Medical Science, Tohoku University Graduate School of Medicine.

Results: Twelve OSAS patients with AHI ≥ 20 underwent nCPAP treatment for 3 months, which improved the PSG parameters and the symptoms of OSAS. AHI and arousal index decreased significantly after 3-month treatment of nCPAP (from 40.2 ± 31.2 events/hr to 6.4 ± 8.6 events/hr, p < 0.005, respectively). Mean blood pressure at 6 am decreased from 100.6 ± 13.7 mmHg to 88.7 ± 9.6 mmHg (p < 0.05). Plasma s(P)RR levels also decreased significantly from 11.4 ± 1.8 ng/mL to 8.1 ± 2.1 ng/mL after nCPAP treatment in these 12 patients (p = 0.0016).

Conclusions: The high plasma levels of soluble (pro)renin receptor were decreased by the nasal CPAP treatment in patients with severe OSAS, suggesting that plasma levels of soluble (pro)renin receptor is a plasma marker that reflects the severity of OSAS and the response to the treatment.

 Methods: Eighty-eight patients with UARS and 365 patients with OSAS participated. All patients had a diagnostic full-night attended polysomnography (PSG) and completed the Athens Insomnia Scale (AIS), Pittsburgh Sleep Quality Index (PSQI), Epworth Sleepiness Scale (ESS), Symptom Checklist-90-Revision (SCL-90-R) and Eysenck Personality Questionnaire (EPQ).

Results: The UARS group scored significantly higher than the OSAS group on the ESS, AIS, and PSQI. The scores of all SCL-90-R subscales in the UARS group were significantly higher than those in the OSA group. Patients with UARS scored lower on EPQ-E and EPQ-L than those with OSA. UARS patients also showed higher scores on EPQ-P and EPQ-N than OSAS patients.

Conclusion: Our results suggest that patients with UARS have worse subjective sleep quality than OSAS patients in spite of their better PSG findings. Patients with UARS tend to be introverted, neurotic, and are likely to experience anxiety, sensitivity, and somatization. These findings suggest that patients in this group are likely to take their symptoms seriously and respond nervously.

0410
AMYGDALA SUB-REGIONAL VOLUME DIFFERENCES IN OBRUPTIVE SLEEP APNEA

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Introduction: The amygdala is important in obstructive sleep apnea (OSA), since it mediates anxiety, a common symptom in the sleep condition, and also serves autonomic nervous system roles, which are affected in OSA. Our objective was to assess regional amygdala volume in OSA, since previous imaging studies are lacking in detailed amygdala-specific structural assessment.

Methods: We performed high resolution T1-weighted imaging in 37 newly-diagnosed OSA (mean age ± SD: 46.3 ± 8.8 years; mean AHI ± SD: 34.1 ± 21.5; 30 male) and 59 healthy control (46.8 ± 9.0 years; 38 male) participants. High resolution T1-weighted scans were acquired and analyzed using “FSL FIRST” software, which segments the amygdala and allows regional surface-based assessment of the structure. Analyses were performed on amygdala volumes scaled for total brain size. ANOVA was used for group comparisons.

Results: Global volume of the right amygdala was greater in OSA than controls (effect size = 3.4sd; p < 0.05). Regional volume differences also included some areas of smaller OSA volume (p < 0.05, corrected). Higher volumes in OSA encompassed the following nuclei: (anterior-most) medial and lateral central amygdaloid, medial amygdaloid, posterior cortical amygdaloid; (mid-region) posterior cortical amygdaloid, anterior medial amygdaloid, central amygdaloid, and anterior cortical amygdaloid; and (posterior-most) basomedial amygdaloid. Lower volumes in OSA encompassed fewer regions, and included the following nuclei: (anterior-most) basolateral amygdaloid, basolateral amygdaloid, and lateral amygdaloid; (mid-region) dorsal-anterior lateral amygdaloid, ventrolateral basolateral amygdaloid; and (posterior-most) lateral amygdaloid, ventromedial basolateral amygdaloid, and basolateral amygdaloid.

Conclusion: The right amygdala is larger in OSA patients, with volume increases specific to especially anterior nuclei. The affected nuclei project to the adjacent hippocampus (predominantly OSA volume reductions), and hypothalamus, insula and prefrontal cortex (predominantly OSA volume increases), structures previously shown to be affected in the sleep disorder. Altered function is likely present in the affected sub-regions. While the volume reductions in isolated areas...
could reflect chronic injury, the volume increases in other sub-regions could reflect inflammation and glial activation, phenomena likely to be at least partially reversible with treatment.

**Support (If Any):** NIH National Institute of Nursing Research NR013693

**0411**

**DOES BASELINE O2 AND END TIDAL CO2 PREDICT AHI IN PATIENTS PRESCRIBED OXYCODONE?**

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**Introduction:** Sleep disordered breathing is highly prevalent in patients using opioid medications. We aimed to determine if baseline wake O2 and EtCO2 in adults prescribed oxycodone were predictive of sleep disordered breathing (AHI) in patients undergoing polysomnography.

**Methods:** We performed a retrospective review of subjects on oxycodone who underwent standard polysomnography including EtCO2 measurement. Patients with tracheostomies, pulmonary disease, and those requiring supplemental oxygen were excluded. The AASM 2012 criteria for hypopneas B was used for scoring. Correlational analyses were used to evaluate the relationship between baseline oxygen saturation and EtCO2 and other sleep related breathing parameters. The sample was also subdivided based on higher and lower baseline O2 and CO2 values to compare whether the groups differed in AHI.

**Results:** 16 subjects (11 female, 5 male) met criteria and were included. Average age was 52 years (range 32–74), average baseline EtCO2 was 42 torr (range 36–48), average baseline O2 was 95% (range 90–98), and average AHI was 11.3 (range 0.6–38). Baseline oxygen saturation correlated with AHI (r = −0.5; p = 0.05), but baseline EtCO2 did not (r = 0.13; p = 0.6). When subdivided by baseline O2 (95 and above vs below 95), the group with lower baseline oxygenation had a higher AHI (Mean 1 AHI = 6.9, Mean 2 AHI = 19.8; p = 0.03). When subdivided baseline EtCO2 (below 44 torr and above torr), there were not group differences in AHI.

**Conclusion:** In our retrospective cohort of patients prescribed oxycodone, we found a correlation between wake O2 saturation at the start of the sleep study and subsequent AHI, but no relationship between starting EtCO2, and respiratory events. This may be related to non state-specific effects of oxygen responsivity. Further study is needed to help delineate possible reasons for the relationship between wake oxygen saturation and AHI.

**0412**

**INCREASED CHRONIC KIDNEY DISEASE PATIENTS IN OBSESE PATIENTS WHO HAVE OBSTRUCTIVE SLEEP APNEA SYNDROME**

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**Introduction:** Previous studies have shown an association between obstructive sleep apnea (OSA) and chronic kidney disease (CKD). The purpose of the present study is to determine whether patients with OSA would show an increase of CKD.

**Methods:** We investigated adult patients with a chief complaint of habitual snoring and/or sleep apnea noticed by the bed partner. Overnight polysomnography, fasting blood triglyceride, cholesterol, glucose, creatinine, albumin and hemoglobin A1c, and first voiding urine albumin and creatinine were examined. Estimated glomerular filtration rate (eGFR), urine albumin-to-creatinine ratio (UACR), and percentage of CKD were calculated.

**Results:** The final analyses involved 40 patients who were middle-aged male, obese and had severe OSA, with an apnea-hypopnea index (AHI) of 33/h. The mean eGFR and UACR were 80 mL/min/1.73 m2 and 15 mg/g, respectively. The prevalence of CKD in severe OSA subjects is 14%. With stepwise multivariate linear regression analysis, AHI and desaturation index were the only independent predictor of UACR and eGFR, respectively.

**Conclusion:** Severe OSA patients that also had a high prevalence of CKD is present. Significantly positive correlations were found between severity of OSA and renal function impairment.

**0413**

**OBSTRUCTIVE SLEEP APNEA IS ASSOCIATED WITH NEW HEART FAILURE AND STROKE IN PATIENTS WITH PREVALENT CARDIOVASCULAR DISEASE: THE SLEEP HEART HEALTH STUDY**

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**Introduction:** Previous analysis of data from the Sleep Heart Health Study (SHHS) found that obstructive sleep apnea (OSA) is associated with incident heart failure and stroke in individuals free of cardiovascular disease (CVD) at baseline; however, it is unclear whether OSA is associated with incident or recurrent heart failure or stroke in patients with prevalent CVD at baseline.

**Methods:** Of 5042 SHHS participants with complete data on baseline CVD status, a total of 480 men and 284 women had prevalent cardiovascular disease (myocardial infarction, revascularization procedure, heart failure or stroke) at the time of the baseline polysomnography. Mean age was 70.3 (SD 9.9) years, mean BMI 28.1 (SD 5.1) kg/m2. Mean follow-up was 9.1 (SD 3.7) years for the development of incident or recurrent heart failure or stroke, in this prospective longitudinal epidemiological study. OSA was defined as an apnea-hypopnea index (AHI) ≥ 5, where events were associated with a 4% or greater fall in SaO2. Logistic regression models were used to examine the association of OSA with adjudicated occurrence of heart failure and stroke, adjusting for age, sex and BMI.

**Results:** Incident or recurrent heart failure was observed in 241 participants. Participants with OSA were 43% more likely to develop incident or decompensated heart failure compared to those without OSA (adjusted odds ratio 1.43 [95% CI 1.02 to 2.00]). OSA was also an independent predictor of incident or recurrent stroke (adjusted odds ratio 1.74 [95% CI 1.11 to 2.73]).

**Conclusion:** OSA is strongly associated with incident or recurrent heart failure and stroke in this community-dwelling population with prevalent CVD. This suggests that treatment of sleep apnea may prevent further cardiovascular morbidity and mortality in individuals with established CVD.

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I. Sleep Disordered Breathing

0414

RELATIONSHIPS BETWEEN AXONAL AND MYELIN ALTERATIONS WITH OXYGEN SATURATION CHANGES IN OBSTRUCTIVE SLEEP APNEA

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Introduction: Obstructive sleep apnea (OSA) subjects show axonal and myelin injury in brain regions that regulate autonomic, mood, and cognitive functions, deficient in the condition. Axonal and myelin injury may vary with O2 saturation changes; however, associations between such alterations and O2 saturation changes are unclear. We examined relationships between regional axonal and myelin changes with oxygen saturation change in OSA subjects.

Methods: We collected diffusion tensor imaging data from 17 recently-diagnosed, treatment naïve OSA subjects (age, 49.8 ± 9.5 years; 13, males; AHI, 40.8 ± 23.4 events/hour) using a 3.0-Tesla MRI scanner, and performed axial and radial diffusion procedures that measure water diffusion parallel and perpendicular to axons and show axonal and myelin changes, respectively. Axial and radial diffusion maps were calculated, normalized, and smoothed; the smoothed axial and radial diffusion maps were used to assess relationships between axonal and myelin alterations and O2 saturation changes (differences between baseline and O2 saturation nadir during overnight sleep study) with partial correlation procedures (covariates; age and gender; uncorrected-threshold; p = 0.005).

Results: The cingulate, prefrontal, temporal white matter, and occipital cortices showed positive correlations with axial diffusivity (axonal status) and O2 saturation changes, and negative correlations emerged in the peri-ventricular white matter, internal and external capsules, thalamus, corpus callosum, putamen, and occipital white matter. The superior frontal, cingulate, parietal and occipital, ventral medial prefrontal cortices, subgenual of the cingulate, and temporal white matter showed positive correlations with radial diffusivity (myelin status) and O2 saturation changes, and negative correlations were distributed in the corpus callosum, internal capsule, thalamus, and occipital white matter.

Conclusion: The findings indicate acute and chronic stages of axonal and myelin injury in OSA subjects, and suggest that extent of O2 saturation changes play a significant role in types of axonal and myelin changes in OSA subjects.

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0415

STRUCTURE-SPECIFIC WHITE MATTER TRACT CHANGES IN OBSTRUCTIVE SLEEP APNEA

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Introduction: Obstructive sleep apnea (OSA) patients show brain structural changes measured as altered water diffusion across multiple gray and white matter structures. While these changes likely represent myelin and axonal injury, the degree to which they are white-matter specific is unclear. Our objective was to identify hypothesized OSA-related structural changes within specific white matter tracts.

Methods: We analyzed white matter in 43 newly-diagnosed OSA patients (mean age ± SD: 46.4 ± 8.8 years; mean AHI ± SD: 34.1 ± 21.5; 34 male) and 58 controls (47.4 ± 9.0 years; 37 male) using diffusion tensor and T1-weighted imaging. We isolated white matter structures with the FreeSurfer software package TRACULA, and extracted track volume, fractional anisotropy (FA), and mean diffusivity (MD) in the overall structure and along points in the tract (“trajectory analysis”). Measures were compared using t-tests (threshold p < 0.05) in the bilateral anterior cingulum bundle, cingulum gyrus, corticospinal tract, forceps major and minor, thalamic tract, and uncinate.

Results: The OSA group showed increased (p < 0.05) tract-to-total intracranial-volume ratios versus control in the left anterior thalamic (control: 7.67x10-4 ± 3.0x10-5; OSA: 9.58x10-4 ± 5.9x10-5) and right corticospinal (control: 1.01x10-3 ± 3.7x10-5; OSA: 1.2x10-3 ± 4.6x10-5) tracts. No differences emerged between OSA and control in overall tract FA measures, but trajectory analysis showed regions of lower FA in the anterior thalamic, corticospinal, cingulum anterior bundle and gyrus, forceps major and minor, and uncinate tracts. MD was lower in OSA in the right uncinate (control: 8.37x10-4 ± 4.9x10-6; OSA: 8.14x10-4 ± 5.9x10-6), forceps major (control: 8.83x10-4 ± 6.5x10-6; OSA: 8.59x10-4 ± 7.8x10-6) forceps minor (control: 9.45x10-4 ± 9.4x10-6; OSA: 9.14x10-4 ± 7.7x10-6), left anterior cingulum bundle (control: 8.21x10-4 ± 8.0x10-6; OSA: 7.87x10-4 ± 9.3x10-6), right cingulum gyrus (control: 8.18x10-4 ± 6.5x10-6; OSA: 7.94x10-4 ± 8.6x10-6), left corticospinal (control: 7.81x10-4 ± 7.4x10-6; OSA: 7.36x10-4 ± 5.5x10-6), right corticospinal (control: 8.00x10-4 ± 7.5x10-6; OSA: 7.57x10-4 ± 5.57x10-6), and right anterior thalamic (control: 8.36x10-4 ± 4.3x10-6; OSA: 8.29x10-4 ± 6.6x10-6) tracts.

Conclusion: OSA is associated with white-matter specific increases in volume, localized reductions in axonal integrity, and widespread reductions in diffusivity. White matter volume increases contrast with gray matter decreases. The findings suggest localized patterns of axonal and myelin injury, and more global cellular changes likely associated with inflammation and glial activation.

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0416

ASSOCIATION BETWEEN OBSTRUCTIVE SLEEP APNEA AND TELOMERE LENGTH

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Introduction: Obstructive sleep apnea (OSA) is associated with cardiovascular diseases including coronary artery disease and hypertension. Inflammation and oxidative stress, key factors in promoting the above conditions, are associated with telomere shortening. Shorter telomeres lead to limited cellular lifespan and are associated with an increased risk of age associated pathologies, including cancer. As systemic oxidant stress also occurs as a consequence of OSA, we hypothesized that shortened telomere length will occur in OSA patients.

Methods: Patients referred for evaluation of OSA were recruited. Diagnostic polysomnography was performed along with a blood draw to assess telomere length. Telomere length was determined using a quantitative PCR assay. A linear regression model analysis was performed
to determine the relation between sleep disorder and telomere length and the data was analyzed using SPSS.

Results: A total of 51 subjects were recruited. Median age was 40 years, ranging from 19–60 years. Ten of the subjects had asleep apnea while 34 of them did not. Using telomere length as a dependent variable, linear regression analysis found sleep apnea to be significant at the 95% confidence level (p = 0.001). Relative telomere length for those subjects with sleep apnea was 0.67 ± 0.15 of normal, while for those without, it was 0.90 ± 0.19 of normal (p = 0.0008).

Conclusion: These preliminary findings suggest that the presence of OSA is associated with shorter telomere length, a risk factor for shortened lifespan.

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0417
ALTERNED HIPPOCAMPAL RESTING-STATE FUNCTIONAL CONNECTIVITY IN OBSTRUCTIVE SLEEP APNEA
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Introduction: Obstructive sleep apnea (OSA) is accompanied by brain tissue injury in autonomic, affective, and cognitive control sites, and corresponding dysfunctions in the condition. The hippocampus plays a pivotal role in mood, memory, and especially, blood pressure regulation, and altering its spontaneous functional connections to other brain areas may contribute to deficient functions. However, the integrity of hippocampal functional connections in OSA remains unclear. Our aim was to assess hippocampal resting-state functional connectivity to other brain areas in OSA, compared to control subjects.

Methods: We acquired resting-state functional MRI data from 67 OSA (age, 48 ± 9.2 years; Females, 16; BMI, 30.7 ± 6 kg/m²; AHI, 35.6 ± 23.5 events/hour), and 75 controls (47.1 ± 9.3 years; 25.1 ± 3.4 kg/m²), using a 3.0-Tesla MRI scanner. Data were processed using SPM8 with standard steps, canonical nuisance signals were removed by regression, and data were band-pass filtered. Using left and right hippocampal seed regions, individual correlation maps between each seed area and data were band-pass filtered. Using left and right hippocampal seed regions, the z-scored maps compared between OSA and controls (ANCOVA; covariates, age and gender; P < 0.05, cluster-corrected).

Results: The left and/or right hippocampus in OSA showed decreased functional connectivity primarily with the orbito/inferior frontal, temporal, occipital, thalamic, and cerebellar regions. However, the left and/or right hippocampus in OSA patients showed increased functional connectivity, respectively with the medial/superior frontal, limbic, cingulate, parietal, cerebellar, brainstem, and basal ganglia regions.

Conclusion: Hippocampal functional connectivity with other autonomic, affective, and cognitive brain regions are disturbed in OSA in a complex way. The functional changes in these regions likely result from the prominent structural injuries reported-earlier in the condition.

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0418
EXPIRATORY TIME CONSTANT AND SLEEP APNEA SEVERITY IN THE OVERLAP SYNDROME
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Introduction: Lung mechanics in the overlap syndrome (COPD and sleep apnea) may have an impact on the severity of the sleep apnea. For instance, an increase in lung compliance with hyperinflation may protect against sleep apnea, whereas an increase in resistance could worsen sleep apnea. We therefore sought to assess whether the expiratory time constant (product of airway resistance and lung compliance) is associated with sleep apnea severity in such patients.

Methods: Polysomnographic records of 34 subjects with the overlap syndrome were reviewed. A time constant was derived by selecting several time and nasal pressure coordinates along the expiratory portion of a nasal pressure signal, fitting those values along an exponentially decaying equation (P(t) = P(0)e^(-t/RC), with RC = Time constant), and solving for RC. Three time constants were measured for each stage from wake through stage N1 to REM sleep. Demographics, right diaphragmatic arc on a chest radiograph (a measure of hyperinflation) and the apnea hypopnea index were recorded.

Results: The time constant was not associated with age, gender, BMI, or right diaphragmatic arc, and was not significantly different between sleep stages. A mean time constant (mTC) was obtained by averaging values across all stages. Subjects with a long mTC > 0.5 seconds had a significantly greater AHI than those with a shorter mTC < 0.5 seconds (AHI 56 vs, 24 respectively, p = 0.002). 76% of subjects with a long mTC, had severe sleep apnea (AHI ≥ 30) compared to 24% of those with a short mTC (p = 0.005; Odds ratio 10.6, 95% CI 3.9–51.1).

Conclusion: A larger time constant in the overlap syndrome is associated with increased odds of severe sleep apnea. This suggests a greater importance of airway resistance relative to lung compliance in sleep apnea causation in these subjects.

0419
CONTINUOUS POSITIVE AIRWAY PRESSURE ELIMINATES INCREASED RISK OF DEATH OF OBSTRUCTIVE SLEEP APNEA IN CHINESE PATIENTS
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Introduction: Whether continuous positive airway pressure (CPAP) therapy mitigates increased mortality in Obstructive Sleep Apnea (OSA) in Chinese adults is not known. The objective of our study was to compare mortality in Chinese patients with simple snoring, untreated OSA, and OSA treated with CPAP.

Methods: We studied adults with OSA or simple snoring from our sleep center. OSA was diagnosed using routine polysomnography. Subjects were followed annually (at least ) for a mean of 8.9 years (SD 1.9). CPAP compliance was assessed using machine use parameters. The outcome was all-cause mortality.

Results: We enrolled 550 simple snorers, 257 with untreated mild OSA, 316 with untreated moderate OSA, 457 with untreated severe OSA, and 235 with mild to severe OSA treated with CPAP. The mortality rate of simple snorers was much lower mortality (2.98 per 1000 person-years [95% CI, 2.93 to 3.02]) than those with untreated severe OSA (11.07 per 1000 person-years [95% CI, 10.86 to 11.29]; P < 0.0001). Fully adjusted
**I. Sleep Disordered Breathing**

mortality was highest in those with untreated, severe OSA compared with simple snorers (Hazard Ratio [HR], 3.51 [95% CI, 1.93–6.39]). Treatment of severe OSA with CPAP eliminated this increased mortality (HR, 0.81 [95% CI, 0.36–1.86]).

**Conclusion:** CPAP treatment with adequate compliance reduces the risk of increased mortality in Chinese patients with severe OSA. DOI 10.1007/s11325-014-1091-9

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**USE OF CPAP THERAPY FOR OBSTRUCTIVE SLEEP APNEA: DIFFERENCES IN VETERANS OF VIETNAM AND PERSIAN GULF WARS**

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**Introduction:** Post-traumatic stress disorder (PTSD) affects more than 20% of veterans, many of whom also have comorbid obstructive sleep apnea (OSA). OSA patients with PTSD are thought to be less accepting and tolerant of CPAP therapy than their counterparts without PTSD. In a prospective observational study we discovered treatment of OSA is associated with a reduction in PTSD symptoms. In this sub-analysis we evaluate the effects of war era on PAP compliance.

**Methods:** Veterans with PTSD diagnosed in mental health clinics were enrolled if they had an apnea-hypopnea index (AHI) > 5/h and agreed to a trial of PAP therapy. Daytime sleepiness (Epworth Sleepiness Scale, ESS), sleep quality (Pittsburgh Sleep Quality Index, PSQI), functional outcomes (Functional Outcomes of Sleep, FOSQ), depression (Patient Health Questionnaire, PHQ-9), quality of life (QOL), and PTSD symptoms (PTSD checklist, PCL-S) were evaluated at baseline and three months. All subjects used autoPAP machines. Compliance was obtained by PAP download at 3 mo.

**Results:** The mean age of Vietnam and Gulf veterans respectively was 63.8 (± 5.5) and 41.7 (± 6.6), mean baseline AHI 27.6/h (± 16.4) and 20.9/h (± 23.6) (p = 0.333), and mean BMI 31.6 and 31.3 (p = 0.869). PTSD was not significantly more severe in Vietnam versus Gulf veterans (55.2 ± 15.3 vs. 64.3 ± 13.9, p = 0.059), but was more long-standing in Vietnam veterans. Sleep quality, depression, and functional outcomes were worse in Gulf veterans. There was no difference in ESS or QOL. Compliance with PAP therapy at 3 mo was better for Vietnam veterans, with overall more days used (81.2% vs 50.1%) and mean use 3.93 ± 2.7 h versus 2.13 ± 2.13 h (p = 0.016). Era independent of PCLS use [Y/N], and industry (i.e. blue collar industry [Y/N]). In a secondary analysis, patients with OSA were almost three times more likely (OR = 2.88, CI = 1.02–8.08, p-value = 0.045) to suffer from an injury likely related to reduced vigilance (e.g. falls or motor vehicle crashes) when compared to patients without OSA, but this again only trended to significance after controlling for confounders (OR = 2.42, CI = 0.085–6.93, p-value = 0.099)

**Conclusion:** Patients with OSA have increased rates of occupational injuries. Screening and treatment of workers with OSA may reduce rates of injury.

**Support (If Any):** CIHR (Sleep Disordered Breathing Team Grant), VCHR Scientist Award, BC Lung Association Operating Grant

**IS TRAVEL TIME BETWEEN HOME AND THE SLEEP CLINIC A BARRIER TO THE DIAGNOSIS OF OBSTRUCTIVE SLEEP APNEA (OSA)?**

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**Introduction:** We sought to determine whether patients with OSA are at increased risk of occupational injury (OI).

**Methods:** We recruited patients referred to the University of British Columbia Hospital Sleep Laboratory for suspected OSA (May 2003 to July 2011). This abstract represents an update of our data from a previous year (2008). Rates and types of validated OI (that caused at least one day of disability) in the five years prior to PSG were calculated by linking to claim data from the Workers Compensation Board. Adult patients who reported working > 10 hours per week were included.

**Results:** There were 1236 patients; 70% were male, median age = 49 yrs (IQR = 40, 55), median AHI = 15/hr (IQR = 7, 30), and 80% had OSA (AHI > 5). 111 suffered at least one OI. Patients with OSA were twice as likely (OR = 1.929, CI = 1.062–3.502, p-value = 0.031) to suffer at least one OI compared to patients without OSA. This association trended to significance (OR = 1.76, CI = 0.95–3.23, p-value = 0.075) after controlling for confounders, which included gender, BMI, alcohol use [Y/N], and industry (i.e. blue collar industry [Y/N]). In a secondary analysis, patients with OSA were almost three times more likely (OR = 2.88, CI = 1.02–8.08, p-value = 0.045) to suffer from an injury likely related to reduced vigilance (e.g. falls or motor vehicle crashes) when compared to patients without OSA, but this again only trended to significance after controlling for confounders (OR = 2.42, CI = 0.085–6.93, p-value = 0.099)

**Conclusion:** Patients with OSA have increased rates of occupational injuries. Screening and treatment of workers with OSA may reduce rates of injury.

**Support (If Any):** CIHR (Sleep Disordered Breathing Team Grant), VCHR Scientist Award, BC Lung Association Operating Grant
30–60 minutes away from the clinic, mean AHI were 20.2 (SD = 19.8), 23.1 (SD = 22.0), and 24.4 (SD = 22.1) respectively (p = 0.04 by ANOVA). After controlling for gender, age and education level, travel time remained a significant predictor of OSA severity (p ≤ 0.01). In the multivariate model, each increase in one minute of travel time was associated with an AHI increase of 0.15 events per hour.

Conclusion: Even moderate travel times are associated with the severity of OSA by AHI, and likely represent a barrier to OSA diagnosis. If the results can be verified in other centers, this may help to guide the planning process for the location of sleep diagnostic sleep centers within the health care system.

Support (If Any): CIHR (Sleep Disordered Breathing Team Grant), VCHRI Scientist Award, BC Lung Association Operating Grant

### 0423

**COSTS OF HOSPITALIZATIONS AND SURGICAL PROCEDURES FOR OBSTRUCTIVE SLEEP APNEA IN THE UNITED STATES, 2011**

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**Introduction:** We characterized costs and surgical procedures for obstructive sleep apnea (OSA) hospitalizations in 2011.

**Methods:** Information about hospitalizations with a first-listed discharge diagnosis of OSA (ICD-9-CM 327.23) was analyzed from the 2011 Nationwide Inpatient Sample, a 20% stratified sample from 1046 community hospitals in 46 states. National estimates of patient characteristics, surgical procedures, and total hospital costs were obtained with SUDAAN to account for complex sampling design.

**Results:** There were 10,073 estimated inpatient hospital discharges (3.2 per 100,000 persons) for OSA in 2011. Hospitalization rates for OSA were higher among males than females (p < 0.05) and blacks than whites (p < 0.05). Average total hospital cost for OSA was $8,844 with a mean stay of 3.1 days. OSA hospitalizations included 23.1% with palate surgeries ($10,060 average total cost), 42.4% with tonsillectomy and/or adenoidectomy ($7,128), 11.0% with other hypopharyngeal procedures ($10,910), 2.1% with maxillomandibular advancement ($28,891), 7.4% with septoplasty or nasal repairs ($8,485), and 2.9% with tracheostomy ($42,728), but 45.4% without any OSA-related surgeries ($7,932). In-hospital continuous positive airway pressure (CPAP) therapy ($11,953) was provided for 9.5% of patients. Over 40.4% of patients had ≥ 6 chronic conditions and 32.4% had major to extreme loss of function. Surgical procedures varied by age, sex, and race. Costs and in-hospital CPAP use increased and percentage having any OSA-related surgical procedures declined with increasing number of chronic conditions and functional loss. Morbid obesity (reported for 27.9% with any ICD-9-CM 278.01 or body mass index ≥ 40 kg/m²) was associated with higher costs, higher in-hospital CPAP use, and lower likelihoods of having any OSA-related surgical procedures.

**Conclusion:** Hospitalizations, inpatient surgical procedures, and costs for OSA varied by socio-demographic characteristics, number of chronic diseases, and morbid obesity. Our findings suggest that assessment of potential preventive strategies for non-surgical hospitalizations is needed.

### 0424

**OPIOID (NARCOTIC) ANALGESICS AND SLEEP DISORDERS: RESULTS FROM A NATIONALY REPRESENTATIVE US SAMPLE**

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**Introduction:** The increased use of opioid analgesics (OA) has been declared a public health concern in the US. OA are FDA approved for the treatment of acute and chronic pain. OA can contribute to multiple sleep-related problems including central apneas, ataxic breathing, decreased inspiratory effort in obstructive sleep apnea (OSA) and longer pauses during breathing, and life-threatening respiratory depression. Addition of CNS depressants such as benzodiazepines enhances the respiratory depressant effect of OA. We examined OA use in a nationally representative sample of patients with sleep disorders.

**Methods:** We examined all sleep-related patient visits from 1995–2010 in the National Ambulatory Medical Care Survey and National Hospital Ambulatory Medical Care Survey. Each patient visit is assigned upto 3 ICD9-CM diagnoses and upto 3 ‘Reasons for Visit’(RFV) (as per National Center for Health Statistics consensus). The ‘Sleep Disorders’(SD) variable included all patient visits with an ICD9-CM SD diagnosis or sleep-related RFV. All medications were coded using the Ambulatory Care Drug Database System (ACDDS); the ‘Opioid Analgesics’(OA) variable included ‘Narcotic Analgesics’(ACDDS class 191) and ‘Narcotic Analgesic Combinations’ (ACDDS class 191).

**Results:** There were 19,325 (representing an estimated 243,088,859 ± 124,504,325) patient visits (Mean ± SD age: 51.28 ± 1.27 years; 54.9% ± 2.2%, female) with SD; 70% ± 5.4% of SD were associated OA use (SD+OA group). There was a significant increase in the frequency of SD+OA during 2003–2010 versus 1995–2002: Odds ratio or OR = 1.85 (95% CI 1.37–2.49). The SD+OA group consisted of the following major SD: ‘OSA’ (ICD9-CM codes 780.57,327.23, R VF 1135.5): 20.3% ± 2.6%; ‘Insomnia’ (ICD9-CM code 780.52, R VF 1135.1): 57.1% ± 2.7%; ‘Sleep Disturbance’; (ICD9-CM code 780.50, R VF 1135.0): 14.7% ± 1.9%; ‘Hypersomnia’ (ICD9-CM code 780.54, R VF 1135.2): 4.7% ± 1.1%, and ‘Restless Legs Syndrome’(RLS) (ICD9-CM codes 333.94,333.99): 5.6% ± 0.9%. The following pain-related non-SD diagnoses were most commonly encountered in SD+OA: Lumbago (ICD9-CM code 724.2): 11.2% ± 2.0%, and Backache, unspecified (ICD9-CM code 754.5): 4.2% ± 0.8%. Benzodiazepines were used in 29.8% ± 1.9% of SD+OA.

**Conclusion:** There was an almost 2-fold increase in OA use in SD from 1995–2010, with only small minority having a comorbid painful condition (mainly backache). About 20% of SD+OA had OA, where OA use can have a significant detrimental effect, especially when used in conjunction with benzodiazepines. Insomnia represented the majority of SD+OA visits. The use of OA in RLS is consistent their known beneficial effect in RLS. These previously unreported findings have important clinical implications and provide leads for further research.
0425
SLEEP DISORDERED BREATHING AND INCIDENT HEART FAILURE IN OLDER MEN
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Introduction: The directionality of the relationship between sleep apnea (SA) and heart failure (HF) is controversial. We assessed whether obstructive or central SA (OSA or CSA) and Cheyne-Stokes Breathing (CSB) are associated with incident HF.

Methods: We conducted a prospective study of 2865 participants enrolled in the Osteoporotic Fractures in Men Study, a multi-center observational study of community-dwelling men aged 67 and older. Participants underwent baseline polysomnography and were followed for a mean of 8.0 years for development of incident HF, our primary outcome. Our main exposures were OSA defined using the obstructive apnea hypopnea index (examined by quartiles), CSA defined as central apnea index ≥ 5, and CSB defined by a minimum 10 minute period of crescendo-decrescendo respiratory pattern in a nadir of central apneas. Covariates included age, race, clinic site, body mass index, history of CAD, CHF, stroke, diabetes, hypertension, alcohol and tobacco use, and physical activity. Incident HF was defined as hospital admission to treat either increased intravascular volume, low cardiac output, or both.

Results: CSA and CSB, but not OSA, were each independently associated with incident HF (adjusted hazard ratio 1.79 [95% CI 1.16, 2.77] for CSA and 2.23 [95% CI 1.45, 3.43] for CSB). Additional adjustments for OSA, wake after sleep onset, atrial fibrillation, and hypoxemia did not appreciably change results. After excluding those with baseline HF, the risk of incident HF was somewhat attenuated and no longer significant for CSA (HR 1.57 [95% CI 0.92, 2.66]) but the association of CSB with incident HF remained significant (HR 1.90 [95% CI 1.10, 3.30]).

Conclusion: After adjusting for several potential confounders and mediators, CSA/CSB, but not OSA, are significantly associated with incident HF in a community-based cohort of older men.

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0426
PERSISTENT SNORING IS ASSOCIATED WITH CARDIOVASCULAR AND METABOLIC DISORDERS IN PREGNANT WOMEN
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Introduction: Prevalence of obesity is increasing in women of reproductive age, heightening the risk for sleep disordered breathing (SDB) in this young population. Pregnancy physiology adds to this risk, making pregnant women more susceptible to SDB. Though SDB has been linked to adverse pregnancy outcomes, it is not clear whether symptoms predating pregnancy are associated with a different set of outcomes compared to symptoms occurring de novo in pregnancy.

Methods: English-speaking women within 48 hours postpartum were recruited and screened for the frequency of snoring in the last three months of pregnancy, using a question from the multivariable apnea prediction index. Women rated their snoring as never, occasionally, sometimes, frequently or always. Pre-pregnancy body mass index (BMI) and BMI at delivery were collected. Pregnancy outcomes collected included preeclampsia, gestational diabetes, neonatal birth weight, gestational age at birth, and Apgar scores.

Results: Participants were 539 pregnant women enrolled in a study assessing outcomes of SDB in pregnancy. 114 women (21%) reported snoring only in pregnancy, and 77 women (14%) reported snoring both prior to and during pregnancy. T-tests were used to examine whether snoring groups differed on maternal characteristics, pregnancy, or infant outcomes. Results revealed that groups significantly differed on pre-pregnancy (t = −4.07, p < 0.001) and pregnancy BMI (t = −5.41, p < 0.001), such that persistent snorers had higher BMI both prior to and during pregnancy than women who snored only during pregnancy. There was a higher prevalence of chronic hypertension (p = 0.009), gestational diabetes (p = 0.01) and Cesarean deliveries (p = 0.01) in persistent snorers compared to de novo snorers. There were no significant differences in gestational hypertensive disorders or neonatal outcomes between the two groups.

Conclusion: Women with pre-pregnancy snoring were more obese, had a higher prevalence of cardiovascular and metabolic disorders, and higher rates of Cesarean deliveries compared to those who started snoring in pregnancy.

0427
OBSTRUCTIVE SLEEP APNEA AND OXIDATIVE STRESS IN RELATION TO OBESITY AND CARDIOVASCULAR DISEASE
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Introduction: Oxidative stress is implicated in cardiovascular disease (CVD) and related to obstructive sleep apnea (OSA); however, inter-relationships of oxidative stress with obesity and cardiovascular risk in OSA remain unclear. We hypothesize OSA and oxidative stress are related and modified by obesity and CVD.

Methods: Data were collected from the baseline visit of a randomized control trial: Oxidative Stress in Sleep Apnea and Cardiac Disease (NCT00607893). Linear regression was used to examine OSA (Apnea-Hypopnea Index (AHI), 3% desaturation) and oxidative stress biomarkers: anti-oxidants: arylesterase (nmol/min/mL), paraoxonase 1 (PON1, nmol/L) and pro-oxidant: oxidized LDL (Ox-LDL, U/L) adjusted for age, sex, race, body mass index (BMI), diabetes mellitus and CVD. Biomarkers were logarithm transformed before analysis and back-transformed for presentation. Binary AHI (≤ / > 30) was used to compare the difference of biomarkers across categories. Interactions between AHI and BMI (dichotomized at 30 kg/m²) and CVD were tested and stratified analyses performed.

Results: 147 participants constituted the final analytic sample (age = 51.1 ± 11.8, 52.4% Caucasian, BMI = 37.2 ± 8.2 kg/m²). There
were no significant associations of OSA and oxidative stress measures in linear models. However, in those with an AHI < 30, there was a significant increase in arylesterase (p = 0.002, 1.45 ± 0.46 nmol/min/mL). A significant OSA-obesity interaction was observed in relation to arylesterase (p = 0.02) with a significant increase of arylesterase with increasing AHI in those with BMI > 30 kg/m² (p = 0.01, 0.35 ± 0.13 kg/m²). A significant OSA-CVD interaction in relation to Ox-LDL was noted (p < 0.001); those with CVD had a stronger positive association of AHI and Ox-LDL (p < 0.001, 0.51 ± 0.12 U/L).

Conclusion: No significant association of OSA and oxidative stress was observed in linear models. A threshold effect was observed for arylesterase suggesting augmented anti-oxidant activity at lower AHI levels. Obese individuals demonstrated a stronger association of increasing AHI and increasing anti-oxidant function and those with CVD may be more susceptible to OSA-related increases in Ox-LDL.

Support (If Any): Supported by National Heart Lung Blood Institute K23HL079114, NIH HL079114, NIH HL09493 (RM) and NIH HL08226, Clinical and Translational Science Collaborative of Cleveland, UL1TR000439 from the National Center for Advancing Translational Sciences (NCATS) component of the National Institutes of Health and NIH roadmap for Medical Research.

0428
SIX-MINUTE WALK TEST IN SEDENTARY BUT FUNCTIONALLY APT COMMUNITY-DWELLING ELDERLY ADULTS WITH OBSTRUCTIVE SLEEP APNEA: A CROSS-SECTIONAL STUDY
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Introduction: Obstructive sleep apnea (OSA) is associated with decreased vitality and poor physical performance. In the elderly, this may be secondary to obesity, age-related musculoskeletal decline, or to OSA-related impairment. We hypothesized that, in elderly individuals with complete independence, OSA severity correlates with the distance covered in the six-minute walk test (6MWT).

Methods: We recruited 65 to 80 year-old individuals in the community by telephone call. If they had risk for OSA in the STOP questionnaire, they were assessed. Exercise was well tolerated. The physical performance in the six-minute walk test is independent of OSA severity in elderly individuals without physical impairment. This preliminary result allowed calculating a sample size of around 400 volunteers to reach a power of 80% in accepting the null hypothesis.

Support (If Any): FIPE/HCPA, FAPERGS

0429
ETHNIC DISPARITIES IN THE SEVERITY OF OBSTRUCTIVE SLEEP APNOEA IN A NEW ZEALAND BASED POPULATION ACCESSING SLEEP SERVICES
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Introduction: Little is known about the ethnic distribution of patients seeking referrals for obstructive sleep apnoea in New Zealand. Understanding the ethnic differences in sleep apnoea is important for improving and targeting health delivery in minority groups. The aim of this study was to investigate the anatomical, objective and subjective sleep differences in the various ethnic populations accessing sleep services in Christchurch, New Zealand.

Methods: A retrospective review (March 2010–November 2014) of all Christchurch based sleep assessments (specialist review + overnight oximetry) was performed (n = 3497). AHI was assessed according to their ethnicity. Ethnicities with < 1% representation were grouped. ANOVA was used to identify differences in age, BMI, Epworth Sleepiness Scale (ESS) and oxygen desaturation index (ODI). Sampled ethnicity data was compared to expected ethnic distribution in Christchurch census data (2013).

Results: Of the whole group, the median age of referral was 52 years (15–90 range). The majority of patients identified as being European (87.1%), followed by Maori (6.3%), Asian (2.4%), Pacific Islander (2.2%) or other (1.9%). Significant ethnic differences were found in the BMI, with Pacific Islanders having the highest at 40.1, followed by Maori (37.0), European (32.7) and Asian (27.8) (p < 0.0001). The Pacific Islander group were the most severe in terms of ODI (32.6) being significantly higher than the Maori (19.3) and European (14.4) groups (p < 0.0001). Pacific Islanders and Maori scored similar on the ESS (13, 12), and were significantly higher than all other ethnic groups (p < 0.0001).

Conclusion: Based on the Christchurch census data the Pacific Islander, Maori and Asian ethnic groups are underrepresented in sleep assessments. Despite this disproportion, both the Pacific Islanders and Maori patients were more likely to be obese and have worse sleep apnoea than Europeans and Asians. This indicates the need to improve referral targeting and sleep health in these minority populations.

0430
CHARACTERISTICS OF SLEEP DISORDERED BREATHING IN EXTREME OBESITY
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Introduction: Extreme obesity, a body mass index (kg/m²) of 40 or higher, is associated with heart disease, hypertension, diabetes mellitus, arthritis and sleep disorders. This study examines a cohort of patients with extreme obesity (BMI ≥ 40).

Methods: 140 adult patients had diagnostic sleep studies (portable or facility-based) between Jan to Oct 2014 (1100 ft elevation). This study was approved by the Mayo Clinic IRB.

Results: The cohort included 75 men and 60 women age ranging from age 18–81. The patients were stratified by BMI 40–44 (92 patients), 45–49 (37), 50–54 (9), 55–59 (3) and ≥ 60 (3) with the highest BMI being 69.5. Data concerning medication usage are being analyzed. OSA was defined as follows: mild AH1 5–14, moderate 15–29 and severe ≥ 30. Overall 95% of patients had OSA. 100% had OSA of patients with a BMI ≥ 45. Continuous positive airway pressure or bilevel airway pressure was the most frequently used treatment. Complex sleep apnea was identified in only 4 patients (BMI 44–47). These patients were placed on adaptive servoventilation. Venous CO₂ data were available.
for only 5 patients. Transcutaneous CO₂ data were not available. Fifty-five patients (38%) had an oxygen saturation nadir < 80% (minimum 56%). Only five patients in this cohort received supplemental oxygen during polysomnography.

Conclusions: Markedly high rates of obstructive sleep apnea were observed in this population of patients with extreme obesity. Complex sleep apnea appeared to be uncommon. The rate of obesity hypoventilation could not be determined based on the available data. Clinicians working with patients with extreme obesity need to screen patients for possible sleep disordered breathing. Especially for patients with an AHÍ > 45 a diagnostic sleep study is highly recommended. Going forward transcutaneous (or equivalent) monitoring of carbon dioxide to detect hypoventilation needs to be strongly considered to detect possible hypoventilation. Medications with the potential to compromise ventilation also need attention.

0431 DIFFERENCES IN SF-36 BETWEEN MEN AND WOMEN DIAGNOSED WITH OBSTRUCTIVE SLEEP APNEA

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Introduction: Men and women with obstructive sleep apnea (OSA) may present differently to the sleep clinic, with women being more likely to complain of insomnia, headache, irritability, and fatigue than symptoms of loud snoring and breathing cessation during sleep. OSA can have a negative impact on quality of life (QOL), and men and women may be affected in different QOL domains.

Methods: Prospective observational single-center study. Men and women 21 years or older, diagnosed with OSA by polysomnography, were enrolled prior to starting CPAP treatment. Baseline QOL was determined by a self-administered Short-Form Health Survey (SF-36), which assesses eight different domains, and the Epworth Sleepiness Scale (ESS) was used to assess daytime sleepiness. The Mann Whitney U was used to compare independent continuous variables between men and women.

Results: Twenty-four men and 24 women were enrolled. Mean age and BMI at enrollment was similar for both men and women respectively (age 45 [37–54] vs 44 [38–49] years; p = 0.99, and BMI 34 [30–39] kg/m² vs 33 [26–37] kg/m²; p = 0.44). AHÍ was greater for men than women (34 [18.9–39] vs 21 [13–23]; p = 0.007). There was no significant difference in enrollment ESS scores (10 [6–12] vs 11 [6–14]; p = 0.38). Women had lower scores in two domains of the SF-36: social function (63 ± 27; p = 0.02).

Conclusion: Despite similarities between men and women in the degree of sleepiness according to ESS and men having higher AHÍs than women, women with OSA demonstrated worse scores in two domains of the SF-36. This suggests that there may be other contributors to QOL that affect women with OSA more than men with OSA.

0432 URIC ACID LEVELS RELATED TO OBSTRUCTIVE SLEEP APNEA SYNDROME IN PATIENTS WITH HYPERTENSION FROM XINJIANG OF CHINA

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Introduction: Recurrent apnea and hypoxia, which is associated with obstructive sleep apnea syndrome (OSAS), leads to an increase in the degradation of adenosine triphosphatase (ATP) into xanthine, which in turn increases uric acid (UA) concentrations. The study aimed to determine whether an association exists between UA levels and OSAS in patients with hypertension from Xinjiang, China.

Methods: A total of 1893 hospitalized patients with hypertension who firstly attended Hypertension Center of Xinjiang from 2006 to 2012 were consecutively recruited, all subjects underwent polysomnography recordings for OSAS diagnosis, blood pressure assessment, and biochemical blood analysis.

Results: The mean age of patients with hyperuricemia was younger than that in controls [(45.5 ± 10.2) yr vs.(47.8 ± 10.1) yr, P < 0.001 in whole population; (44.9 ± 9.9) yr vs.(46.1 ± 9.7) yr, P = 0.035 in males] respectively. Adjusted for age, body mass index, blood pressure, the patients with hyperuricemia presented shorter deep sleep time but greater AHÍ, mean oxyhemoglobin saturation (SpO₂), frequency of SpO₂ decreased ≥ 4% and ≥ 5%, and light sleep time. The UA levels significantly increased with the severity of OSAS in whole population and in males, but in females, the lowest level of UA was detected in patients with mild OSAS. Further analysis indicated that waist circumference (WC) displayed lower level in female patients with mild OSAS than those without OSAS. Importantly, AHÍ and age were significant contributing factors of UA levels in males by stepwise linear regression. While in females, the WC, besides of AHÍ and age, played as significantly predictor of UA level [β = 1.32 (0.76–1.88), P < 0.001] regardless of OSAS status.

Conclusion: A strong association was found between UA levels and OSAS in a large number of hospitalized patients of Xinjiang. Although it does not qualify for a biomarker alone, besides of obesity, UA levels may be involved in OSAS severity and should be considered in sleep apnea management in the future.

0433 PSYCHOSOCIAL AND SLEEP CHARACTERISTICS IN COMORBID INSOMNIA AND SLEEP APNEA

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Introduction: Comorbid insomnia and sleep apnea (CIO) is increasingly recognized as a highly prevalent comorbidity. However, little is known about the characteristics of this phenotype and the potential similarities and differences between CIO and the individual disorders. Our aim was to compare psychosocial and sleep characteristics of those with CIO, insomnia only (INS), and obstructive sleep apnea only (OSA).

Methods: 155 community-dwelling adults (mean age 59.8 ± 9.0, 67% female) with and without a lifetime history of depression underwent polysomnography (PSG) and completed 7–14 days of actigraphy (mean days 9.1 ± 1.6) and sleep diaries (mean days 9.8 ± 1.8). Participants underwent a structured clinical interview to assess for psychiatric and sleep disorders and severity of current depressive symptoms (Hamilton Rating Scale for Depression). Participants also completed questionnaires about sleep quality (Pittsburgh Sleep Quality Index (PSQI)), sleep disturbance and sleep-related impairment (Patient Reported Outcomes Measurement Information Systems (PROMIS)), daytime sleepiness (Epworth Sleepiness Scale), fatigue (PROMIS fatigue), perceived stress (Perceived Stress Scale), and social support (Interpersonal Support Evaluation List-12). ANCOVA controlling for age and current major depressive episode with post hoc comparisons were conducted.
in 17 INS (based on DSM-IV criteria for primary insomnia), 50 OSA (apnea-hypopnea index ≥ 5 without INS), and 10 CIO.

Results: There were no differences among the 3 groups on diary-, actigraphy-, and PSG-measured sleep parameters, PSQI, daytime sleepiness, fatigue, and social support. The INS group reported significantly greater PROMIS sleep disturbance and sleep-related impairment than the OSA group. Compared to the OSA group, the CIO group had greater PROMIS self-reported sleep disturbance (p = 0.08) and the INS group (p = 0.09) endorsed greater perceived stress (not statistically significant, largely due to small sample sizes).

Conclusion: Those with CIO appear to have psychosocial and sleep characteristics that are similar to those with INS and OSA, with the exception of self-reported sleep disturbance, which was similar to those with INS and tended to be worse than those with OSA.

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0434
RELATION OF CARDIAC ARRHYTHMIAS TO HYPOXIC TIME AND LOWEST OXYGEN SATURATION IN PATIENTS WITH OBSTRUCTIVE SLEEP APNEA IN AN ASIAN CONTEXT: A SINGAPORE SLEEP CENTRE STUDY
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Introduction: Cardiac arrhythmia is an established association of obstructive sleep apnoea (OSA). However, the utility of hypoxic time as a predictor of cardiac arrhythmia in patients with OSA is not well described. This study aims to evaluate the relationship of cardiac arrhythmias with hypoxic time during polysonography in patients with OSA at an academic medical centre.

Methods: Retrospective chart reviews of 117 patients with cardiac arrhythmia diagnosed with OSA during overnight in-laboratory polysomnogram from January 2011 to December 2012 were performed. Prediction performance of hypoxic time when lowest oxygen saturations (Lsat) were < 85% and < 90% were analyzed using receiver operating characteristic (ROC) curve from a univariable logistic model. A cut-off point which achieved best sensitivity and specificity was obtained. Log transformation was used to reduce the skewness of hypoxic time.

Results: Age (p < 0.001), BMI (p = 0.001), Apnoea-Hypopnoea Index (p = 0.003), Lsat (p = 0.001) and hypoxic time when Lsat < 85% (p = 0.002) and < 90% (p < 0.001) were significantly associated with incidence of cardiac arrhythmias. When Lsat < 85%, hypoxic time cut-off of 251 s had 64% sensitivity and 50% specificity of predicting cardiac arrhythmia (area under ROC curve, AUC = 0.59). When Lsat < 90%, hypoxic time cut-off of 794 s had 63% sensitivity and 53% specificity (AUC = 0.59). Therefore, the sole utilization of hypoxic time as predictor of cardiac arrhythmia showed poor performance. Prediction performance was better when age and BMI were included in a multivariable model (AUC = 0.7, aOR = 1.22, p = 0.11 when Lsat < 85%; and AUC = 0.69, aOR = 1.25, p = 0.097 when Lsat < 90%).

Conclusion: Although hypoxic time when Lsat < 85% and < 90% were significantly associated with cardiac arrhythmia, using hypoxic time as sole predictor of arrhythmia produced poor results. However, when age and BMI are taken into consideration, hypoxic time is a good predictor of cardiac arrhythmia.

0435
ASSOCIATION OF SLEEP DISORDERED BREATHING WITH EMOTIONAL COMPLAINTS AND ANTHROPOMETRIC PARAMETERS (RESULTS OF THE SCREENING SURVEY IN RESIDENTS OF ST. PETERSBURG)
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Introduction: Sleep disordered breathing (SDB) are widespread in population and affect everyday life. We studied correlation of SDB symptoms with emotional complaints, anthropometric and lifestyle characteristics in a representative sample of residents of the large metropolis (St. Petersburg, Russia).

Methods: Cross-sectional analysis of the interview and anthropometric methods in survey of 358 residents of St. Petersburg at the age of 21–68 years. We evaluated frequency of sleep disorder breathing (snoring, apneas in breathing during sleep), emotional complaints, body mass index, lifestyle characteristics. 21.5% of respondents (mostly women, 25.9% vs 14.2%, p < 0.05) did not answer the question about symptoms of SDB. So the data were analyzed by 281 respondents, 115 men and 166 women.

Results: Prevalence of regular snoring was 29.6% in men and 22.9% in women. Frequency of snoring increased with age only among women (r = 0.21, p < 0.01). The presence of apnea episodes reported 14.3% of respondents. Snoring was associated with obesity: body mass index (r = 0.26; p < 0.001) and waist circumference (r = 0.24; p < 0.001). There were no relationships between the frequency of apnea episodes and obesity. Frequency of snoring was associated with sleepiness (r = 0.21, p = 0.001). Severity of emotional intensity (r = 0.24, p < 0.001), depression (r = 0.20, p < 0.01), frequency of bruxism episodes (r = 0.18, p < 0.01) and waking up with feeling of heaviness in the chest (r = 0.17, p < 0.01). Frequency of apnea episodes correlated with fatigue after a night’s sleep (r = 0.16, p < 0.01), frequency of awakenings with heaviness in the chest (r = 0.17, p < 0.01), and frequency bruxism episodes (r = 0.16, p = 0.01). There were no associations between SDB and lifestyle.

Conclusion: Quarter of the adult residents of St. Petersburg have symptoms of SDB associated with general reduce in the quality of sleep, emotional and dissomnia complaints, as well as the prevalence of obesity.

Support (If Any): Russian Humanitarian Fund №14-06-00219

0436
ARE OBESITY, SLEEPINESS, AND SLEEP APNEOA SEASONAL?
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Introduction: Paediatric sleep apnoea (OSA) prevalence shows winter seasonality correlated with respiratory infections. We recently found spring and fall peaks in obesity and sleepiness, but not OSA risk or severity in a large subset (N = 1011) of mostly adult patients undergoing replicated home diagnostic sleep polygraphy. Our aim was to confirm these adult seasonal findings using our complete database.

Methods: Of 37 489 subjects referred for home sleep polygraphy interpretation (Remmers Sleep Recorder, Sagatech Electronics, Ltd., Calgary, Alberta, Canada; www.sagatech.ca) 37 363 diagnostic studies had complete demographics. Run sequence plots of body mass index (BMI), Epworth sleepiness scale (ESS), pre-test OSA probability (derived from adjusted neck circumference), and estimated respiratory
I. Sleep Disordered Breathing

Weisfogel G, Patel A

Garcia D, Abreu A, Ramos A

vs. 31.1 ± 24.9). Weight range in the Hispanics was more homogenous.

There a difference?

295.44 ± 92.1), BMI (42.9 ± 6.6 vs 47.8 ± 11) and AHI (28.89 ± 25.9

B. Clinical Sleep Science

Conclusion: After expanding from 1 000+ to 37 000+ subjects we could not replicate seasonality in obesity, sleepiness, OSA risk, or OSA severity.

Support (If Any): RCPSC and MITACS

0437

HISPANICS AND NON-HISPANICS WITH OBSTRUCTIVE SLEEP APNEA UNDERGOING BARIATRIC SURGERY: IS THERE A DIFFERENCE?

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Introduction: Obesity represents one of the most important risk factors for the development of Obstructive Sleep Apnea (OSA) and studies have reported that weight gain was associated with an increase in the odds of developing OSA as high as a 6-fold increase. Our study aims to evaluate possible differences between Hispanic and non-Hispanics in regards to the development of OSA.

Methods: This is a cross-sectional analysis of 147 consecutive adult patients, who were evaluated for bariatric surgery and underwent attended polysomnography (PSG) from June 2011–December 2013 at a tertiary referral center. The variables of age, sex, ethnicity, AHI, RDI, BMI, weight and type of surgery were obtained from the electronic medical record. Chi-square and student t-test were used to compare proportions and means respectively. We then generated bivariate descriptive statistics for the overall analytic sample and the outcomes of interest.

Results: Of the 147 patients, 81 underwent bariatric surgery (78.2% were female). Hispanic population accounted for 53%. Mean age was similar in both groups (45.7 ± 8.3 in hispanics and 45.3 ± 10.7 in the non-hispanics). Hispanics had lower mean weight (250.5 ± 46.6 lbs vs 295.44 ± 92.1), BMI (42.9 ± 6.6 vs 47.8 ± 11) and AHI (28.89 ± 25.9 vs. 31.1 ± 24.9). Weight range in the Hispanics was more homogenous (198–390 lbs vs. 206–687 lbs). Of the total population, the severity of OSA was mild in 20.7% (hispanics/non-hispanics 14/23.7%), moderate in 37.9% (hispanics/non-hispanics 39.5/36.8%) and severe in 41.4% (hispanics/non-hispanics 46.5/39.5%). Gastric bypass was the preferred option in the non-hispanics (68.4% vs. 53.5% in the Hispanics).

Conclusion: Although it appears that Hispanic patients undergoing bariatric surgery had lower BMI than the non-hispanics, the percentage of them with moderate and severe OSA appears to be higher. Further studies are recommended in order to determine such discrepancies in the Hispanic population suffering for OSA.

0438

SLEEP DISORDERED BREATHING: SCREENING AND TREATMENT SUCCESS RATES IN A CARDIOLOGY PRACTICE

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Introduction: Sleep Disordered Breathing (SDB) is estimated to be present in 30–60% of patients seen in cardiovascular practices yet many of these patients are not treated or even identified. A screening and aggressive treatment program for SDB was integrated into a cardiology practice to assess the prevalence, testing success rates, treatment options chosen, adherence to treatment, and clinical improvement in this select population.

Methods: Consecutive patients presenting for cardiovascular assessment over a 3 month period were screened for SDB via a survey which included questions about neck circumference, snoring, excessive daytime sleepiness, Epworth sleepiness scale, history of hypertension, congestive heart failure, and atrial fibrillation. If the results suggested SDB, the patients were tested with either home sleep tests or nocturnal polysomnograms. Patients diagnosed with SDB from these test were then treated with either CPAP or dental oral appliances and were followed for a minimum of 6 months to determine adherence to treatment and change in clinical status.

Results: 256 consecutive patients were surveyed with 116 (46%) being tested for SDB based on positive responses to the survey. 83/116 (72%) were diagnosed with SDB requiring treatment. 58 patients were treated with CPAP and 11 patients with a dental appliance. Thus 69/83 (83%) of patients diagnosed with SDB were treated. 50/69 (72%) of treated patients were compliant for a minimum of 6 months and 45/69 (65%) had clinical improvement.

Conclusion: SDB is highly prevalent in patients seeing cardiologists. An aggressive screening and treatment program for patients with SDB can be integrated into cardiology practices resulting in identifying and treating these patient, with high treatment compliance rates and clinical improvement in the majority of this select population.

0439

HIGHER PREVALENCE OF SNORING IN HIGH RISK GROUP FOR COPD: AN SURVEILLANCE IN AGED JAPANESE POPULATION

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Introduction: Previous data indicated that sleep disordered breathing (SDB) is one of complications of chronic obstructive pulmonary disease (COPD), and that continuous positive airway pressure (CPAP) improved their prognosis. Controversially, weight loss, which is frequently observed in COPD patients, is associated with the lower prevalence of SDB. The aim of this study is to elucidate whether or not prevalence of snoring is higher in high risk group for COPD by surveillance of aged Japanese population.

Methods: A cross sectional study was conducted on 13,595 participants, using the data from Japan Gerontological Evaluation Study (JAGES) 2013 to investigate that SDB increased in a COPD high risk group. International Primary Care Airways Group (IPAG) questionnaire, which consists of 8 questions, was partially administered to identify COPD high risk individuals, as 6 of their 8 questions were in JAGES 2013 questionnaire. According to the partial IPAG scores, the participants were divided into three groups on tertiles. Participants were stratified by sex and body mass index (BMI). Multivariate logistic analyses were performed with adjustment of education history and drinking history. All the statistical analyses were performed, using SAS ver 9.4 (SAS Institute Inc. Cary, NC).

Results: Our results demonstrated that odds ratios (OR) for snoring were significantly higher in participants with higher IPAG scores: OR was 1.55 (95% C.I. = 1.29 to 1.88, p < 0.0001) in the 3rd tertile in participants whose BMI is less than 22, while OR was 1.22 (95% C.I = 1.07 to 1.39, p = 0.003) among those whose BMI was 22 or higher, in comparison with the 1st tertile. On the other hand, OR was not comparable between the same tertiles in 2 groups of women. Our study also showed that education history did not affect snoring, while the odds ratio for snoring was significantly higher in participants who had drinking history.
Conclusion: In aged Japanese population, those who had higher risk for COPD were likely to snore. BMI was positively associated with SDB and inversely COPD. After stratification, our results indicated that COPD and SDB shared several common risks, including smoking and age.

Support (If Any): This study used data from the Japan Gerontological Evaluation Study (JAGES), conducted by the Nihon Fukushi University Center for Well-being and Society as one of their research projects.

0440 UNCOVERING THE SLEEP DISORDERS AMONG YOUNG DOCTORS
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Introduction: Introduction: Sleepiness and tiredness are common complaints among young doctors. Sleep deprivation is believed to be the main culprit. However we believe that occult obstructive sleep apnea (OSA) may contribute to these symptoms.

Methods: Methods: A prospective cross-sectional study was performed among young doctors working at King Chulalongkorn Memorial Hospital, Thailand and Hospital Kuala Lumpur, Malaysia. The study was conducted from January to September 2014. The objectives of this study were the evaluations of prevalence of OSA, OSAS, sleep deprivation, excessive daytime sleepiness (EDS), tiredness, and perception of not enough sleep as well as their predictors. All the subjects were required to answer a questionnaire and undergo a portable sleep test (ApneaLink Plus) for one night.

Results: Results: Total of 52 subjects completed the study. Mean age was 31.3 ± 4 years. There was equal gender distribution. Sixty-one percent were Thai and 39% were Malaysian. The mean body mass index was 23.3 ± 3.6. The prevalence of OSA was 40.4% and for OSAS was 5.8%. One third of OSA subjects were at least moderate OSA. Prevalence of sleep deprivation, EDS, tiredness, and perception of not enough sleep were 44.2%, 15.4%, 65.4%, and 61.5%; respectively. Snoring, male sex, and perception of not enough sleep were significant predictors for OSA with the odd ratio of 34.5 (p = 0.016, 95% CI = 1.92–619.15), 18.8 (p = 0.001, 95% CI = 3.10–113.41), and 7.4 (p = 0.037, 95% CI = 1.13–48.30); respectively. Only observed apnea was a significant predictor for OSAS with odd ratio of 30.7 (p = 0.012, 95% CI = 2.12–442.6). OSA was a significant predictor for tiredness and perception of not enough sleep with the odd ratio of 4.8 (p = 0.036, 95% CI = 1.11–20.72) and 4.5 (p = 0.022, 95% CI = 1.24–16.59); respectively.

Conclusion: Conclusion: Our result demonstrated relatively high prevalence of OSA and OSAS among young doctors. OSA was noted to be a significant predictor for tiredness and perception of not enough sleep.
assessed a total of 1,042 volunteers, aged 20–80 years at the time of their enrollment in EPISONO, for OSAS and hormonal parameters. OSAS diagnosis was defined according to International Classification of Sleep Disorders (ICSD-2).

**Results:** OSAS was significantly associated with higher levels of TSH compared to healthy subjects, even after correction for age, gender, body mass index, medication, and social class. For cortisol, OSAS led to a decrease in its concentrations only in women. No relevant changes were observed for prolactin levels. Binary logistic regression model showed that OSAS was associated with 77% increased risk for increase in TSH levels, after control for confounders.

**Conclusion:** The marked increase in TSH levels found in both men and women with OSAS and the decrease in morning cortisol observed only in women with OSAS could have a negative impact on health, including possible metabolic dysfunction. These findings provide additional understanding of the influence of this sleep breathing disorder on endocrine function considering gender differences.

**Support (If Any):** Associação Fundo de Incentivo à Pesquisa (AFIP), São Paulo Research Foundation (FAPESP) #2014/15259-2 to C.H and CNPq.

### 0443 HIGH INCIDENCE OF OBSTRUCTIVE SLEEP APNEA NOTED IN AN OLDER POPULATION PRESENTING FOR COGNITIVE BEHAVIORAL THERAPY FOR INSOMNIA (CBTI) TREATMENT
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**Introduction:** Chronic insomnia includes difficulty falling or staying asleep and is increasingly treated by psychologists with cognitive behavioral therapy for insomnia (CBTI). Unrefreshing sleep with frequent nocturnal awakenings can also occur in obstructive sleep apnea (OSA). The incidence of sleep apnea in CBTI populations is not well characterized and may impact proper referrals.

**Methods:** A retrospective chart review was performed of 110 patients presenting with chronic insomnia from October 2013 to October 2014 who enrolled in CBTI with a sleep physician at a community-based clinic. Those patients with prior diagnoses of OSA with apnea-hypopnea index (AHI) > 5 were identified. Additional subjects with symptoms—excessive daytime sleepiness, snoring, nocturia, and bruxism—and signs suggestive of OSA were recommended to have diagnostic sleep studies.

**Results:** The population consisted of 65% women (71 subjects) and 35% men (39 subjects). The average age was 61.09 years (ranging from 20 to 90 years). The average body mass index (BMI) was 27.95. The average Epworth sleepiness scale score at presentation was 6.74. OSA was present by testing in 67.3% of the population (74 subjects) and 30.9% (34 subjects) had a new diagnosis made. Recommended testing based on clinical suspicion was deferred in 19.1% (21 subjects). Only 9.1% (10 subjects) had a negative sleep study and an additional 4.5% (5 subjects) were not suspected of having sleep apnea based on clinical assessment.

**Conclusion:** Obstructive sleep apnea is very common among older patients presenting with insomnia complaints for CBTI. Contrary to popular understanding, these patients may not be obese and may have a normal Epworth score. Given the high incidence of comorbid sleep apnea, older patients with insomnia should be evaluated by a board-certified sleep physician for symptoms or signs suggestive of sleep apnea and undergo routine diagnostic evaluation.

### 0444 SLEEP APNEA AND RISK OF RECURRENT CORONARY HEART DISEASE EVENTS IN THE SLEEP HEART HEALTH STUDY
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**Introduction:** Sleep apnea (SA) is characterized by intermittent hypoxia (IH) followed by re-oxygenation. Ischemic preconditioning occurs with atherothrombotic coronary occlusion and associated myocardial ischemia/hypoxia that are transient, with rapid re-perfusion and re-oxygenation. Such temporary ischemia stimulates coronary collateral formation and cellular changes that combine to make cardiomyocytes less susceptible to acute ischemic injury. The similarities between SA-induced IH and ischemic preconditioning led us to propose that SA could have a cardioprotective influence. We examine the relationship between SA and recurrent coronary heart disease events.

**Methods:** Of 5025 SHHS participants with complete data on baseline cardiovascular disease status, a total of 306 men and 134 women had a previous myocardial infarction (MI) or coronary revascularization procedure at the time of baseline polysomnography. Mean age was 69.6 (SD 10.3) years, mean BMI 27.8 (SD 4.9) kg/m2. During a mean follow-up of 9.0 (SD 3.7) years, 68 (15.5%) participants had a MI and 130 (29.6%) had MI or a coronary revascularization procedure. OSA was quantified as the apnea-hypopnea index (AHI), where both apneas and hypopneas were associated with a 4% or greater fall in SaO2. Logistic regression models were used to examine the association of AHI with the occurrence of MI or revascularization procedure, adjusting for age, sex and BMI.

**Results:** In this sample with prevalent coronary heart disease at baseline, the risk of a recurrent coronary heart disease event (MI or need for coronary revascularization) decreased with increasing severity of OSA. For every 10 events/hour increase in AHI, there was a 24% decrease in the risk of MI or revascularization (adjusted odds ratio 0.76, 95% CI 0.62–0.93, p = 0.008).

**Conclusion:** Among community dwelling individuals with prevalent coronary heart disease, SA is associated with a reduced risk of recurrent non-fatal coronary heart disease events. Further work is required to replicate and characterize this association.

### 0445 NEIGHBORHOOD WALKING ENVIRONMENT AND ACTIVITY LEVEL ARE ASSOCIATED WITH SLEEP APNEA: THE MULTI-ETHNIC STUDY OF ATHEROSCLEROSIS
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**Introduction:** The neighborhood built environment has been associated with obesity, diabetes, and cardiovascular disease, all of which are also associated with obstructive sleep apnea (OSA). Neighborhood disadvantage has been associated with OSA in children, but has not been examined in adults. Neighborhood walkability may contribute to OSA by promoting obesity, sedentary habits and limiting physical activity. Walking improves peripheral edema thereby reducing rostral fluid redistribution. We hypothesize that neighborhood walkability will be as-
associated with OSA and that this association will be partially explained by both obesity and activity level.

**Methods:** Data were analyzed from the 10-year follow-up exam of the Multi-Ethnic Study of Atherosclerosis (MESA), a community-based 6-center cohort study. Ratings of walking environment (WE) for one mile around the home were assessed in a questionnaire administered to willing MESA participants and to a random community sample that resided in the same neighborhoods. A subgroup of MESA participants underwent in-home polysomnography and 7-day wrist actigraphy. From the actigraphy data, activity counts during active (wake) intervals were extracted. We evaluated the association of neighborhood WE survey scale with apnea hypopnea index (AHI), adjusting for age, gender, site, race, comorbidities and neighborhood socio-economic status. We examined if obesity and actigraphy activity level attenuated these associations.

**Results:** 1,896 MESA subjects were studied (mean age 68.5 ± 9.1 years, BMI 28.6 ± 5.5 kg/m²; 36% white, 12% Chinese-American, 28% black and 24% Hispanic). The median AHI was 14 (6, 27 IQR). Neighborhood WE was associated with OSA severity; AHI was 2.5 higher in the lower walking environments, (95% CI: −4.2, −0.3; p < 0.026). This association was not attenuated by BMI or activity level, although both were also associated with AHI.

**Conclusion:** Poor neighborhood walking environment and lower activity level are associated with more severe OSA. This association is not explained by obesity.

**Support (If Any):** R01HL098433 (PI Redline) MESA-SLEEP, R01 HL071759 MESA-Neighborhood (PI Diez Roux), MESA is supported by N01-HC-95159 through N01-HC-95169 from the National Heart, Lung and Blood Institute and by grants U11-TR-000040 and U11-TR-001079 from NCRR

0446

APNEA DURATION AND INTER-APNEA INTERVAL AS PREDICTORS OF MORTALITY IN A PROSPECTIVE STUDY

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**Introduction:** Obstructive sleep apnea (OSA) is a risk factor for stroke, heart disease, and death. The physiological links between these may be repetitive hypoxemia, mechanical stresses of obstructed breathing, and altered autonomic activity. These factors all vary through the night, depending on sleep stage, posture, time of night, and severity of the event. Despite this variability in events, diagnosis and treatment recommendations rest predominantly on the apnea-hypopnea index (AHI), number of events per hour of sleep. Therefore, we tested whether measures that better reflect individual apneas, including their duration and their clustering, might better predict future mortality.

**Methods:** Annotated scoring records and outcomes data from the Sleep Heart Health Study were obtained from the National Sleep Research Resource. Average event duration was calculated across apneas and hypopneas in all sleep stages. Inter-event intervals were calculated within blocks of uninterrupted NREM or REM sleep. Variability in apnea occurrence was modeled as the coefficient of variation of the inter-event intervals. Cox proportional hazard models were constructed to assess the relationship between these novel OSA metrics and adverse outcomes. Models were adjusted for age, sex, race, BMI, smoking status, OSA severity from AHI, and prevalent hypertension, diabetes, and use of lipid-lowering medications.

**Results:** In subjects without prior cardiovascular disease or stroke, those in the shortest event quartile had a 38% greater risk for all-cause mortality compared to those with the longest events (hazard ratio = 1.38, CI: 1.12–1.69, p < 0.01). Subjects with the smallest coefficient of variation of inter-event intervals (least variability) were also at greater risk (HR = 1.31, CI: 1.08–1.60, p < 0.01). Clinical OSA severity was not a significant risk factor in either model.

**Conclusion:** Short regularly occurring respiratory events are associated with greater mortality, and may indicate a hyper-arousable state. The temporal pattern of respiratory events contains important information that the AHI does not capture.

**Support (If Any):** R24HL114473 (AW), K24HL76446 (SAS), P01HL095491 (SR)

0447

SLEEP IN GRANDPARENTS CAREGIVERS AND THE CHILDREN IN THEIR CARE

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**Introduction:** 1 in 11 children and 1 in 5 black children live with a grandparent or other relative at some point before age 18, little is known about sleep behavior for the grandparent caregivers and the children in their care.

**Methods:** KIN-Tech 2012 Fostering Connections federal demonstration project funded by the US Children’s Bureau with participants from two southeastern US counties randomly assigned to several treatment groups and a control group to examine program effectiveness related to biopsychosocial outcomes was utilized. Fifty grandparents (54 ± 2.44 years; 88% female, 66% single, 56% African American, low income household ($27,000 ± $1460) raising grandchildren had self-reported twelve month follow up about themselves and the children in their care. The grandparent sleep assessment included information on general sleep behavior, conditions, and sleep aid usage. The child assessment included bedtime, general sleep behavior, waking at night, and stimulant usage. Frequencies and descriptive statistics were used to provide a sleep profile for grandparents and the children in their care.

**Results:** 44% of caregivers reported that their sleep was troubled, with 42% indicated that caregiving for children impacts their sleep. 75% of caregivers are short sleepers (< 6 hours) with 23% diagnosed with sleep apnea by a physician and 30% have reported that they have fallen asleep out of bed, not on purpose during the week. 29% of caregivers take sleep aids. Caregivers report that the average sleep time of children as 9.6 ± 1.6 hours. 66% report that their child is restless and moves a lot during sleep. 64% of the children are taking medication(s) that caregivers are concerned could be impacting their sleep. ANOVA was conducted to compare the effects of the child waking up more than once per night on caregivers’ perception of how caregiving impacts their sleep [F(4,42) = 2.74], whether the child sleeps about the same amount each day [F(4,42) = 3.25], and caregiver diagnosis of sleep apnea [F(4,42) = 6.49], all p < 0.05.

**Conclusion:** Results suggest that in addition to other caregiving-related stressors, grandparents also face troubled sleep, esp. short sleep, and report having sleep apnea. Additionally, caregivers report restless sleep for their children with a high percentage of children taking medication that may impact sleep. More research is needed to examine sleep for these caregivers and children so interventions can be developed to improve their sleep.

**Support (If Any):** US Administration on Children and Families, Children’s Bureau Juvenile Welfare Board of Pinellas County, FL, Children’s Home, Inc., Tampa, FL, PCORI (1IP2 PI000781).
RESIDUAL SLEEPINESS AFTER CPAP TREATMENT IN TWO CLINICAL SETTINGS IN JAPAN
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Introduction: Residual excessive daytime sleepiness even with CPAP (Continuous Positive Airway Pressure) treatment may have adverse effects on their quality of life of OSA (obstructive sleep apnea) patients. However, prevalence of residual excessive daytime sleepiness is not well understood, especially in Japan. Thus we evaluated subjective sleepiness in OSAS patients prior to and under CPAP treatment.

Methods: Participants are out-patients in two clinical settings in Japan. One is attached to Department of Psychiatry in a university hospital (U) (n = 146). The other is attached to Department of Otolaryngology in a city hospital (C) (n = 165). According to Japanese regulation, CPAP was prescribed to sleep apnea patients with AHI ≥ 20 by in-lab polysomnography, or with AHI ≥ 40 by portable monitors. AHI scores from CPAP devices were also used. The Epworth Sleepiness Scale (ESS) was used to assess subjective sleepiness.

Results: In the C setting, age, male% and BMI were 55.4 ± 12.3 yr, 90.7%, 270 ± 47.6. CPAP treatment reduced AHI from 46.4 ± 18.4 to 3.16 ± 3.10, and ESS from 9.41 ± 5.36 to 6.16 ± 4.61. CPAP reduced proportions of subjects with sleepiness from 25.2% (ESS: 11–15) and 12.9% (ESS ≥ 16) to 10.3% (ESS: 11–15) and 5.5% (ESS ≥ 16). In the U setting, age, male% and BMI were 57.7 ± 13.1 yr, 85.4%, 28.1 ± 5.54. CPAP treatment reduced AHI from 45.6 ± 19.6 to 2.99 ± 2.74, and ESS from 9.42 ± 5.70 to 6.01 ± 4.47. CPAP reduced proportions of subjects with sleepiness from 23.0% (ESS: 11–15) and 16.3% (ESS ≥ 16) to 6.2% (ESS: 11–15) and 7.5% (ESS ≥ 16). In this setting, subjects with ESS < 11 used CPAP for 5.70 ± 1.85 hr and 87.7 ± 16.9%, while those with ESS ≥ 11 used for 5.19 ± 2.04 hr and 82.5 ± 23.5%, respectively (P = 0.26 and 0.23, Independent t-test).

Conclusion: In the C and U settings, 15.8% and 13.7% (p = 0.743, chi square test) of CPAP treated OSAS patients still have daytime sleepiness (ESS ≥ 11), respectively. This suggests that certain proportion of CPAP treated OSAS patients still suffer from excessive daytime sleepiness, independent of clinical settings in Japan. More detailed background data are needed for further analysis.

Support (If Any): MEXT/JSPS KAKENHI Grant Number: 26507006. HK’s laboratory is supported by donation from Philips Respironics GK, Takeda Pharmaceutical Company Limited, Sanofi K.K., and TEIJIN Limited to Shiga university of Medical Science.

FOLLOW UP OF POLYSOMNOGRAPHIC DATA OF PRADER-WILLI INFANTS DIAGNOSED WITH CENTRAL SLEEP APNEA
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Introduction: Prader-Willi syndrome (PWS) is a rare genetic disorder arising from the loss of expression of paternal genes within chromosome 15q11-q13, and is characterized by mental retardation, behavioral problems, hyperphagia, and obesity. Children with PWS commonly have sleep-disordered breathing; including hypopnoea and obstructive sleep apnea, as well as central sleep breathing abnormalities that are present from infancy. Central sleep apnea (CSA) is more prevalent in infants compared to older children with PWS. The aim of this study was to evaluate the course of CSA in PWS infants within 2 years of baseline assessment.

Methods: A retrospective chart review of PWS infants with CSA who had a baseline polysomnogram (PSG) and follow up PSG in the first 2 years of life. Demographic characteristics and PSG data results including central apnea index (CAI) were collected. Comparisons were made between baseline and follow up PSG data.

Results: We identified 28 (14 male) PWS infants who had baseline PSG at mean age of 1.1 (± 0.9) years. The overall median CAI at baseline was 2.45 events per hour (range 0.1–68.3). Of these, 12/28 (43%) PWS infants were diagnosed with clinically significant CSA (CAI ≥ 5 events/hour). Of the 12 patients, 9/12 infants had follow up PSG data at a mean age of 2.3 years and the median CAI has improved from 10.6 to 3.7 events per hours (p = 0.008). Only one PWS infant had persistent CSA beyond infancy. However, 3/9 subjects with previous CSA had evidence of mild obstructive sleep apnea (OSA) at follow-up.

Conclusion: Central sleep apnea is prevalent in infants with PWS but it is reassuring to note that CSA improves with age. However, these patients will continue to require monitoring as they are at risk of developing OSA.
Support: The first author of the study received a dissertation grant from the Center for Integrative Research in Cognitive and Neural Sciences, Southern Illinois University Carbondale.

0451

PREDICTING EQUATIONS FOR SLEEP RELATED HYPOVENTILATION AND OBESITY

HYPVENTILATION SYNDROME

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Introduction: Chronic hypercapnia occurs in a subset of obstructive sleep apnea (OSA) patients particularly in the obese group. Daytime hypercapnia (PaCO2 of more than 45 mm HG) is a pre-requisite for obesity hypventilation syndrome (OHS) diagnosis. Sleep related hyperpnoea (SRH) may predate the development of daytime hypoventilation.

Methods: Data from 221 patients diagnosed with OSA were retrospectively reviewed. All had a BMI of at least 30 kg/m². SRH was defined as an increase of at least 10 mmHg of end tidal CO2 during sleep in comparison to awake supine value. We compared the SRH group against the non-SRH group in terms of clinical and polysomnographic characteristics. Predicting equations for the presence of SRH were defined. We conducted subgroup analysis of 43 patients who had arterial and venous blood gases. OHS patients were compared with non-OHS patients in order to identify predictors for OHS.

Results: For the SRH data, the parsimonious model was derived which contained 4 variables: BMI, total AHI, ESS and morning headache (at least 3–4 times a week). Our equation was - 4 +2xTotal AHI (> 30) +2xBMI (at least 35) +1xESS (at least 10) +1x morning headache (at least 3–4 times a week). At a cut off point of 0, the sensitivity, specificity, positive predictive value and negative predictive value of predicting SRH were 80.6%, 70.1%, 55.1% and 88.8% respectively. In the subgroup analysis, prediction score estimates using regression co-efficient achieved a sensitivity of 100% at a cut off point for venous HCO3 of 27 and specificity of 100%.

Conclusion: Some clinical and polysomnographic parameters were incorporated into predicting equations for SRH. Serum HCO3 of 27 was identified as a reasonable screening for OHS.

0452

PREDICTIVE FACTORS FOR CENTRAL SLEEP APNEA IN PATIENTS TAKING HIGH DOSE OPIOID MEDICATIONS

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Introduction: Opioids are an indicated treatment for non-malignant chronic pain. However, the development of central sleep apnea (CSA) is linked with opioid treatment. Auto servo-ventilation (ASV) is an effective treatment for CSA but treatment adherence is low. The aim of this study was: 1) to determine which factors predict the development of CSA in these patients; and 2) to determine if sleep, respiratory or psychosocial factors are linked with greater ASV treatment adherence.

Methods: This multicenter study recruited chronic pain patients prescribed with ≥ 100 morphine equivalents for at least 4 months. Participants underwent polysomnography and those with CSA received ASV treatment. Pain levels, daytime sleepiness and fatigue, and psychological and social well-being were investigated using questionnaires.

Results: Linear Regression Analysis (R² = 0.414) identified age (p = 0.02) and the total dosage of Morphine Equivalents (MEQ) (p = 0.003) as being significant predictors of the severity of CSA, as determined using the central apnea index, in chronic pain takings on opioid therapy. After controlling for age with Hierarchical Regression, the relationship between Morphine Equivalent dosage and severity of CSA was no longer significant (p = 0.124). Sleep onset latency (SOL) was significantly shorter (p = 0.01) and apnea-hypopnea index (AHI) and oxygen desaturation index (ODI) were more severe (p = 0.02 and 0.01, respectively) in those who were more adherent to ASV therapy. However, regression analyses failed to identify SOL, AHI or ODI as being significantly predictive of increased treatment adherence to ASV therapy.

Conclusion: Our study points to high MEQ dosage and older age as co-predictors of the development of CSA in chronic pain patients on opioid therapy. Age has a modifying effect on the relationship between MEQ dosage and the development of CSA. Those patients who were adherent to ASV treatment had shorter SOL and increased AHI and ODI, but were not found to be predictive of greater ASV treatment adherence.

Support (If Any): This study received support from Philips Respironics Inc.

0453

FEASIBILITY, QUALITY AND VALUE OF INPATIENT PORTABLE SLEEP TESTING (IPST) IN A PUBLIC ACADEMIC HOSPITAL

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Introduction: Sleep breathing disorders (SBD) are associated with major co-morbidities and high hospitalization rates. SBD diagnostic testing is usually deferred in hospitalized patients until after discharge. We compared IPST and home sleep testing (HST) to confirm our hypothesis that IPST is feasible and provides similar quality and value as HST.

Methods: Overnight IPST was performed in 2-bed ward rooms, ICU or Stepdown units (SDU) with routine nursing care and supplemental oxygen determined by the hospital team. HST was performed in patient homes with device set-up and next-day interpretation at the Sleep Center. Stardust II (Philips) or Noxturnal T3 (Carefusion) devices were used. Tracings were autoscored and edited using standard AASM criteria for apneas and alternative criteria for hypopneas (50% flow rate/3% SaO2 reduction). Comparisons were made using Bonferroni correcterd student-t tests and normally approximated Z-tests.

Results: During July 2012–July 2013, 77 IPST were ordered; 64 (83%) were completed in ward rooms, ICU or Stepdown units (SDU) with routine nursing care and supplemental oxygen determined by the hospital team. HST was performed in patient homes with device set-up and next-day interpretation at the Sleep Center. Stardust II (Philips) or Noxturnal T3 (Carefusion) devices were used. Tracings were autoscored and edited using standard AASM criteria for apneas and alternative criteria for hypopneas (50% flow rate/3% SaO2 reduction). Comparisons were made using Bonferroni corrected student-t tests and normally approximated Z-tests.

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O2 (8% vs 0%); greater respiratory effort indices (REI) (45.4 ± 27.3/hr vs 33.3 ± 27.1/hr, p = 0.005), lower SaO2 nadirs (68.7 ± 10.9% vs 77 ± 13.1%, p < 0.001), and were more frequently diagnostic (75% vs 62%, p = 0.02). IPST resulted in a similar proportion of CPAP prescriptions as HST (86% vs 87%), but higher CPAP acceptance (92% vs 79%, p = 0.002).

**Conclusion:** IPST is feasible and provides useful results, despite a greater proportion of inadequate tracings. Higher IPST REIs and diagnostic rates and lower SaO2 nadirs may indicate greater SBD severity in the inpatients.

**Support (If Any):** ASMF Humanitarian Award

### 0454

**HOME SLEEP TESTING IN PATIENTS SUSPECTED TO HAVE OBSTRUCTIVE SLEEP APEANA: AN OUTCOMES STUDY**

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**Introduction:** The American Academy of Sleep Medicine (AASM) recommends that a home sleep test (HST) should only be performed in patients with a high pretest probability for moderate to severe obstructive sleep apnea (OSA). In the current healthcare environment, however, many patients suspected to have OSA are steered by their healthcare insurance companies towards having a HST irrespective of their pretest probability. The purpose of this study was to look at the outcomes under this testing paradigm.

**Methods:** This was a retrospective study performed at Dartmouth Hitchcock Sleep Disorders Center. All patients who underwent a HST in 2013–2014 irrespective of their pre-test probability of having OSA were included in this study. All HSTs were performed using equipment which measured respiratory airflow, respiratory effort, and oxygen saturation. Hypopneas on the HST were scored using the 4% rule and those on the polysomnogram (PSG) were scored using the 3% and arousal rule.

**Results:** 133 patients underwent a HST. Of these, 90 (67.67%) met the criteria for OSA on the HST and 43 (32.33%) did not. These 43 patients were advised to undergo an in-laboratory PSG. Only 27 of the 43 (62.79%) eventually ended up undergoing an in-laboratory PSG. Of these, 25 (92.6%) met the criteria for obstructive sleep apnea.

**Conclusion:** Performing a HST in all patients suspected to have OSA irrespective of their pretest probability can result potentially in a significantly elevated number of false negatives.

### 0455

**RATE OF ABNORMAL POLYSOMNOGRAM AFTER NORMAL PORTABLE MONITORING STUDY**

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**Introduction:** Portable monitoring is becoming a more common practice of diagnosing sleep apnea. In this retrospective chart review, we analyzed patients with a normal portable monitoring study who then underwent further testing with fully attended in-lab polysomnogram.

**Methods:** Patients were referred to the Memphis VA Sleep Health Center from primary care, specialty, and Community Based Outpatient Clinics (CBOC), with complaints of snoring and daytime sleepiness. Patients at high risk for obstructive sleep apnea (age, male gender, body mass index, and daytime sleepiness) and had limited comorbidities, were screened and setup with portable monitoring. From July 2013 to August 2014, 13 patients (9 males, 4 females) underwent unattended portable monitoring to evaluate for the presence of sleep apnea, that was then followed with fully monitored in-lab polysomnography.

**Results:** Sleep apnea was defined with an apnea-hypopnea index of > 5 events per hour in symptomatic patients. In the subsequent fully attended polysomnograms, 38% (5) of them were abnormal and consistent with sleep apnea.

**Conclusion:** The presence of sleep apnea can be missed with portable monitoring for patients with high probability for sleep apnea. Therefore, fully monitored polysomnograms should follow normal portable monitored studies in patients with a high probability for sleep disordered breathing.

### 0456

**A CONTACTLESS SYSTEM FOR RESPIRATORY EVENT IDENTIFICATION**

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**Introduction:** Home sleep testing is cumbersome with high failure rates. We developed a mobile, contactless system capable of accurately identifying sleep related respiratory events.

**Methods:** We designed an active sonar system on an “off-the-shelf” smartphone that transmits inaudible sound signals and measures minute changes in their reflections to monitor abdominal breathing effort and limb movements. We use body movements to ascertain total sleep time and variability in breathing effort signal to identify apnea events. An automated algorithm identifies the absence of breathing effort for 10 seconds as central apnea, a decrease in breathing effort beyond a threshold (30%) for 10 seconds as hypopnea, and a sudden increase in breathing effort due to absence of airflow for 10 seconds as obstructive apnea. We categorized subjects into four groups by apnea-hypopnea index (AHI): no apnea (< 5), mild apnea (5–15), moderate apnea (16–30), and severe apnea (> 30).

**Results:** We tested 37 patients (17 female and 20 male, median age = 51) undergoing in-laboratory polysomnography or CPAP titration at UW Medicine Sleep Center at Harborview. We placed a phone in one corner of the bed during the sleep study and then compared device generated respiratory events with events identified by polysomnography. Our algorithm defined respiratory events were highly correlated with manual scoring with an ICC of 0.9978 for central apnea, 0.9582 for hypopnea and 0.9863 for obstructive apnea (all p < 0.00001). The average error in AHI computation was 1.9 events/hour. We accurately classified 32 out of 37 patients between the four-apnea groups with four out of the five misclassifications occurring at the clinically ambiguous boundary between no-apnea and mild-apnea (AHI error < 1 event/hour). Mean and median total sleep time discrepancy with polysomnography was 36 and 27 minutes.

**Conclusion:** Our system accurately identifies respiratory events using an "off-the-shelf" smartphone in a contactless manner.

### 0457

**CLINICAL CHARACTERISTICS OF PATIENTS WITH REM-ONLY OBSTRUCTIVE SLEEP APEANA**

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**Introduction:** A new operational definition for REM associated OSA has emerged, i.e., AHI in non REM sleep of fewer than 5 events/h and an AHI in REM of at least 5 events/h with at least 30 minutes of REM sleep (so called REM only OSA). Its clinical utility, however, remains unclear.

**Methods:** The cohort (n = 400) consists of consecutively referred patients to Mayo Clinic Sleep Laboratory for suspected diagnosis of sleep disordered breathing. We compared clinical and polysomnographic
features among patients with REM only OSA, REM-related OSA (total AHI > 5, REM AHI/NREM AHI > 2 and NREM AHI ≤ 15), non-stage OSA and patients without OSA.

Results: Of the 400 referred patients, 41 patients (10.2%) were classified as REM only OSA, 95 (23.7%) as REM related OSA, 251 (62.7%) as non-stage OSA and 81 (20.2%) as without OSA. When compared to patients without OSA, patients with REM only OSA were older (51.3 ± 12.5 vs 44 ± 16, p = 0.01), predominant male (46.2% vs 34.5%, p = 0.1), and had a higher BMI (31.6 ± 7.5 vs 29 ± 6.5, p = 0.05). They had lower mean oxygen saturation (%; 93.3 ± 1.7 vs 94.8 ± 1.7, p < 0.01), spent longer time with oxygen saturation < 90% (min; 5.2 ± 11.2 vs 2.1 ± 9.4, p < 0.01), and had higher respiratory effort related arousal (7.3 ± 4.5 vs 5.4 ± 6.4, p < 0.01). There was no difference when comparing neck circumference, Epworth sleepiness score (ESS) and mean arterial pressure between the two groups. Patients with REM only OSA had a higher disease burden based on Charlson Index at presentation and at 36 months (2.6 ± 2.0 vs 1.9 ± 1.9, p = 0.04 and 3.3 ± 2.3 vs 2.3 ± 2.1, p = 0.02) respectively.

Conclusion: The new definition of REM only OSA identifies a population of patients with unique clinical characteristics, and higher comorbidity burden which may worsen if left unaddressed. Classic OSA clinical predictors such as neck circumference and ESS cannot differentiate them from those without OSA.

0458
PRESENCE OF MANDIBULAR TORI AS A DIAGNOSTIC PRECURSOR TO OBSTRUCTIVE SLEEP APNEA
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Introduction: Obstructive sleep apnea (OSA) is a disorder characterized by repetitive upper airway obstructions during sleep. We aimed to investigate whether any correlation exists between the presence of mandibular tori and OSA. The presence of mandibular tori, lingual exostoses on the jaw, is currently considered a primarily clinical finding to differentiate them from those without OSA.

Methods: Participants were new patients in a clinical sleep practice seen from August 1, 2013 until December 1, 2014 (n = 886). All patients were screened for the presence of mandibular tori. Patients who presented with mandibular tori were compared with all new patients in the time period. Gender and average baseline apnea hypopnea indices (AHI) were compared among those patients with mandibular tori.

Results: In the time period between August 1, 2013 and December 1, 2014, 886 patients were seen, 1.69% presented with mandibular tori (9 male, 6 female). Of those patients with mandibular tori, 93% were diagnosed with OSA, with an AHI of 28.9 events/hour, as observed during in-lab baseline overnight polysomnography or via portable home sleep test. 80% of these patients were diagnosed with at least moderate OSA (AHI > 15), with 53% receiving a diagnosis of severe OSA (AHI > 30).

Conclusion: While a small proportion of the patient population presents with mandibular tori, more than half of those patients had severe OSA. Though this provides compelling evidence of a positive correlation between torus mandibularis and OSA, more research is required to determine the mechanism underlying the link between these disorders.

0459
A MULTI-CENTER STUDY ON APPLICATION OF TRIPLE MEASURING NECK CIRCUMFERENCE, BODY MASS INDEX AND EWPORWTH SLEEPINESS SCALE IN PREDICTING THE OCCURRENCE OF OSA IN SNORING POPULATION IN GUANGXI REGION IN CHINA
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Introduction: To study the correlation between the neck circumference (NC), body mass index (BMI), Epworth sleepiness scale (ESS) and the occurrence of obstructive sleep apnea (OSA) in individuals with snoring or OSA.

Methods: A cohort of subjects with snoring was consecutively enrolled from May 2009 to June 2014 in four hospitals in Guangxi region in China. They all received physical examination including measuring NC, BMI and ESS; and underwent polysomnography. The relationship between the apnea-hypopnea index (AHI) and the parameters of NC, BMI, ESS in the subjects with OSA and those with snore but without OSA were analyzed. Determined by SPSS’s Optimal Binning methods, the cutoff-points and the logistic regression coefficients were NC ≥ 38.5 cm (3 points), BMI ≥ 25.7 kg/m² (5 points), ESS ≥ 9 points (1 value) for males and NC ≥ 34.5 cm (5 points), BMI ≥ 24.5 kg/m² (2 points), ESS ≥ 7 points (1 value) for females. The integral value was obtained according to the receiver operating characteristic (ROC) curve.

Results: A total of 2803 subjects, 2366 males and 437 females, were included. A positive correlation between the parameters of AHI and NC, BMI or ESS was obtained in both the males (r = 0.389, 0.485, 0.293, respectively, all P < 0.001) and females (0.386, 0.439, 0.291, all P < 0.001). High sensitivity (71.4%; 73.3%), specificity (65.5%; 63.6%) and positive predictive value (91.1%; 66.3%) in the prediction of the occurrence of OSA could be achieved if the integral value was ≥ 6 in males or ≥ 3 in females.

Conclusion: A positive correlation between AHI and NC, BMI and ESS was demonstrated. Triple measurements of NC, BMI and ESS may aid in predicting the occurrence of OSA in snoring populations, particularly in males.

Support (If Any): This research was supported by the National Natural Science Foundation of China (No. 81160014) and the Natural Science Foundation of Guangxi (No. 0991211)

0460
SLEEP APNEA EVENT IDENTIFICATION ALGORITHM USING THORACIC-ABDOMINAL MOTION
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Introduction: To construct an algorithm which can determine the sleep apnea and hypopnea events by using thoracic (THO) and abdominal (ABD) motion signal measured by Polysomnography (PSG).

Methods: Considering the THO and ABD signals are majorly counter-phase while an obstructive seep apnea (OSA) event is happening, the correlation-calculating method is used to detect whether the phase of THO and ABD signals are in-phase or counter-phase. The THO and ABD signals became vibrating little and in-phase as a central sleep apnea (CSA) event occurs. Chirp z-transform (CZT) analysis method is applied to get the frequency of THO and ABD signals and a threshold
is set to distinguish normal and CSA condition. That THO and ABD signals turn smaller than usual as a hypopnea event occurs is known, so maximum value detection (MVD) is used to find the event. The identification algorithm is built by combining the above methods, correlation, CZT, and MVD, to detect OSA, CSA, and hypopnea events. The constructed sleep apnea event identification algorithm (SAEIA) is applied to 6 snorers and 57 sleep apnea syndrome patients receiving standard PSG study, thirty for parameter-training and thirty-three for verification.

**Results:** Four estimation indexes, accuracy, sensitivity, specificity and precision, are referred to estimate performance of the SAEIA. The number of events identified by SAEIA is used to calculate the assessed apnea-hypopnea index (AHI). Patients with AHI smaller than 15 is defined as mild; otherwise, they are defined as severe. Comparing the assessed severity with severity recognized by medical experts, it shows accuracy 84.85%, sensitivity 84.21%, specificity 90.91%, and precision 94.12% in parameter-training group and accuracy 80%, sensitivity 80%, specificity 80%, and precision 88.89% in verification group.

**Conclusion:** The constructed SAEIA can distinguish the severity of patients’ sleep apnea/hypopnea. It is both helpful for doctor to give a primary diagnosis and for engineers to build a home-caring system.

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**0461**

**THREE-DIMENSIONAL EVALUATION OF THE UPPER AIRWAY WITH MAGNETIC RESONANCE IMAGING IN JAPANESE PATIENTS WITH OBSTRUCTIVE SLEEP APNEA**

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**Introduction:** To better understand risk factors for obstructive sleep apnea (OSA), its pathogenesis must be investigated. Although various studies, including nasal pharyngoscopy, fluoroscopy, cephalometry, and computed tomography have been used to examine the upper airway in patients with OSA, upper airway soft tissue is most accurately visualized with magnetic resonance imaging (MRI). Some 2-dimensional MRI studies have shown a relationship between the severity of OSA and the soft tissues of the upper airway but few 3-dimensional studies of Japanese patients with OSA have been performed.

**Methods:** Three-dimensional volumetric studies were performed to evaluate the relationship between the severity of OSA and the volume of the pharyngeal wall, upper airway, tongue, and parapharyngeal fat pads. Polysomnography and upper airway MRI were performed for 83 patients (59 men and 24 women; mean age, 50 years; mean body-mass index, 25.7 kg/m²; apnea-hypopnea index, 26.4 events/hour), and the volumes of the pharyngeal wall, upper airway, tongue, and parapharyngeal fat pads from the rostral hard palate to the tip of epiglottitis were analyzed. The volumetric measurements were obtained with the software program Virtual Place (AZE Ltd., Tokyo), and volumes were calculated through interpolation of contiguous axial data sets.

**Results:** On multiple regression analysis, variables identified as independent risk factors for OSA were patient age and the volume of the tongue and the parapharyngeal fat pads. In addition, independent risk factors for OSA in nonobese patients (body-mass index < 25 kg/m²) were age and the volume of the parapharyngeal fat pads.

**Conclusion:** Our results suggest that tongue volume is a risk factor in patients with OSA, but in nonobese patients, tongue volume is not a risk factor. Three-dimensional studies provide abundant information about the volume of the upper airway and soft-tissue structures and indicate upper-airway risk factors for OSA.

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**0462**

**ASSOCIATION BETWEEN SERUM BIOMARKERS AND OBSTRUCTIVE SLEEP APNEA**

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**Introduction:** There is a large unmet need for biomarkers to identify individuals with possible obstructive sleep apnea (OSA). Diagnosis is currently based upon overnight polysomnography, and patients are often not referred for this definitive testing. Because OSA is linked to hypertension, heart disease, stroke, memory decline, diabetes, obesity and metabolic syndrome, it is important to identify those persons who should be referred to a sleep center. Here we present data that demonstrates an association between OSA and various metabolic and endocrine biomarkers.

**Methods:** A multicenter prospective trial was conducted enrolling symptomatic patients with suspected OSA. All subjects underwent a diagnostic sleep study. A non-symptomatic control group was also obtained from a separate Healthy Controls study. Eleven biomarkers were tested: HbA1c, CRP, IL-6, uric acid, EPO, cortisol, hGH, prolactin, testosterone, DHEA (Beckman Coulter UniCel DxC 600i Synchron® Access® Clinical Systems), and IGF-1.

**Results:** A total of 128 subjects have been enrolled in this ongoing study. Of these, 26 were diagnosed with moderate to severe OSA. OSA is more prevalent in males, and a Receiver Operating Characteristic (ROC) curve analysis of results from male subjects (n = 70) was performed. Areas Under the Curve (AUCs) were > 0.70 for HbA1c and CRP. AUCs were > 0.60 for uric acid, IL-6, and EPO. AUCs were > 0.60 for gender-specific markers (prolactin, testosterone, DHEA). AUCs were > 0.50 for hGH, IGF-1, and cortisol. Many of the OSA subjects were pre-diabetic (A1c > 5.7%), with high cardiovascular risk (CRP > 0.3). Individual biomarkers performed better or worse in specific clinical subgroups, e.g. A1c achieved wide group separation in obese subjects (p < 0.05), as did CRP in non-obese subjects (p < 0.01).

**Conclusion:** Our results identified promising biomarkers that may be useful in the diagnosis of patients with OSA.

**Support (If Any):** This work was supported by a research grant from Beckman Coulter (Brea, California).

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**0463**

**RISK OF OBSTRUCTIVE SLEEP APNEA AMONG BLACKS WITH METABOLIC SYNDROME**


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**Introduction:** The metabolic syndrome (MetS) and its components, which include hypertension, diabetes, dyslipidemia, and obesity, have been linked to obstructive sleep apnea (OSA). Blacks bear a greater burden of the metabolic syndrome risk factors and are generally at a greater risk for OSA than their white counterparts. This study aimed to determine whether Blacks with MetS are at a significantly increased risk for OSA than those without. It also ascertained which MetS component is the greatest predictor of OSA risk.

**Methods:** A total of 1,035 participants with metabolic syndrome (ages 20–90, mean = 55.7 years; male/female ratio = 1:2.19) and 516 without metabolic syndrome (ages 20–91, mean = 62.4 years; male/female ratio = 1:2.57) were enrolled. They provided sociodemographic and
I. Sleep Disordered Breathing

Results: MetS was associated with an increased risk for OSA (OR = 3.85, 95% CI: 2.70–5.48). Diabetes (OR = 2.31, 95% CI: 1.77–3.01) and obesity (OR = 3.35, 95% CI: 2.12–5.28) were the strongest predictors of increased risk. Of note, the risk of OSA decreased slightly with increasing age (OR = 0.97, 95% CI: 0.96–0.98). Education, family income, birthplace and sex did not have significant effects on these associations (p > 0.05).

Conclusion: These findings suggest that a diagnosis of MetS increases risks of OSA independent of the effects of MetS components (diabetes or obesity). Patients with metabolic syndrome, diabetes, or obesity should be routinely assessed for OSA and treated appropriately to improve overall health and quality of life.

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0464
DATA FROM FINGER PULSE OXIMETRY AND FROM LIMITED CHANNEL MONITORING WITH AIRFLOW AND FOREHEAD OXIMETRY DIFFER DEPENDING ON PARAMETERS BEING ASSESSED

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Introduction: The ARES Unicorder is a limited channel monitor with forehead reflectance oximetry, airflow and movement channels and has good agreement with polysomnography for diagnosis of OSA. The Nonin Finger pulse oximeter (Nonin) is widely used in screening for OSA.

We compared these devices for evaluating sleep disordered breathing in a non-sleep clinic population with a low pre-test probability of OSA.

Methods: 146 subjects (87 Male/13 Female, BMI = 30.5 ± 5.8 kg/m2, age = 52.8 ± 9.1) recruited without regard to OSA symptoms used the Nonin and ARES simultaneously for 2 nights (n = 270). Automated analysis of the Nonin yielded ODI (4% O2 dips/hr) and Pulse Event Index (change in rate of 6 bpm). Automated analysis with manual editing of ARES yielded AH14% (hypopneas defined by 4% desaturation) and RDI (hypopneas defined by 4% desaturation or arousal surrogates).

Results: 7.8% (n = 21) of studies were excluded for < 2 hrs of data on either device (6.6% Nonin; 2.2% ARES). Correlation between Nonin_ODI and ARES_AHI4% was high (ICC = 0.89, bias ± SD = -0.71 ± 0.64). Correlation between Nonin_Pulse_Event_Index and ARES_RDI was low (ICC = 0.14). There were significant differences in reported O2 time below 90% between the Nonin and ARES oximeters (ICC = 0.26, bias ± SD = 6.52 ± 13.61). The definition of OSA affected results. Using ARES as the gold standard: for ARES_AHI4% > 5/hr, the sensitivity of Nonin_ODI > 5 = 91.5% and specificity = 66.6%; for ARES_RDI > 5/hr, the sensitivity of Nonin_ODI > 5 = 73.3% and specificity = 100%; for ARES_RDI > 15/hr, the sensitivity of Nonin_ODI > 5 = 86.1% and specificity = 61.5%.

Conclusion: In this non-sleep clinic population, both devices had low data loss. Nonin_ODI is a good surrogate for ARES_AHI4%. However, significant differences were seen in O2 time below 90% between devices likely due to differences in oximeter type. Oximetry alone showed adequate sensitivity for diagnosis of OSA using most ARES definitions for OSA. However specificity was modest at 61–67%. The intended use of the data should be considered when using oximetry alone for evaluation of sleep disordered breathing.

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0465
RETHINKING AASM GUIDELINE FOR SPLIT-NIGHT POLYSOMNOGRAPHY IN ASIAN PATIENTS WITH OBSTRUCTIVE SLEEP APNEA

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Introduction: Split-night polysomnography (SN-PSG) provides both a diagnosis and titration of continuous positive airway pressure over a single-night in patients with suspected obstructive sleep apnea (OSA). However, in Asian patients, the diagnostic validity of American Academy of Sleep Medicine (AASM) guidelines for SN-PSG remains uncertain. Therefore, we examined whether the current criteria for SN-PSG are available in Asian patients.

Methods: We investigated 134 consecutive patients who were diagnosed with OSA (AHI ≥ 5). We divided the raw data (full-night study) into two parts and compared the first 2 hours of sleep with the full-night sleep to evaluate the diagnostic precision and accuracy of the first 2 hours of sleep.

Results: No difference in AHI was observed between the first 2 hours and the full night of sleep. A significant correlation of AHI was observed between the first 2 hours and the full night of sleep for severe OSA patients (AHI ≥ 30). A correlation coefficient of AHI was higher by the criteria of AHI ≥ 30 than by the criteria of AHI ≥ 40 (r = 0.831 and r = 0.778, respectively), which is the current criteria for SN-PSG. Moreover, the diagnostic accuracy was the same for both criteria (87.3%).

Conclusion: This study found the possible evidence of the different diagnostic criteria for SN-PSG in Asian population. Therefore, we suggest that further studies from other Asian populations will be necessary to confirm this issue before modifying the current guideline for SN-PSG.

0466
SUPINE SLEEP DURING POLYSOMNOGRAPHY AND THE DIAGNOSIS OF OBSTRUCTIVE SLEEP APNEA

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Introduction: Since the supine position worsens obstructive sleep apnea (OSA) by promoting upper airway collapse, patients may avoid supine sleep in order to mitigate its effects. However, the avoidance of supine sleep during polysomnography (PSG) may result in a missed diagnosis of OSA. This study aims to examine the association between the absence/presence of supine sleep and the diagnosis of OSA during PSG.

Methods: This cross-sectional analysis of a prospective cohort study analyzed the demographic, anthropometric, and PSG results on 243 patients who underwent PSG for suspected OSA. The crude and adjusted association between the absence/presence of supine sleep and OSA diagnosis during PSG was determined using Pearson Chi-square (χ2) testing and binary logistic regression model fitting, respectively.

Results: Adult patients suspected of OSA who had no supine sleep during PSG had statistically significantly lower odds [crude odds ratio (OR) = 0.263, 95% CI: 0.085, 0.816, p = 0.014] of being diagnosed with OSA compared to those who achieved some supine sleep. This asso-
cation remained robust despite adjusting for known confounders such as age, BMI, and comorbid coronary heart disease (CHD) [adjusted OR = 0.137, 95% CI: 0.038, 0.483, p = 0.002].

**Conclusion:** Absence of supine sleep during PSG reduces the odds of an OSA diagnosis, even after adjusting for age, BMI, and CHD. Sleep laboratory policies should incorporate protocols that encourage patients to achieve some supine sleep in order to facilitate OSA diagnosis.

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**0467**

**BIOMARKERS ASSOCIATED WITH OBSTRUCTIVE SLEEP APNEA AND MORBIDITIES: A SCOPING REVIEW**

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**Introduction:** Several different morbidity biomarkers have been proposed for obstructive sleep apnea and its morbidity consequences over the last decade. However, critical evaluation has thus far been conducted to understand what we know about the use of biomarkers in the identification and management of obstructive sleep apnea-associated morbidities. Therefore, the purpose of this research was to perform a scoping review of the potential predictive value of biomarkers in both adults and children.

**Methods:** A literature search using scoping review operational guidelines was conducted. Retained articles were only those studies whose main objective was to identify morbidity biomarkers in subjects with obstructive sleep apnea, the latter being confirmed with a full overnight polysomnography in a laboratory or at-home settings. The methodology of the selected studies was classified using an adaptation of the evidence quality criteria recommended by the American Academy of Pediatrics. Additionally, the biomarker clinical application was classified as (1) potential clinical biomarker(s) of obstructive sleep apnea-morbidity; (2) inconclusive for clinical biomarker of obstructive sleep apnea-morbidity, and (3) evidence not supportive as potential biomarker(s).

**Results:** 572 citations were identified of which 48 met inclusion criteria. Thirty-four studies were conducted in adults and 14 involved children. Most of the studies evaluated blood biomarkers, and presented 31 respiratory events are needed.

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**0468**

**A NEW APPROACH TO SCORING SLEEP DISORDERED BREATHING**

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**Introduction:** Scoring of hypopnea requires the presence of physiologic consequences, namely de-saturation or arousal. However, the magnitude of de-saturation may depend on weight and baseline pulmonary function. The objectives of this study were (1) to determine whether respiratory events that do not meet the hypopnea definition are associated with physiological consequences including heart rate changes, (2) to determine the effect of positive airway pressure (CPAP) on these respiratory events and the normalization of associated heart rate changes.

**Methods:** Eleven symptomatic patients [5 females; age 42.8 ± 14.3 years; BMI 28.0 ± 3.6 kg/m²] completed battery of questionnaires [Epworth sleepiness scale (ESS), Pittsburgh sleep quality index (PSQI), and fatigue severity scale (FSS)] and polysomnography. Hypopneas (H) was scored using AASM 2012 criteria and 30% drop in flow without de-saturations were scored as respiratory events (RE) to calculate the respiratory event index (REI). Each event was assessed for ventilation (VE) and R-R interval (RRI). Seven patients with SDB underwent CPAP titration.

**Results:** Majority of patients had sleep related symptoms (ESS = 13.3 ± 5.1, PSQI = 9 ± 7.9, FSS = 35.8 ± 17.7). 8 (73%) patients had AHI > 5 events/h versus 11 (100%) patients had REI > 5 events/h. VE decreased significantly during H and RE compared to baseline (6.5 ± 1.1 vs. 4.0 ± 0.8 L/min and 7.2 ± 1.4 vs. 4.2 ± 0.8 L/min, respectively, P < 0.05). RRI dropped significantly following H (929.4 ± 146.1 vs. 804.8 ± 112.3 ms for event beginning and nadir RRI, respectively, P < 0.05) and RE (926.9 ± 152.9 to 801.7 ± 119.1 ms for event beginning and nadir RRI, respectively, P < 0.05) but no difference in nadir RRI between H and RE (P = NS). On PAP titration, 7 patients with SDB were treated until normalization of AHI and REI (CPAP = 8± 2.4 cmH2O).

**Support (If Any):** The study was funded by the U.S. Department of Veterans Affairs R&D Awards # 1I01CX001040 and # 1IK2CX000547.
Wells TR, Spampinato L, Mokhlesi B, Aurora V, Balachandran JS

The volume of sleep consult requests, sleep diagnostic testing, and 225%. Patients diagnosed with OSA increased 66%. All newly diag

SLEEP

B. Clinical Sleep Science

0470 HOUSE STAFF EDUCATION REGARDING OBSTRUCTIVE SLEEP APNEA SCREENING INCREASES UTILIZATION OF INPATIENT SLEEP MEDICINE CONSULTATION SERVICE AND INPATIENT TESTING FOR OSA Wells TR, Spampinato L, Mokhlesi B, Aurora V, Balachandran JS

Introduction: Obstructive sleep apnea (OSA) remains underdiagnosed and undertreated, despite increased recognition of the consequences of untreated disease (Kapur, V et al, 2002). Given the high prevalence of OSA in hospitalized patients (Shear, TC et al, 2014), the inpatient setting may be an ideal time and place to address OSA. Therapy for OSA in the inpatient setting may even improve patient outcomes (Kauta, SR et al, 2014). Unfortunately, OSA recognition and screening proficiency among hospital staff remains poor. We hypothesized that an educational intervention to improve screening for OSA among inpatients would increase utilization of sleep diagnostic services and OSA therapy.

Methods: A novel educational curriculum, SIESTA (Sleep for Inpatients: Empowering Staff To Act) was developed and included: a webinar covering the prevalence of OSA, importance of diagnosis and therapy, pocket cards with STOP-BANG screen, and instruction on how to obtain sleep consultation. The curriculum was piloted with one internal medicine resident team rotating on one inpatient medical ward. The volume of sleep consult requests, sleep diagnostic testing, and therapy for OSA among inpatients on medicine wards was reviewed pre- and post-intervention.

Results: Inpatient sleep consultation volume increased 89% in the five months following implementation of the curriculum. Furthermore, there was a 118% increase in the number of inpatient portable sleep studies performed. In-lab study referrals from consultation increased 225%. Patients diagnosed with OSA increased 66%. All newly diagnosed patients were either initiated on auto-titrating positive airway pressure therapy or scheduled for outpatient sleep evaluation shortly after discharge.

Conclusion: The implementation of a curriculum to increase OSA awareness and screening can have a positive impact on the volume of an inpatient sleep medicine consultation service leading to increased diagnosis and treatment of OSA. Future exploration should include cost effectiveness of hospital sleep medicine programs, and quality and patient outcomes.

0471 SLEEP QUALITY ASSESSED BY QUESTIONNAIRES PRE- AND POSTOPERATIVELY IN PATIENTS WITH NASAL POLYPsis Värendh M1, Johannisson A2, Hrubros-Strom H3, Andersson M4

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Introduction: Nasal polyposis reduces nasal patency and has a great impact on quality of life. However, to what extent sleep quality is disturbed and if certain questions/questionnaires can catch this impact is not investigated. Objectives of the study were to examine sleep quality using different sleep questionnaires in patients with nasal polyposis before and three months after endoscopic sinus surgery. The aim was also to investigate the effect of surgery on lung function.

Methods: We examined 38 patients with pronounced nasal obstruction due to nasal polyposis with sleep questionnaires and spirometry prior to FESS (Functional Endoscopic Sinus Surgery) and three months later. MAP (Multivariable Apnea Prediction, three questions about snoring and apnea), BNSQ (Basic Nordic Sleep Questionnaire), ESS (Epworth Sleepiness Scale) and Sino-Nasal Outcome Test (SNOT-22) were used.

Results: Surgery evidently improved nasal symptoms in general. MAP changed from 16.4 pts. before to 8.8 pts. (p ≤ 0.001) after surgery. Regarding sleep quality, BNSQ was calculated as a total sum and demonstrated an impaired sleep quality before surgery: 13.0 pts. ± 1.6 (mean ± sem) which nasal surgery reduced to 10.0 pts. ± 1.6 (mean ± sem) (p ≤ 0.01). ESS changed from 9.7 pts. ± 0.8 (mean ± sem) before surgery to 6.4 pts. ± 0.7 (mean ± sem) three months later (NS). In contrast, nasal surgery could not demonstrate any tendency for change in MAP. An non-significant improvement in FEV1 was seen after surgery that changed from 92% to 102%.

Conclusion: Patients with nasal polyposis suffer from sleep related symptoms. Nasal surgery improves sleep related quality assessed by BNSQ questionnaire. Other questionnaires (ESS & MAP) were not sensitive to changes in quality of sleep before and after surgery of nasal polyposis.

0472 THE POSSIBILITY OF NEW EVALUATION CRITERIA OF OBSTRUCTIVE SLEEP APNEA (OSA) SEEN FROM THE RELATIONSHIP OF THE ARousAL WITH ESOPHAGEAL PRESSURE Watanabe S1, Chiba S2, Isaka N1, Onda N3, Moriwaki H2

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Introduction: Golden standard of diagnosis in obstructive sleep apnea (OSA) is overnight polysomnography (PSG). But esophageal pressure (Pes) is a more accurate way for measurement of respiratory effort. We have investigated new diagnostic method using Pes.

Methods: Concordance rate between obstructive respiratory events in PSG (obstructive apnea, mixed apnea, hypopnea) and respiratory events determined by the Pes measurements (Pes event) was investigated. Pes events were classified in POE and non POE by the position relations with arousal. (POE: pure obstructive event)

Results: Concordance rate of obstructive respiratory events for Pes events and concordance rate of Pes events for obstructive respiratory events had a divergence. In addition, frequency of preoperative POE and improvement rate of postoperative ODI 3% had a positive correlation.

Conclusion: Esophageal pressure measurement is useful as a new pathology evaluation method.
0473
INCIDENCE OF SLEEP APNEA IN CONSECUTIVE TRAUMATIC BRAIN INJURY ADMISSIONS AT A VETERANS AFFAIRS POLYTRAUMA REHABILITATION CENTER
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Introduction: A recent study reported 84% of 205 consecutive acute traumatic brain injury (TBI) neurorehabilitation admissions had sleep disruption as measured by clinician ratings. During a time of critical neural repair, two-thirds remained with unspecified sleep disturbance at rehabilitation discharge. After controlling for demographic and injury factors, presence of sleep disturbance predicted longer length of stay (LOS) and lack of improvement on serial cognitive testing. Limitations included gross characterization of sleep disturbance rather than identification of specific disorders. The purpose of this study was to evaluate incidence of sleep apnea (SA) in consecutive neurorehabilitation admissions to inform sleep management strategies and potentially improve outcomes.

Methods: Sleep technologist placed Level 2 polysomnography (PSG; Somnomedics) on consecutive neurorehabilitation admissions. Data were downloaded for sleep staging and interpretation by a board-certified sleep medicine physician. Demographic and injury severity information were abstracted from medical records by trained research assistants.

Results: Fifty-eight of 70 TBI admissions met study inclusion/exclusion criteria. The sample was primarily male (96%; Mean Age = 38 [15]) with severe TBI (GCS = 7). SA was present in 20 of 58 participants (35%) with primarily obstructive sleep apnea (18/20). Mean apnea hypopnea index (AHI) was 13.1. Mean lowest oxygen saturation was 86%, and mean time spent with an SpO2 < 90% was 3.7% of sleep time. Individuals with apnea did not differ from those without in regards to injury severity or demographic characteristics.

Conclusion: Sleep apnea is prevalent in the neurorehabilitation setting potentially mediating negative outcomes. Earlier assessment for diagnosis of SA should be considered in acute TBI management.

0474
THE IMPLEMENTATION OF OVERNIGHT PULSE OXIMETRY GREATLY IMPROVES THE DETECTABILITY OF SLEEP APNEA IN PATIENTS WITH CARDIOVASCULAR DISEASES IN OUTPATIENT CLINIC
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Introduction: The incidence of sleep apnea (SA) in patients with cardiovascular diseases is high (30–50%), but there is no health insurance coverage for SA in Russian Federation. In order to deal with this problem a simple, effective and low-cost screening method is required. The purpose of the current study was to evaluate the usability of screening for SA via overnight pulse oximetry (OPO) in patients with cardiovascular diseases in outpatient clinic.

Methods: Data were obtained from patients who visited the cardiologist in outpatient department between 16.05.14 and 24.10.14. OPO was assigned to the patients in stable clinical condition with a high test probability of SA based on the following diagnoses in patient’s chart: arterial hypertension, ischemic heart disease, chronic heart failure, atrial fibrillation, sleep-related arrhythmias. The evaluation of SA was carried out with PulseOx 7500 device (SPO Medical, Israel). All subjects with desaturation index (DI) of 15 per hour and higher were referred to a formal sleep study.

Results: A total of 379 patients were analyzed, 224 (59.1%) of them met inclusion criteria. SA was already detected in 1 subject at the time of appointment. OPO was performed in 200 patients (89.3% of the inclusion group). DI of 15–29 per hour was detected in 61 patients (30.5%), ID > 30 per hour, in 37 (18.5%), which corresponds to moderate and severe SA respectively. All 98 patients have been advised to undergo a sleep study, 26 of them did and verified the diagnosis of SA.

Conclusion: The study confirms high prevalence of SA in patients with cardiovascular diseases. Screening for SA using OPO in outpatient clinic significantly improves detection of the disorder, and help to form a group of patients for referral to a formal sleep study.

0475
RECURRENCE ANALYSIS OF THE SLEEP-STAGED EEG ACCURATELY IDENTIFIES SUBJECTS WITH OBSTRUCTIVE SLEEP APNEA
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Introduction: Recurrence analysis (RA) is a new method for quantifying non-randomness in the EEG. Applied to the sleep-staged EEG (SS-EEG), RA yields 16 markers for stage-dependent sleep depth and fragmentation. We postulated that RA could accurately identify the presence of temporal information (“signature”) in the SS-EEG specifically associated with OSA, as assessed by RA’s capability to reliably identify the subjects in a cohort consisting of those who did and did not have OSA.

Methods: Cohorts were formed from a population of 149 subjects without OSA (AH130). Staged PSGs were obtained from the Sleep Heart Health Study. RA markers computed from the C3 EEG were analyzed by discriminant analysis to identify marker combinations that reliably classified individual subjects into No-OSA and OSA (AH1 > 5) groups (each N = 25). The OSA group composition was 40% mild, 40% moderate, 20% severe. Classification accuracy (CA) was assessed using area under the receiver operating characteristic curve (AUROC). The analysis was done three times, employing three independent cohorts randomly selected from the population. Each analysis was cross-validated. CA was also assessed by means of the accuracy ratio, [TP+TN]/[TP+FP+TN+FN].

Results: In three successive independent analyses, an ABR-produced EEG biomarker function accurately identified the subjects with OSA (respective AUROC values 0.87, 0.92, and 0.87). The respective cross-validated AUROC values were 0.82, 0.86, and 0.81. Successful classification was confirmed by ratio determinations (82%, 86%, 82%, respectively).

Conclusion: OSA subjects (AH1 > 5) were identified by RA, using only a single EEG lead. The SS-EEG contained a signature detectable by RA that allowed a reliable binary classification of the individual subjects in a cohort that included a group with no OSA and an equal-sized group of subjects who exhibited a wide range of disorder severity.
0476
INCREASING THE SENSITIVITY OF HOME SLEEP TESTING
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Introduction: Home Sleep Tests (HSTs) are ideal for those with high pre-test probability of having moderate to severe obstructive sleep apnea (OSA). HSTs are favored by insurers due to lower cost, and by patients due to ease of testing at home. In addition, it is clinically difficult to discern which patients will have moderate to severe OSA prior to testing. Therefore, HSTs are often performed as a first step. HSTs, however, underestimate the severity of OSA. This is because “total recording time of the study” is used as a surrogate for the shorter “total sleep time” to calculate the apnea-hypopnea index (AHI). Underestimation and under-diagnosis leaves patients vulnerable to the consequences of untreated OSA. Current guidelines suggest that providers may use either a 3% or 4% desaturation to define respiratory events during sleep, specifically to define hypopneas. We hypothesize that use of 3% desaturations increases the sensitivity, especially in HSTs, which already have decreased sensitivity in those with mild sleep apnea.

Methods: A retrospective review of 100 consecutive HSTs of military veterans was performed to evaluate whether a diagnosis of OSA was made with our current scoring methods, which use a 4% desaturation rule. HSTs of those patients who were not diagnosed with OSA, were re-scored using a 3% desaturation rule.

Results: Of the 100 studies, 5% of patients had un-interpretable data. 68% were diagnosed to have OSA with AHI greater than 5. HSTs were available for 24 patients of the 27 patients who had AHI less than 5 by the 4% desaturation rule. When rescored using a 3% desaturation rule, an additional 13 patients, (52% of the previously undiagnosed patients) were found to have OSA.

Conclusion: Our data shows that using 3% desaturations to define respiratory events may greatly increase the sensitivity of HSTs, especially in those with mild OSA. This may allow us to diagnose more patients to prevent the adverse consequences of untreated OSA.

0477
WITHDRAWN

0478
UPPER AIRWAY MEASUREMENTS AS PREDICTORS FOR OSA SEVERITY AND AHI IN CHINESE PATIENTS
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Introduction: the present time, level 1 polysomnography is the gold standard in assessing OSA. However, a simple clinical screening method that can accurately identify the presence of OSA and estimate its severity is lacking. In this current study, various clinical measurement of the upper airway and neck configuration were analyzed and correlated with AHI. A combination of these parameters were used to establish a clinical index that can potentially serve as a screening tool as well as estimation of OSA severity.

Methods: The following parameters were recorded in 120 patients: thickness and degree of palatal droop (PD; subjective scores 0–3); tonsil size (1–4); palatal width (PW; at the oropharynx and nasopharynx junction in mm); presence and degree of posterior palatal webbing (PWw; subjective measurement of posterior palatal folds and webs (0–3)); Mallampati scores (1–4); neck length (from the angle of jaw to clavicle in cm); submental fat content (using skinfold calipers); man- dibular distance (from angle of jaw to mental protuberance in cm) and Body Mass Index (BMI). All subjects underwent level 1 polysomnography with respiratory events scored according to AASM guideline. All results were analyzed using multiple regression method with SPSS software.

Results: Significant correlations were observed between average AHI and tonsil size; PD; PW; Mallampati score and submental fat content (p < 0.035). On the other hand, Mallampati score, PD, submental fat and BMI were found to be significantly correlated with supine AHI (p < 0.0216). By using a combination of these measured parameters, an index was established that can accurately estimate AHI levels.

Conclusion: This study suggests that a clinical screening index based on a combination of simple clinical upper airway measurements and neck configurations can be established and used as a screening tool as well as estimation of severity of OSA.

0479
ENHANCED DETAIL OF IN LAB NPSG TESTING SUPPORTS THE NEW SCORING RULE FOR HYPOPNES INTRODUCED IN 2012 THAT DO NOT REQUIRE SAO2 DESATURATION IF EEG AROUSALS ARE PRESENT
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Introduction: The AASM introduced new scoring rules for hypopneas in 2012 but retained the older criteria, making the new rules optional. The inconsistency weakens the adoption of the enhanced new rule that provides more sensitivity in the diagnosis of patients who are stricken by clinically significant obstructive respirations, by eliminating the requirement of desaturation in SaO2 levels if an EEG arousal is present. Prior to the new rule adoption, we presented data at the 2012 APSS from over 120 patients with EDS who’s NPSG were abnormal in a fashion consistent with the new rules (EEG arousals from obstructive respirations in the absence of SaO2 desaturation) and demonstrated that about 80% of these individuals significantly improved clinically by treatment with CPAP. Unfortunately, many insurance plans, and Medicare, utilize policies that do not adopt the new rules. Clearly more objective review of this controversy is necessary to assist the field in widely adopting the new rule features for hypopneas identification. We will provide extensive data on upper airway physiology characterized by esophageal pressure monitoring during NPSG testing, and cases where sleep endoscopy demonstrates obstruction, in patients where routine methods of NPSG testing failed to identify OSA in spite of clear symptoms.

Methods: NPSGs performed with Pes monitoring were reviewed to identify instances of increased respiratory effort leading to arousals in the EEG in the absence of desaturation. Only patients with clinical symptoms raising suspicion of OSA were included in the review. Additional assessments beyond NPSG testing, such as Cone Beam CT, or sleep endoscopy were collected. Follow up after treatment with CPAP for 6 months or longer was obtained. Data collection to enhance our findings continues.

Results: More than 300 studies met our criteria, demonstrating hypopneas with EEG arousals in the absence of 3% desaturation. More than 75% of these patients achieved significant improvement in their EDS with CPAP. The Pes enhanced assessment and treatment.

Conclusion: Trends towards out of lab testing may be adequate for patients with obvious OSA who repeatedly desaturate. However, to set the threshold of identifying OSA based on desaturations cuts short treatment to many in need. In lab NPSG testing needs to be enhanced to assist in identifying pathology in less obvious cases. More detailed presentations such as ours that address the milder forms of OSA are
**B. Clinical Sleep Science**

**I. Sleep Disordered Breathing**

needed in order to widen the scope of patients that can receive appropriate airway treatment.

**0480**

**SIMPLIFYING THE DIAGNOSIS OF SLEEP APNEA AFTER TIA AND STROKE: EVALUATION OF FIVE SIMPLE SCREENING TOOLS**

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**Introduction:** Obstructive sleep apnea (OSA) is common after TIA and stroke. Left untreated, it is associated with recurrent vascular events, poor functional outcomes, and long-term mortality. Despite its high prevalence, OSA often remains underdiagnosed after TIA and stroke. Simple screening tools have the potential to reliably detect patients requiring further work-up for post-TIA/stroke OSA, however, limited work has examined the clinical utility of such tools.

**Methods:** We prospectively studied 39 patients (mean age 67.4 ± 15.0 years, 42% male, mean BMI 27.9 ± 5.7 kg/m²) who had sustained a TIA or stroke within the past 90 days. All patients underwent ambulatory sleep monitoring using the ApneaLink Plus device, which has been validated against full polysomnography, as well as completed five screening tools (4-Variable Screening Tool [4V], Epworth Sleepiness Scale, SOS score, STOP questionnaire, and Berlin questionnaire) within 72 hours. Clinically relevant obstructive sleep apnea (CR-OSA) was defined as an apnea-hypopnea index (AHI) ≥ 15 (moderate to severe OSA) or an AHI ≥ 5 with a lowest nocturnal oxygen desaturation ≤ 88% (mild OSA with significant desaturation). The area under the curve (AUC), sensitivity and specificity for detecting CR-OSA were computed for each of the screening tools.

**Results:** Twenty patients (51.3%) were found to have CR-OSA using the ApneaLink Plus device. The 4V had the greatest AUC (0.910, 95% CI 0.78–1.0, p = 0.002); using a cut-off of 7, the sensitivity and specificity were 93% and 71%, respectively. No other screening tool demonstrated significant results in detecting CR-OSA.

**Conclusion:** Our preliminary results suggest that the 4V may be a useful tool to screen for OSA within 90 days after TIA or stroke. This tool may assist in determining which patients would most benefit from further evaluation and treatment for OSA early after a cerebrovascular event.

**Support (If Any):** This study was supported by a Canadian Stroke Network summer studentship and by donations to Dr. Black’s research program. In addition, ambulatory sleep monitoring equipment was donated to Dr. Boulos’ research program by ResMed.

**0481**

**AMBIENT ASSESSMENT OF SLEEP APNEA IN THE HOME USING NON-CONTACT FORCE SENSORS**

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**Introduction:** We previously demonstrated detection and accurate severity stratification of sleep apnea using non-contact load cell (LC) force sensors when compared to polysomnography within a sleep laboratory. Sleep apnea testing is increasingly done at home to reduce cost and capture sleep characteristics in a natural living environment. We investigated whether LC sensors could detect sleep apnea at home when compared to a Type III home apnea test (HAT).

**Methods:** Data was collected from LC sensors deployed under the supports of 8 subjects’ beds in their own homes for a minimum of 6 nights. HAT was performed for one to two nights. The apnea-hypopnea index (AHI) was visually scored for each HAT following American Academy of Sleep Medicine guidelines. Each night of LC data was processed with a machine learning algorithm developed in our lab to create an estimate of AHI (AHI-LC) utilizing only the load cell data.

**Results:** Average AHI and AHI-LC values were 13.82 and 14.84, respectively. The root-mean-squared error across all subjects was 6.46 apneas per hour. Using a cutoff AHI of 5, 7 out of the 8 subjects were correctly diagnosed as being positive or negative for sleep apnea when averaging across all nights of in-home AHI-LC data. Six subjects were correctly identified as having sleep apnea using the average AHI-LC, and 1 subject was correctly classified as not having sleep apnea. One misclassified subject had mild sleep apnea, but AHI-LC ≥ 5 for only 1 of 7 nights (average AHI-LC = 2.13).

**Conclusion:** This data demonstrates that load cells can be used within subjects’ own homes to detect sleep apnea over multiple nights. More research is needed to improve deployment for different bed types. This application might improve apnea testing by avoiding sleep disruption from sensors and providing assessment of many nights without patient interaction or contact with sensors.

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I. Sleep Disordered Breathing

0483
INCORPORATING BODY-TYPE (APPLE VS. PEAR) IN STOP-BANG QUESTIONNAIRE IMPROVES VALIDITY OF THE TEST TO DETECT OSA

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Introduction: The STOP-BANG questionnaire is a well-validated screening tool for Obstructive Sleep Apnea (OSA). The type of body fat distribution (Apple vs. Pear) has different effects on the presence and severity of OSA. Some components of the questionnaire (age, gender, and BMI) are associated with different body types. We hypothesized that adding body type to STOP-BANG questionnaire may improve its predictive parameters.

Methods: This is a prospective observational study of subjects who were referred for an evaluation of OSA and received polysomnogram (PSG) at Tulane Sleep Center. STOP-BANG and body types were obtained during the clinic visit. STOP-BANG and STOP-BANG-Apple (Apple: 1 point, Pear/Indeterminate: 0 point) scores were calculated. Using an Apnea/Hypopnea Index (AHI) cut-off of ≥5, we compared the statistical parameters and plotted the ROCs for both screening methods.

Results: A total of 134 subjects (35% males) were included. The average age was 52.6 ± 12.6. The mean AHI and BMI were 27.7 ± 13.5 events/hour and 37.1 ± 10 kg/m², respectively. The sensitivity/specificity/PPV/NPV of STOP-BANG was 98%/17%/81%/71%. Whereas, those predictive parameters for STOP-BANG-Apple with cut-off score of ≥3 and ≥4 were 99%/14%/80%/80% and 91%/31%/83%/50%, respectively. Applying body type (Apple vs. Pear) sequentially to those identified as high risk (for OSA) per STOP-BANG questionnaire led to an improved net specificity of 65%. The presence of Apple body type increased the risk of having PSG-confirmed OSA with the odds ratio of 2.49. Adding body type to STOP and STOP-BANG questionnaires improved the test performances over the range of possible values via the ROC curves compared to without body type (STOP AUC difference p = 0.0563, STOP-BANG AUC difference p = 0.6492).

Conclusion: In the setting of in-laboratory PSG testing, applying body type to STOP-BANG questionnaire leads to a net gain in specificity. The presence of Apple body type increases the probability of having PSG-confirmed OSA.

0484
CORRELATION BETWEEN RESPIRATORY RESISTANCE MEASUREMENTS AND APNEA-HYPOPNEA INDEX

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Introduction: Due to increasing demand, many sleep centers experience prolonged wait times before patients can be evaluated for obstructive sleep apnea (OSA) using polysomnography (PSG). Establishing an accurate means of screening in the office is essential for prioritizing studies. We sought to determine whether measurements of respiratory resistance at the initial office visit could predict the presence and severity of sleep apnea.

Methods: The airflow perturbation device (APD) is a handheld unit that provides measurements for both inspiratory and expiratory resistance. Along with baseline demographic factors, we measured inspiratory and expiratory resistance in both the upright and supine positions prior to PSG. Resistance values were correlated with the apnea hypopnea index (AHI) on PSG.

Results: We enrolled 63 patients in our study. Mean age and BMI were 40.6 ± 8.0, and 28.7 ± 4.6 respectively, and median AHI was 10.6 (IQR: 5.7-23.4). Intra-class correlation coefficients across trials were excellent (0.63–0.89). At baseline, the average inspiratory and expiratory resistances were 3.1 ± 0.9 and 3.5 ± 1.2 cmH2O/L/s respectively in the sitting position. Age (p = 0.01), hypertension (p = 0.01), and change in inspiratory (p = 0.01) and mean (p = 0.06) respiratory resistance going from sitting to supine were all associated with AHI. Logistic regression analysis using these variables demonstrated that the change in inspiratory respiratory resistance going from sitting to supine (OR: 4.7, 95% CI: 1.2–18.2; p = 0.03) was independently associated with an AHI ≥ 15 on PSG.

Conclusion: Resistance values measured in the office using a handheld device were independently associated with AHI and the presence of moderate OSA. Along with known predictors of OSA, the APD can be used in the office to help clinicians predict which patients will need PSG.

0485
PRE OPERATIVE STOP BANG SCREENING PREDICTS POST OPERATIVE PAIN AND OPIOID USE

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Introduction: An estimated 22 million Americans have moderate-severe sleep apnea (OSA) with 80% being undiagnosed. Among surgical patients the presence of untreated OSA may increase postoperative morbidity. We assessed whether pre surgery identification of risk for OSA with the STOP-BANG (SB) questionnaire is predictive of post surgery pain and opioid use.

Methods: We performed a retrospective review of 115 consecutive Henry Ford Hospital patients, 18–65 yrs old, undergoing elective surgeries (from 1-2014 to 5-2014) who completed the SB before surgery. We excluded patients with NYHA III-IV heart failure, severe COPD, neuromuscular disorder, history of drug/alcohol abuse or undergoing ophthalmological or cardiovascular surgery. Endpoints were: hourly post-operative visual analog pain scores in recovery and during in-patient post operative day 1 and 2 and total morphine mg equivalents (corrected for BMI) in recovery and during the two-day inpatient hospitalization.

Results: SB scores of ≥ 2 and ≥ 4 were not predictive of any post surgery outcomes. SB scores ≥ 6 (n = 14) were associated with greater overall use of opioids (total morphine mg equiv) than SB < 6: (367.6 vs 151.9 mg, p < 0.002). Compared to SB < 6, SB ≥ 6 was associated with greater daily average pain ratings on day 1 and day 2 (5.9 vs 4.9, p < 0.03). In SB question-by-question analyses; reporting Tiredness (yes n = 33 vs no n = 82) was associated with greater recovery opioid use (30.3 vs 13.3 mg; p < 0.04) and total opioid use (282.3 vs 135.9 mg; p < 0.004) and greater inpatient daily pain ratings (5.6 vs 4.7; p < 0.06). No other single question was predictive of post surgery outcomes.

Conclusion: STOP-BANG scores ≥ 6 are predictive of patient opioid use and pain reports post-operatively. Reporting Tiredness (yes-no) alone was associated with greater opioid use and pain ratings.
B. Clinical Sleep Science

0486

CHART-REVIEW VERSUS CLINIC-VISIT FOR INITIAL EVALUATION WHEN ORDERING UNATTENDED SLEEP STUDIES

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Introduction: Obstructive sleep apnea (OSA) is a prevalent disorder that is associated with multiple medical consequences. While in-lab polysomnography is the gold standard for its diagnosis, portable monitors have been developed and studied to help increase efficiency and ease of diagnosis as well decrease cost. We aimed to describe the adequacy of a sleep medicine specialized mid-level provider to risk stratify patients for OSA and determine their appropriateness for unattended sleep studies. Patient selection and outcomes in patients who underwent testing with unattended polysomnograms after chart review versus clinic visit were compared.

Methods: This study involved a retrospective chart review of all patients who received a modified non-monitored sleep study performed at the Memphis VA Sleep Health Center during the first 13 months of the program (5/1/2011 to 5/31/2012). 205 patients were included in the data analysis.

Results: Analysis shows no statistically significant difference between chart review and clinic visit groups (p = 0.54). Although not statistically significant, the analysis shows a trend towards higher mean age (50.3 vs 47.4), higher mean incidence of hypertension (80.0 vs 74.6), and lower mean BMI (34.4 vs 36.0) in those who were evaluated by a clinic visit. A statistically significant difference is seen in terms of the pre-test clinical probability of OSA being moderate or high in 62.2% of patients in the clinic visit group and 95.7% in the chart review group with a χ² p-value ≤ 0.0001.

Conclusion: When ordering portable polysomnograms for the diagnosis of obstructive sleep apnea, a high pretest probability is needed. In the Veterans Health Administrations system, if an adequate amount of information is available through the patient charts, the assessment of pre-test probability may be determined by a mid-level provider using chart review or clinic visit with no significant difference appreciated in diagnosis.

0487

CORRELATION BETWEEN TONGUE FAT, SEVERITY OF OSA AND METABOLIC SYNDROME

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Introduction: Obstruction sleep Apnea (OSA) is the multifactorial disease. The upper airway lumen is narrower in patients with obstructive OSA than normal subjects Dr.Tsukui et al. hypothesized that anatomical imbalance between the upper airway soft-tissue volume and the craniofacial size may result in pharyngeal airway obstruction during sleep, and therefore development of OSA. Tongue is the biggest soft-tissue in the oral cavity. Both its structural and functional side, Tongue would have some effects to the OSA. In this study, we examined correlation between tongue fat, severity of OSA and metabolic syndrome.

Methods: We conducted this study in Ota Memorial Sleep Center, Japan, from February 2007 to August 2010. 89 patients who suspected as OSA were included in this prospective study. As control group, 22 healthy volunteer. All participants underwent polysomnography and cephalometry and upper airway and abdomen CT which were analyzed by some soft wares. We calculate square of the neck fat and square of the abdomen visceral fat and square of the abdomen subcutaneous fat, and the mean of tongue CT value. We define the mean of tongue CT value as tongue fat. Also All participants underwent blood test CBC and Biochemistry including adipocytokines and physical examination.

Results: 1 Tongue fat is related to some parameters. 2 Tongue fat can be expected by Square of abdomen visceral fat and Age. (multiple regression analysis, R2 = 0.490). 3 PAS can be expected by Size of jaw bone and tongue fat. (multiple regression analysis, R2 = 0.426). 4 Severity of OSA can be expected by Tongue fat and neck circumference and MPH. (multiple regression analysis, R2 = 0.322). 5 Square of abdomen visceral fat > 100 cm2 (one of the diagnostic criteria of the metabolic syndrome in Japan) can be expected by Square of Neck fat (OR = 1.127) and Tongue fat (OR = 0.920), and AH1 (OR = 1.043).

Conclusion: Tongue fat is related to severity of OSA and Metabolic syndrome. Measurement of the Tongue fat can especially be useful for diagnosis of severe OSA as a new key point.

0488

NON-BENZODIAZEPINE SEDATIVE HYPNOTICS REDUCE THE OCCURRENCE OF THE LOW AROUSAL THRESHOLD PHENOTYPE OF OSA

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Introduction: Zolpidem and eszopiclone are non-benzodiazepine sedative hypnotics (NBSH) that improve sleep onset latency and efficiency. Several studies have shown that neither drug affects the apnea-hypopnea index (AHI) in unselected patients undergoing polysomnography (PSG). In patients with the ‘low arousal threshold phenotype’ of obstructive sleep apnea (OSA), NBSHs may actually improve the AHI.

Methods: We abstracted demographic and PSG data for patients undergoing studies at our sleep center. It is common practice for physicians to prescribe a NBSH to be used during PSG, and administration of drug is recorded by our technicians. We used a recently defined clinical definition, > 58.3% hypopneas, O2 nadir > 82.5% and mild- to-moderate OSA on PSG, to identify the low arousal phenotype of OSA. Patients who met all three criteria were labeled as having this phenotype.

Results: A total of 489 patients had data available for analysis. Mean age was 41.4 ± 10.1 and the median AHI was 11.0 (5.7–18.8). There were 363 (75.7%) patients who received a NBSH (83 eszopiclone and 280 zolpidem) and 118 (24.5%) who took no medication prior to PSG. There was no significant difference in pre-test probability for OSA, using a score that incorporated snoring, hypertension, age and neck circumference, when comparing those who received a NBSH and those who did not (p = 0.12). The majority of patients in the group (304 (63.2%)) met criteria for having the low-arousal phenotype. There was no difference in the number who met these criteria when comparing those who received a NBSH (227 (62.5%)) versus those who did not (77 (65.3%)), p = 0.60.

Conclusion: Administration of a NBSH did not decrease the likelihood of having a low arousal phenotype for OSA. Prescribing a NBSH for the night of PSG should not reduce the sensitivity for detecting OSA. Our study was limited in that the patients had an average AHI that was very low which likely hurt the discriminatory capacity of the variables used to define the low arousal threshold.
0489
SLEEP DISORDERED BREATHING BEFORE AND AFTER CARDIOVASCULAR SURGERY
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Introduction: Sleep disordered breathing (SDB) is highly prevalent in patients with cardiovascular diseases. SDB could ameliorate after cardiovascular surgery with improved cardiac function. Analysis of cardiopulmonary coupling (CPC) offers new diagnostic approach with one-channel electrocardiography (ECG) by integrating heart rate variability (HRV) and ECG-derived respiration. Resulting spectrogram can distinguish between ‘stable’ (high-frequency coupling [HFC] 0.1–0.4 Hz) and ‘instable’ sleep (low-frequency coupling [LFC] 0.01–0.1 Hz). SDB lead to higher percentage of instable sleep with LFC-narrow band pattern in periodic breathing (Cheyne-Stokes-Respiration = CSR) and LFC-broad band pattern in obstructive sleep apnea.

Methods: In this prospective monocentric clinical study patients with indication for coronary artery bypass graft surgery (CABG) have undergone pre-and post-surgery portable monitoring (ApneaLink plus: nasal flow, snoring, breathing effort, oximetry, pulserate) and CPC-investigation by one-channel-ECG (M1) for prevalence and changes of SDB. Furthermore validity of CPC-analysis was compared with portable monitoring for SDB.

Results: 38 patients have been investigated pre- and post-surgery (mean duration: 9 days post-surgery). Pre-surgery portable monitoring detected relevant SDB (mean apnea-hypopnea-index AHI = 15.1/h ± 10.8/h) in 31 patients (82%) with mainly CSR in 14 patients (45%). Post-surgery measurement revealed an elevated mean AHI of 25.7/h ± 17.3/h with higher portion of CSR in 66% of all patients (n = 25). In those patients we could detect a shorter cycle length post-surgery.

Conclusion: With an elevated AHI with higher portion of CSR in post-surgery setting, a cardio-depressive effect of cardiovascular surgery with usage of extracorporal circulation has to be discussed. Contrary, the elevated AHI could be explained by a shorter cycle length in patients with CSR which could be associated with an improved cardiac function after surgery. Nocturnal CPC-analysis by one-channel ECG could be discussed as more tolerable diagnostic device for detection of SDB especially with patients having undergone surgery with thoracotomy.

0490
EVOLUTION OF SLEEP DISORDERED BREATHING IN PATIENTS WITH DOWN SYNDROME: POLYSOMNOGRAPHIC FINDINGS
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Introduction: Patients with Down syndrome are at risk for both obstructive and central sleep apnea. This study aims to explore changes in apnea in this population. We hypothesized that obstructive apnea severity increases with increasing age in patients with Down syndrome.

Methods: A total of 171 polysomnographic reports were identified: 55 in G1; 46 in G2; 42 in G3 and 28 in G4; and the ten most recent studies in each group were selected for analysis. Findings for G1, G2, G3 and G4 respectively showed: mean obstructive apnea indexes of 4.4, 4.2, 8.9, and 30.1 and mean central apnea indexes of 1.92, 1.20, 0.68, and 0.36. Mean z-scores of BMI were +2.5, +1.7, and +2.1 for G2, G3 and G4 respectively. There was a greater degree of obstructive breathing in G4 than other groups (p < 0.05); in contrast, the central apnea and z-score of BMI did not show a statistical difference between groups.

Conclusion: In patients with Down syndrome, obstructive breathing increases with age but does not appear to be associated with increasing BMI. Central apnea did not show a statistical difference but the mean of central apnea decreased over time. The reported data is currently limited by a small sample size, but in the next phase of this study we plan to perform longitudinal analyses in larger sample.

0491
THE PREVALENCE OF SLEEP DISORDERS IN CHILDREN FOLLOWING LUNG TRANSPLANTATION
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Introduction: Sleep disorders have a prevalence of 4–10% and are associated with a high morbidity in the pediatric population. Lung Transplantation is a life-saving modality for children with end stage lung disease. There is limited data available regarding sleep disorders after lung transplantation in children. We hypothesized that the prevalence of sleep disorders is higher in post lung transplant patients when compared to healthy pediatric patients.

Methods: This was a cross-sectional study performed at Texas Children’s Hospital. We utilized the Pediatric Daytime Sleepiness Scale (PDSS), Pediatric Sleep Evaluation Questionnaire and sleep surveys routinely used at our center. Inclusion criteria included pediatric patients who had undergone lung transplantation and are at least 3 months post-transplant. Fisher-exact test and t-tests was used for comparing sleep disorders and PDSS respectively between transplant patients and previously reported controls.

Results: Data from 10 patients was available at the time of analysis. Mean age was 12.3 ± 5.1. Overall, 7 patients reported insomnia and 4 patients reported snoring. There were significant differences in prevalence of snoring and insomnia between transplant patients and prior reports in controls with p = 0.024, 0.002 respectively. Polysomnography (PSG) data was available for 2 patients. PSG revealed sleep disordered breathing in both patients. Four patients reported excessive daytime sleepiness, PDSS > 15. Mean PDSS in patients was 13.2 ± 6.1 (95% CI 9.42–16.98). Out of the 7 patients who responded, nightmares and sleep talking were reported in 3 and 2 patients respectively.

Conclusion: The prevalence of snoring and insomnia in children who had undergone lung transplant was higher, while the prevalence of other sleep disorders was similar as compared to previous reports in healthy pediatric patients. Hence, it is important to screen children post-lung transplant for sleep disorders. Future studies include enrollment of further subjects and evaluation of polysomnographic data.
B. Clinical Sleep Science

I. Sleep Disordered Breathing

0492

IMPACT OF A CUSTOM-MADE MANDIBULAR REPOSITIONING DEVICE ON BLOOD PRESSURE IN OBSTRUCTIVE SLEEP APNEA PATIENTS NONCOMPLIANT WITH CONTINUOUS POSITIVE AIRWAY PRESSURE

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Introduction: Guidelines recommend mandibular repositioning devices (MRDs) as second-line therapy for obstructive sleep apnea (OSA) pts noncompliant with continuous positive airway pressure (CPAP). The prevalence of arterial hypertension (HTN) is high in patients with OSA and MRD therapy may improve blood pressure (BP). ORCADES, a French prospective multicenter cohort study, is evaluating the clinical benefits of a custom-made MRD over 5 years in OSA pts who refused or did not tolerate CPAP. Interim 3-month follow-up data are presented.

Methods: Sleep data, OSA symptoms, BP, quality of life, side effects and MRD compliance were evaluated in OSA pts fitted with a CAD/CAM MRD (Narval CC®). HTN was defined as systolic (SBP) and/or diastolic BP (DBP) of ≥ 140 and ≥ 90 mmHg, respectively. Treatment success was defined as a ≥ 50% decrease from baseline in the apnoehypopnea index (AHI).

Results: 299 OSA patients treated with MRD were analyzed: 222 (74%) without HTN (non-HTN; SBP 122 ± 9 mmHg, DBP 74 ± 8 mmHg) and 77 (26%) with HTN (SBP 140 ± 8 mmHg, DBP 89 ± 8 mmHg). Sex ratio (75%; male), age (53 ± 11 y) and baseline AHI (29 ± 15/h) were similar in both groups. In the HTN group, body mass index, neck and waist circumferences were higher and nadir SpO2 was lower. MRD treatment success rate was higher in non-HTN group (84% vs. 66%, p = 0.0012). Improvements in oxygen saturation, symptoms and quality of life were similar in the two groups and weight was unchanged. In the HTN group, MRD therapy significantly reduced SBP and DBP, by −7.6 ± 12.7 and −6.8 ± 10.2 mmHg, respectively (p < 0.0001 vs. baseline and p < 0.0001 vs. non-HTN group); BP was normalized in 59% of patients. There was no change in SBP or DBP in the non-HTN group. There was a significant correlation between reduction in BP and baseline AHI. Only 25 patients (8%) stopped MRD therapy due to side effects and mean usage was similar in both groups (6.7 hours/night).

Conclusion: Custom-made CAD/CMR MRD is effective in OSA pts noncompliant with CPAP and may also have beneficial effects on cardiovascular parameters.

0493

ASSOCIATION BETWEEN PAIN AND DIFFICULTY SETTING UP POSITIVE AIRWAY PRESSURE DEVICE AMONG COMMUNITY-DWELLING OLDER ADULTS WITH SLEEP-DISORDERED BREATHING

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Introduction: Sleep-disordered breathing (SDB) is prevalent among older adults. Positive airway pressure (PAP) nonadherence is problematic in SDB treatment, including among older adults. Prior research has not adequately addressed whether upper extremity problems, such as pain, contribute to difficulty getting PAP equipment ready for use (i.e., assembling and putting it on) among older adults. We hypothesized that upper extremity pain is associated with more difficulty getting PAP equipment ready for use among older adults.

Methods: We mailed 1,803 surveys to community-dwelling older adults (≥ 65 years) prescribed PAP over a 36-month period. Bivariate analyses were performed between upper extremity pain (single item; none, mild, moderate, severe or extreme), depressed mood (single item; present versus absent), and health perception (single item; excellent, very good, good, fair or poor) and self-reported difficulty getting PAP equipment ready for use (single item; difficulty vs. no difficulty). A multivariable logistic regression model assessed the relationship between upper extremity pain and difficulty getting PAP ready for use, adjusted for age, race, ethnicity, gender, education, health perception, and mood.

Results: 585 patients returned a survey (32% response rate; mean age 71.7 [SD 8.6] years, 85% male, 60% non-Hispanic white). 28% of respondents reported difficulty getting PAP ready for use, 62% reported upper extremity pain, 36% reported depressed mood, and 33% reported fair or poor health. In bivariate analyses, upper extremity pain (p = 0.001) and depressed mood (p = 0.017), but not health perception (p = 0.056) were associated with more difficulty getting PAP ready for use. In the multivariable model, only upper extremity pain was associated with difficulty getting PAP ready for use (OR 1.5; p = 0.001).

Conclusion: Upper extremity pain is frequent among older adults prescribed PAP, and is associated with difficulty getting PAP equipment ready for use. Pain may be a modifiable factor contributing to adherence problems in older patients prescribed PAP.

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B. Clinical Sleep Science

0494
RESPIR@DOM - A RANDOMIZED CONTROLLED TRIAL OF TELEMEDICINE IN SLEEP APNEA PATIENTS
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Introduction: Medico-economic evaluation of OSAS (Obstructive Sleep Apnoea Syndrome) treatment by telemonitored PAP (Positive Airway Pressure) in comparison with the routine care without telemonitoring.

Methods: This study involved 201 patients M/F (M = 66%) 18–75 years with an AHI ≥ 30/hr, in France (Paris region), 12 sites (7 hospitals and 5 private medical centers). Three randomizations have been applied: telemonitoring using GSM technology, device (RESMED/PHILIPS), auto-adjusted vs. constant PAP set at the P90 value measured at D7. After the setup of PAP, follow-up visits at D7, M1, M3 were done by the home-care provider and at M1 and M3 by the physicians. Data were fed into an electronic sleep medical record (DMS) everyday for review and alarms on compliance, leaks and residual index were set up for the telemonitoring using GSM technology, device (RESMED/PHILIPS). The baseline BP (average of two readings prior to PAP) was 12 ± 5.5, AHI = 52.8 ± 20.3/hr on average. Residual AHI at inclusion both telemonitored and non-telemonitored arms were identical: age = 51.9 ± 11 years, BMI = 33.3 ± 0.5 kg/m², Epworth = 12 ± 5.5, AHI = 52.8 ± 20.3/hr on average. Residual AHI at M3 were not significantly different between the two arms: 2.6 ± 3.1/hr. Compliance with treatment at M3 was high and identical in both arms: 5.25 ± 1.97 hr with telemonitoring vs. 5.31 ± 2.09 hr without. Associated costs were 360€/3 months with telemonitoring and 320€ without (P < 0.0001). Cost-efficacy analysis showed that telemonitoring is more expensive but associated with a slightly better outcome. Quality of life scores (SF36, FOSQ) were not significantly different. Patient satisfaction scores were positive with telemonitoring. Telemonitoring increased the physicians’ workload, nevertheless they wished to continue its use.

Conclusion: Telemonitoring is as efficient as routine care. It is more expensive but tends to be more effective. Patients and physicians are satisfied.

Support (If Any): DGCIS and ARS Ile de France.

0495
BLOOD PRESSURE CHANGE IN PATIENTS NEWLY STARTING CPAP THERAPY FOR MODERATE TO SEVERE OBSTRUCTIVE SLEEP APNEA: CLINIC-BASED COHORT STUDY
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Introduction: Although it is widely believed that continuous positive airway pressure CPAP therapy reduces blood pressure (BP) in hypertensive patients with obstructive sleep apnea (OSA), published studies show only a small decrease in systolic blood pressure (SBP) and/or diastolic blood pressure (DBP), with recent research showing only a 3.1 mmHg and 3.2 mmHg decrease in SBP and DBP respectively in 94 subjects. To address this controversy we propose comparing SBP and DBP changes between individuals with uncontrolled BP at baseline versus subjects with well-controlled BP at baseline prior to CPAP therapy.

Methods: A clinic-based cohort study of fifty subjects, newly diagnosed with moderate-to-severe OSA (AHI ≥ 15) was conducted in a University hospital based sleep disorders center. Subjects were classified as either, uncontrolled hypertensives (SBP ≥ 140 mmHg or DBP ≥ 90 mmHg) or controlled BP patients (SBP < 140 mmHg and DBP < 90 mmHg). The baseline BP (average of two readings prior to CPAP therapy for SBP and DBP respectively) and BP at 3 months follow-up visit after CPAP initiation (average of two readings) was used to calculated interval change in SBP and DBP.

Results: Thirty-three subjects were classified as controlled BP patients (3 with normal BP, 9 borderline-normal BP, 21 with controlled hypertension) and 17 individuals were classified as uncontrolled hypertensives. At the 3 month follow-up, uncontrolled hypertensives had very significant decreases in both SBP (−15.6 mmHg vs −1.1 mmHg; p < 0.005) and DBP (−9.6 mmHg vs. −3.2 mmHg; p < 0.01) compared to the controlled BP individuals when adjusting for age, sex and CPAP adherence.

Conclusion: Although CPAP therapy for moderate-to-severe OSA decreased both the SBP and DBP, individuals with uncontrolled hypertension at baseline showed significantly greater reductions in both SBP and DBP. These findings support aggressively addressing the possibility of OSA in patients with uncontrolled hypertension as successful treatment with CPAP may reduce blood pressure and long term morbidity and mortality.

0496
MOTIVATIONAL ENHANCEMENT AS A MEANS OF INCREASING ADHERENCE TO CPAP IN CLINICAL TRIAL SETTINGS: A RANDOMIZED CONTROLLED TRIAL
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Introduction: The use of motivational enhancement (ME) shows promise as a means of increasing adherence to continuous positive airway pressure (CPAP). However, the value of ME in relation to CPAP use in clinical trials investigating cardiovascular disease (CVD) in obstructive sleep apnea is not known.
B. Clinical Sleep Science

I. Sleep Disordered Breathing

Methods: We performed a 6-month, parallel-arm, randomized trial of conservative management, sham-CPAP, CPAP-only, or CPAP+ME; results reported here are from the latter two arms. Subjects aged 45–75 with obstructive sleep apnea (apnea hypopnea index ≥ 15 events/hour) without marked sleepiness and either established CVD or at risk for CVD were recruited from three sites. All patients received standard clinical care alongside CPAP; those randomized to CPAP+ME were also scheduled two 45–60 minute appointments and five phone calls with a trained therapist spaced over six months. Mixed effect models with subject-specific intercepts and slopes over time were fitted to compare nightly adherence between arms, adjusting for follow-up duration, randomization stratification factors, and device manufacturer.

Results: Overall, 83 patients (n = 42 CPAP-only; n = 41 CPAP+ME) contributed 14,273 nights of data. Patients were predominantly male (67%), mean ± SD age 63.9 ± 7.4 years, BMI 31.1 ± 5.2 kg/m², AHI 26.2 ± 12.9 events/hour, and Epworth Sleepiness Scale 8.0 ± 4.5/24. Average nightly CPAP adherence was 3.3 ± 2.7 hours/night and 4.4 ± 2.9 hours/night in the CPAP-only and CPAP+ME arms, respectively. In our fully adjusted model, average nightly adherence was 99.0 minutes higher with CPAP+ME compared to CPAP-only (p = 0.003).

Conclusion: Motivational enhancement delivered during brief appointments and phone-calls resulted in a clinically-significant increase in CPAP adherence compared with CPAP alone. This strategy may be a useful addition to future large-scale CPAP efficacy studies as a means of ensuring a maximal treatment effect and improving statistical efficiency.

Support (If Any): NIH-U34-HL105277

0497

UPPER AIRWAY STIMULATION FOR OBSTRUCTIVE SLEEP APNEA: PATIENT REPORTED OUTCOMES AFTER 30 MONTHS OF FOLLOW-UP

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Introduction: Upper airway stimulation has been shown to be safe and effective in participants with moderate-to-severe obstructive sleep apnea in a large cohort study (STAR Trial) after 12 months of follow-up. This current study aimed to assess patient reported outcomes after 30 months of follow-up.

Methods: A total of 126 participants received an implanted upper airway stimulation system (Inspire Medical Systems, Minneapolis, USA) in a prospective phase III trial. The co-primary outcomes were the AHI and ODI. The secondary outcome measures included patient-reported outcomes: Epworth Sleepiness Scale (ESS) and the Functional Outcomes of Sleep Questionnaire (FOSQ). Patient reported outcomes were reassessed at 30 months post-implant.

Results: A total of 124 participants completed follow up at 12 months and 111 participants at 30 months. ESS was reduced significantly from 11.6 (5.0) mean (SD), at baseline to 7.0 (4.3) at 12 months (p < 0.001) and 6.7 (4.0) at 30 months (p < 0.0001). Similarly, FOSQ improved significantly from 14.3 (3.2) at baseline to 17.3 (2.9) at 12 months (p < 0.001) and 17.6 (2.7) at 30 months (p < 0.001).

Conclusion: Upper airway stimulation via cranial nerve XII maintained a sustained benefit on patient reported outcome measures (ESS and FOSQ) after 2.5 years of follow-up.

0498

EFFECTS OF EXERCISE TRAINING AND CPAP IN PATIENTS WITH HEART FAILURE AND OBSTRUCTIVE SLEEP APNEA

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Introduction: Exercise training in patients with heart failure (HF) has been associated with improved functional class, exercise capacity and quality of life. Since obstructive sleep apnea (OSA) is common in patients with HF, and exercise could improve OSA, we hypothesized that the noted improvement in HF patients could be in part due to improvement in OSA.

Methods: This was a prospective randomized controlled trial. Patients with HF ranging from 30–70 years of age, NYHA II-III, ejection fraction < 40%, and OSA were randomized to: Group 1 (control), Group 2 (exercise training), Group 3 (CPAP t) and Group 4 (exercise training with CPAP t). Full night attended polysomnography, cardiopulmonary exercise testing, isokinetic strength and endurance tests were performed at baseline and 3 months. Patients also completed quality of life (SF 36 and Minnesota living with heart failure), Epworth sleepiness scale and sexual function questionnaires.

Results: 70 patients were randomized and 65 completed the protocol. Mean AHI did not change significantly in the control group. AHI (n/ hour of sleep) decreased significantly with exercise (28 ± 17 to 18 ± 12), CPAP (32 ± 25 to 8 ± 11) and CPAP with exercise (25 ± 15 to 10 ± 16). Similar to CPAP intervention exercise improved sleepiness, NYHA class and quality of life. Only exercise training improved muscle strength. The combination of exercise and CPAP treatment improved cardiopulmonary performance and increased sexual function.

Conclusion: In patients with stable HF and OSA exercise training significantly decreased the severity of sleep apnea, improved excessive daytime sleepiness, New York heart class and quality of life. Importantly, only when exercise was combined with CPAP intervention significant improvement in cardiopulmonary performance, muscle endurance, and sexual function were noted. Exercise training has important therapeutic benefits when added to CPAP therapy for the treatment of OSA in patients with HF and reduced ejection fraction.

Support (If Any): AFIP, FAPESP, CNPq

0499

THE CHANGING FACES OF OBSTRUCTIVE SLEEP APNEA: 2-YEAR FOLLOW-UP OF A CLUSTER ANALYSIS IN THE ICELANDIC SLEEP APNEA COHORT

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Introduction: We identified 3 distinct phenotypic presentations of OSA using cluster analysis in 822 Icelandic individuals with newly diagnosed OSA: “disturbed sleep” (DS), “minimally symptomatic” (MS), and “excessive daytime sleepiness” (EDS) phenotypes. We compared CPAP adherence and changes in symptoms among the clusters 2 years after treatment initiation.

Methods: Adherence was compared among clusters using chi-square or Kruskal-Wallis tests. Changes in symptoms were compared using linear mixed models (continuous variables) or generalized estimating equations.
I. Sleep Disordered Breathing

Victores AJ, Olson K, Takashima M

5001

Clinical Prediction Rule for Patient Selection in Home Management Pathways for Obstructive Sleep Apnea

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Introduction: Home-based “alternate” management pathways for sleep-disordered breathing generally do not address the additional need for oxygen (O2) supplementation during home-based treatment initiation of auto-titrating positive airway pressure (PAP) therapy. The availability of a clinical prediction tool that helps exclude patients needing O2 supplementation in addition to PAP therapy would be useful.

Methods: In 200 sleep laboratory patients, we measured postural oxygen desaturations between upright and reclining positions during calm wakefulness. Patients who were already hypoxic at their physician’s office or who were already on supplemental O2 were excluded.

Results: During wakefulness, by design, oxygen saturation of patients eventually needing O2 supplementation in addition to PAP therapy (median 96%; inter-quartile range [IQR] 95, 97; n = 50) and patients not requiring O2 supplementation (95%; IQR 93, 97; n = 150) did not reveal evidence for hypoxia. Postural change in oxygen saturation during calm wakefulness, however, was greater in patients who eventually required oxygen supplementation in addition to PAP therapy (5%; IQR 2, 7) than those who needed PAP therapy alone (3%; IQR 1, 4; P < 0.0001).

The presence of COPD (Odds ratio 6.0; 95% confidence interval [CI] 2.1, 17.5; P = 0.001), morbid obesity (3.6; 95% CI 1.9, 7.0; P < 0.0001), and age > 50 years (OR 2.8; 95% CI 1.3, 5.9; P = 0.007) were associated with the need for O2 supplementation. A clinical prediction rule of < 2 of the following factors—age, morbid obesity, COPD, and postural oxygen desaturation > 5%—had excellent negative predictive value (0.92; 95% CI 0.85, 0.96) and Likelihood Ratio of negative test (LR-) (0.08; 95% CI 0.04, 0.16).

Conclusion: A clinical prediction rule based on the degree of postural oxygen desaturation, clinical history of COPD, older age, and morbid obesity can help exclude patients from inappropriately entering alternate management pathway because they likely need O2 supplementation in addition to PAP therapy.

Support (If Any): PCORI (IHS-1306-2505)

0502

Concordance Between Therapeutic Pressure Determined During Titration Polysomnography with Three Predictive Equations in Sleep Apnea

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Introduction: The most effective treatment of obstructive sleep apnea (OSA) is the continuous positive airway pressure (CPAP). The pressure required to eliminate the obstructive events is usually determined by polysomnography. It has been proposed alternative methods as titration with automatic devices and predictive equations. The aim was to establish the correlation between three formulas with the pressure found by PSG in a population at an altitude of 2,640 meters.

Methods: Study of concordance in patients with OSA referred to PSG titration. We compare the PSG pressure with three equations: I. Hoffs-
I. Sleep Disordered Breathing

0179

AUTOMATED GRADUATED CPAP (AGPAP) FOR IMPROVED ADHERENCE IN NEWLY DIAGNOSED OSA PATIENTS - MULTICENTER TRIAL

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Introduction: Although PAP is a highly effective treatment for sleep apnea, adherence to therapy remains an obstacle. AGPAP is an extended duration ramp, where the patient receives pressure below their prescription during an acclimation phase. The algorithm gradually increases pressure to therapy level based on usage. The aim of this study was to determine the effectiveness of the AGPAP acclimation period and its impact on short term adherence.

Methods: Newly diagnosed OSA patients who were prescribed CPAP (≥ 10 cmH2O) were enrolled into this multicenter, randomized, double-blind, controlled trial. Participants were randomized to either the AGPAP or the control group (standard CPAP therapy). Treatment efficacy was determined by comparing the AHI obtained from the PAP devices during the acclimation period to the diagnostic PSG baseline AHI. Adherence was monitored remotely. Continuous variables were compared with an independent samples t-test. Differences in proportions were tested using the Fisher’s exact test.

Results: The AHI was reduced by 92% and 97% by day 2 and day 7 respectively during the acclimation period. After three months average hours of use for all days tended to favor participants in the AGPAP group (4.0 ± 2.3 vs. 3.6 ± 2.5 hrs, p = 0.23, n = 95) and for all days where the device was used (4.95 ± 1.7 vs. 4.62 ± 2.1 hrs, p = 0.20) when compared to the control group (n = 120). The AGPAP group tended toward a higher percentage of nights with ≥ 4 hours of use (54.3 ± 33.4% vs. 48.3 ± 35.1%, p = 0.20) and a higher percentage of participants with adherence meeting CMS criteria (62.1% vs. 52.5%, p = 0.17). Male participants assigned to the AGPAP group (n = 71) were significantly more compliant than those assigned to the control group (n = 59) (4.3 ± 2.4 vs. 3.4 ± 2.4 hrs, p = 0.04).

Conclusion: AGPAP is effective in treating OSA and may facilitate treatment compliance in newly diagnosed OSA patients, especially in males, requiring moderate to high PAP pressures.

Support (If Any): This study was sponsored by Philips Respironics.
gession analysis was used to determine factors associated with nasal mask failure.

**Results:** 285 patients were enrolled; 90 required a full-face mask due to mouth leaks and were excluded. 195 (ITT) and 151 (OT) patients were included in the analyses. More patients in MFX vs. Control showed mask acceptance (ITT: 79% vs 68%, p = 0.067; OT: 90% vs 76%, p = 0.022). The number of additional HCP visits as a result of nasal mask issues was lower in MFX vs. Control (ITT: 4.5% vs 14.5%, p = 0.025); time for initial mask training was similar. Compliance with CPAP was higher in MFX vs. Control (ITT: 5.1 ± 2.4 vs 4.7 ± 2.0 p = 0.13; OT: 5.9 ± 1.8 vs 5.1 ± 1.6 h/night, p = 0.011). In the ITT population, nasal mask failure was significantly associated with more mask leaks (OR 1.18, 95% CI 1.06,1.32, p = 0.002) and lower pressure therapy (OR 0.83, 95% CI 0.69,0.99, p = 0.042).

**Conclusion:** The initial choice of nasal mask may have a significant impact on compliance and ongoing management of CPAP therapy. Unintentional leaks seem to be related to mask design and are a strong predictive factor of nasal mask failure.

**Support (If Any):** ResMed

**0506**  
**XEROSTOMIA AND PAP USE**  
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**Introduction:** The complaint of dryness with PAP use is common; however its cause and impact are poorly understood. We hypothesized that PAP patients on higher pressures would complain more of dryness than patients on lower pressures.

**Methods:** We created a final 25 item questionnaire relating to average pressure, mask type, PAP type, % days used, average hours used, severity of dryness, use of a heated humidifier, description/symptoms of dryness, use of supplemental oxygen, large leak, AH1, dryness affecting use of PAP, and medications causing dryness.

**Results:** Of 87 patients (85 males and 2 females), 29 (33%) had no complaint of dryness, while 59 (67%) did. Overall, a complaint of dryness did not affect use. In the 59 patients, 15.5% reported that dryness did affect use of PAP. There was no difference in mean PAP pressure in those with dryness vs those without dryness (11.1 ± 2.9 vs 11.5 ± 3.6 cmH2O; M ± SD; p > 0.05). Those wearing a full face mask were more likely to complain of dryness than those wearing other masks (66.7% vs 33.3%; p < 0.004). No other factors were significant.

**Conclusion:** A complaint of dryness is more common in those using full face masks. Complaints of dryness did not affect PAP adherence.

**Support (If Any):** VA Medical Center

**0507**  
**THE INFLUENCE OF RACE ON THE TRAJECTORY OF CPAP USE DURING THE FIRST 12 WEEKS OF TREATMENT: STANDARDIZING BY SLEEP DURATION**  
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**Introduction:** Studies have shown that blacks use CPAP 1 hour less than whites. However blacks also, on average, sleep less than whites. Limited research has examined the trajectory of CPAP use that is standardized for habitual sleep duration. Our aim was to determine if racial differences in CPAP adherence remained when CPAP use is standardized for self-reported total sleep time (TST).

**Methods:** Consecutive CPAP-naive OSA patients (n = 315, 43% black) attended the Miami VA sleep clinic to receive CPAP and complete baseline questionnaires. Patients returned for follow-up and adherence download. Outcomes were weekly averages of CPAP use both in raw minutes and standardized by baseline self-reported TST. Models were fitted for the first 12 weeks of treatment. We used longitudinal mixed-effects modeling to characterize the influence of race on the trajectory of these two outcomes. Models were fully adjusted for relevant covariates.

**Results:** With raw CPAP use (min), the estimated conditional model with race as a level 2 predictor is (a = p < 0.05): CPAP Use = 251a−70a (race)−5 (weeks)−7 (weeks*race) + 0.08 (weeks2)+ 0.44 (weeks2*race). Black race predicted less CPAP use (min) at week 1 compared to whites. However, there were no significant racial differences in the rate of change of CPAP use over the 12 weeks. With standardized CPAP use (%), the estimated conditional model with race as a level 2 predictor is: CPAP Use = 80.8a−15.8a (race)−1.9 (weeks)−3.0 (weeks*race) + 0.03 (weeks2)−0.20 (weeks2*race). In this model, CPAP use (%) in blacks did not differ significantly from whites during week 1, nor did the rate of change differ between races.

**Conclusion:** These analyses replicate previous findings demonstrating that blacks use CPAP for, on average, an hour less than whites. However, when CPAP use is standardized by TST, this difference is no longer evident. Interventions targeting sleep duration may be an important addition to comprehensive care for sleep apnea.

**0508**  
**RESIDUAL EVENTS DURING USE OF CPAP: PREVALENCE, PREDICTORS, AND DETECTION ACCURACY**  
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**Introduction:** Residual events during use of CPAP: prevalence, predictors, and detection accuracy.

**Methods:** The BIDMC Encore Anywhere database was queried for data between 1/1/2013 to 6/30/2013. The entry criteria: 3 months or greater use of 4 hours or greater. The most recent high-resolution flow data samples (transmitted weekly) was printed and manually scored using modifications of standard criteria (AHIFlow). Statistical analysis included summary measures, Bland-Altman plots, correlation coefficients, logistic regression for prediction of high residual AHIFlow.

**Results:** 156 subjects were studied, mean age was 53.3 ± 13.8; BMI was 33.4 ± 7.6; 58 were women (37%); 98 were men (63%); duration of use was 6.3 ± 1.5; 120 were white and 36 were non-white; automated AHIFlow was 4.87 ± 3.8 and Manual AHIFlow was 8.2 ± 5. Automated AHIFlow scoring showed that 54 patients of 156 (35%) had an AHIFlow > 15, 16 patients (10%) had an AHIFlow > 10, and 4 patients (2%) had an AHIFlow > 15. Manual scoring showed that 112 of 156 patients (72%) had AHIFlow > 5, 39 patients (25%) had an AHIFlow > 10, and 14 patients (8%) had an AHIFlow > 15. Both in the multiple regression and logistic regression, the central apnea index was the only predictor for a manual scored AHIFlow > 5 with a p of 0.02 after adjusting for age, sex, and BMI. BA plots showed the Limits of agreement: −10.604 to 3.095, a mean difference: −3.754 (CI −4.424 to −3.085), and range: 1.000 to 11.688 for those with an auto AHIFlow < 5/hour of use. When the AHIFlow > 5, Limits of agreement: −13.832 to 8.968, mean difference: −2.432 (CI −3.988 to −0.876), range: 4.018 to 21.364.

**Conclusion:** Residual events on stable compliant CPAP use are frequent. Central apneas on the baseline assessment are a risk factor. Auto-detection is variably and unpredictably accurate, and may reflect both device algorithms and changes in time constants of respiratory flow change on treatment (vs. diagnostic assessments).
B. Clinical Sleep Science

Support (If Any): Beth Israel Deaconess Medical Center Chief Academic Officer’s Research Innovation Initiative

0509
IMPROVING APAP COMPLIANCE: THE IMPORTANCE OF INDIVIDUALIZED PRESSURE RANGES AND EARLY FOLLOW-UP

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Introduction: Positive airway pressure is an effective treatment for obstructive sleep apnea (OSA), but compliance with therapy is often low. This may be more true of auto-titrating devices (APAP), when set to a wide range of pressures. The hypothesis that individually tested pressure ranges with intensive patient education and rapid follow-up after therapy initiation can improve compliance was tested.

Methods: Data were collected by a chart review of eligible patients over a year. Participants were newly diagnosed with OSA by polysomnogram and were scheduled to try APAP. Patients visited the sleep laboratory to try CPAP at various pressures, and APAP machines were ordered for each patient for their range of tolerable pressures. Each patient’s compliance data was downloaded at follow-up. The sample was split based on number of days to follow-up. Average usage time for days used, percent of days with usage, and compliance failure rates as assessed by CMS were compared.

Results: The overall success rate was 76.92%. Of 78 patients who received APAP, median time to follow-up was 29 days. For individuals following-up earlier than 29 days, the nightly average number of hours of device usage was 5,399 compared to 5,264 for individuals following-up later (t = 1.0001, p = 0.160). In the earlier follow-up group, the average percentage of days with device usage was 91% compared to 84.84% in the late follow-up group (t = 1.806, p = 0.037). The failure rate for the early follow-up group was 13.15% compared to 32.5% for patients following up later. Of the compliance failures in the late follow-up group, 69.23% would have been detected had they followed up within two weeks of receiving APAP.

Conclusion: An introductory visit to determine tolerable levels of pressure leads to higher levels of compliance. Additionally, rapid follow-up assures better compliance and is able to assess and mitigate potential problems adapting to APAP.

0510
A NEW APPROACH FOR PATIENT PAP COMPLIANCE: CENTRALIZED COMPLIANCE MONITORING

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Introduction: PAP compliance remains the biggest challenge in patients with sleep disordered breathing. Therefore patient’s compliance rates were compared using two different monitoring approaches. Standard methods based on scheduled manual calls, and Central Team method based on live calls and automated text/email notification.

Methods: All patients were monitored via wireless modem for data transfer. The standard care process consists of manual calls at scheduled intervals. Patients are followed by one local therapist who has multiple scheduled daily activities. Follow up with patient compliance can often be pushed back causing the compliance process to fall behind. The Centralized compliance team utilizes a software program that provides text and email alerts in combination with live phone support and local branch support. The texts and emails are sent to notify patients of issues and offer suggestions to correct the issues on their own and feel more empowered. Patients are monitored on usage < 4 hours per night, modem connection, high leak, high AHI, and central apnea index. Patients are managed by exception instead of being generalized which allows for specific issue identification and focused patient coaching.

Results: A total of 384 patients were monitored using the standard care model for monitoring over a 10 month period. 152 patients were compliant during that period which resulted in a 60.4% Medicare defined compliance rate. A total of 701 patients were monitored using the centralized compliance model for monitoring over a 10 month period. 609 patients were compliant during that period which resulted in an 86.8% Medicare defined compliance rate. Statistical analysis using the two-sided and one-sided tests revealed essentially the same p-value of < 2.2e-16 indicating a statistical significant difference.

Conclusion: Using a centralized compliance team approach utilizing software allows the specialized team to identify patients at risk earlier and provide appropriate intervention which subsequently improved our compliance significantly.

0511
LONG TERM IMPACT OF TREATMENT OF OSA ON METABOLIC PROFILE IN VETERANS

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Introduction: Obstructive Sleep Apnea (OSA) is associated with impaired glucose tolerance, elevated blood pressure (BP), dyslipidemia and elevated body mass index (BMI). Positive airway pressure (PAP) is the recommended treatment. This study examines effects of initial adherence to treatment of OSA on metabolic parameters over five years.

Methods: Single center retrospective study. Inclusion criteria were (1) confirmed sleep apnea (2) PAP initiation between 1/2008–12/2009 & (3) objective PAP adherence data. Good adherence (GA) defined as usage for ≥ 10 hours for ≥ 70% of nights at initial download. Demographics of the GA group were compared with poor adherence (PA) group. SBP, DBP, BMI, HbA1c, LDL, HDL, TG were compared at baseline (0–1 year prior to PAP) and 5 years after treatment. Within GA and PA, a 2-tailed paired t-test was used to compare baseline values with the 5 year values.

Results: 148 charts were reviewed, 55 patients qualified for inclusion in the study. 18 had good and 37 poor adherence. Both groups were primarily Caucasian males. Prominent differences in baseline characteristics were: GA was older (Median age 61.5 vs 58), had higher baseline BMI (51.9 vs 34.8), higher prevalence of HTN (78% vs 57%), higher baseline BMI (36.7 vs 34.9), lower prevalence of psychiatric comorbidities (27% vs 11%). Baseline prevalence of DM, CAD, other sleep disorders or arrhythmias was similar between 2 groups. Within GA, HDL increased from 40.7 to 49.7 mg/dl (p = 0.046). Within PA, SBP increased from 130.4 to 139 mmHg (p = 0.003). There was no statistically significant difference in other parameters

Conclusion: At 5 years, good PAP adherence was associated with improvement in HDL and poor adherence was associated with increase in systolic BP and decrease in BMI.

0512
IMPACT OF OSA TREATMENT ON 5 YEAR HOSPITALIZATION AND MORTALITY RATES IN THE VETERAN POPULATION: A SINGLE CENTER EXPERIENCE

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Introduction: Obstructive Sleep Apnea (OSA) is associated with higher morbidity and mortality rates. Studies have revealed improvement
in mortality with treatment of OSA with PAP therapy. There are no studies that look at difference in outcomes based on PAP adherence as defined by Medicare on morbidity and mortality. This study examines the impact of good vs poor PAP adherence on hospitalization and mortality rates over five years in a Veteran population.

Methods: This is a single center retrospective study. Inclusion criteria were: (1) Confirmed sleep apnea (2) PAP initiation between January 2008—December 2009 (3) Objective PAP adherence data. Good adherence was defined as usage for ≥ 4 hours for ≥ 70% of nights at initial download. Demographics of good adherence (GA) group were compared with poor adherence (PA) group. Number of admissions and deaths within 4.5–5.5 yrs after PAP prescription were reviewed.

Results: Of 148 charts identified, 55 qualified for inclusion in this study. Of these 18 had good adherence (GA) and 37 had poor adherence (PA). Both groups were composed primarily of Caucasian males. Prominent differences in baseline characteristics were: GA was older (Median age 61.5 vs 58), had higher baseline AHI (51.9 vs 34.8), higher prevalence of HTN (78% vs 57%), higher baseline BMI (36.7 vs 34.9) and lower prevalence of psychiatric comorbidities (27% vs 11%). Baseline prevalence of DM, CAD, arrhythmias and other sleep disorders was similar between 2 groups. Within GA, 6 patients were hospitalized (33%) and 2 died (11%) during the study period. Within PA, 16 patients were hospitalized (43.2%) and 6 died (16.2%). The frequency of repeat admissions was lower in GA, with a maximum of 2 admissions vs 8 admissions in PA.

Conclusion: Good PAP adherence was associated with lower mortality, a lower hospitalization rate and a lower risk of multiple admissions over a 5 year period in the Veteran population.

0513 INACCURATE CPAP-DERIVED AHI IN CPAP COMPLIANT PATIENTS EXPERIENCING OSA SYMPTOMS
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Introduction: Obstructive sleep apnea (OSA) is a prevalent disease, potentially affecting over 40 million Americans. CPAP (continuous positive airway pressure), the gold standard treatment, is sometimes cumbersome and challenging. Long term compliance rates as low as 30% −40% have been reported. Poor mask fit, emergence of complex apnea, under or over titration, claustrophobia, improper humidification, and overall sleep fragmentation from CPAP itself, may account for poor compliance. However, in some cases a failure of the device itself may contribute to CPAP difficulties. Compliance and efficacy of CPAP is commonly derived from downloaded data indicating pressure, leak flow, flow limitation, time of use, AHI, as well as in some cases central apnea detection. We suggest that machine failure that was undetectable and misleading in the CPAP download may affect CPAP compliance and success.

Methods: We employed the Watch Pat 200 (Itamar) as a test for the validity of CPAP data. This recorder has been shown in a number of studies to accurately assess sleep apnea in patients with OSA, in comparison to PSG, and the concomitant use of CPAP with Watch Pat testing has been described previously. Adult patients, at our CPAP clinic, used their CPAP machine while wearing the watch Pat 200 on their non-dominant wrist with pulse oximetry and PAT probe in place. Patients with no complaints relative to CPAP use and good CPAP compliance, served as internal controls to determine the agreement of the recorder data with the CPAP data.

Results: Watch PAT AHI values in 7 patients with complaints of CPAP difficulties was abnormal, despite relatively normal CPAP downloads. Results were not unique to one brand of CPAP machine. In all 7 cases the downloaded CPAP AHI was in the normal range. One patient, in particular, had a discrepancy of more than 40 for AHI (CPAP AHI = 0.5; Watch PAT AHI = 45). The internal controls had reproducible download data which agreed closely with the Watch Pat results.

Conclusion: We report that in that a small number of patients having complaints of continued fatigue, despite using CPAP, therapeutic failure was undetected by the CPAP machine download. Most estimates of CPAP efficacy and compliance are derived from information generated from CPAP machine downloads, and our findings raise concerns about the validity of this practice. CPAP, machine failure, such as that described here, may be under-appreciated and may contribute to CPAP noncompliance, and lack of therapeutic benefit.

0514 PROMOTING ADHERENCE TO CPAP WITH TAILORED EDUCATION AND FEEDBACK: A RANDOMIZED CONTROLLED CLINICAL TRIAL
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Introduction: Educating people about the benefits of a medical treatment and feeding back personal results have been shown promising in improving adherence to medical treatments. Currently, most of the interventions to promote CPAP adherence take a one-size-fits-all approach. An enhanced impact is expected by tailoring the information style to the information processing characteristics of the patient. The study aims to compare the efficacy of tailored and untailored education and feedback with standard of care.

Methods: This randomized, controlled multicenter clinical study recruited 150 patients diagnosed with mild to severe OSA and prescribed to start CPAP treatment. Three groups were included: a Standard of Care (SoC) group, a Tailored Intervention group (TI) receiving in addition to SoC tailored education and feedback, an Untailored Intervention group (UI) receiving untailored education and feedback. The intervention groups received 2 educational leaflets in week 1 and 2 of their treatment followed by 7 weekly feedback reports about CPAP usage and recommendations for improvement.

Results: We present the preliminary results of the first 100 patients that completed the study. Given the preliminary nature, we refrain at this moment from statistical testing and report here the observed means. Average minutes of CPAP use declined for all three groups in the first two months of treatment, but was smaller for TI (4%) and UI (2%) than for SoC (19%). 59.2% of participants in the TI group subjectively reported an intention to increase their CPAP use compared to 39.5% in the UI group.

Conclusion: Education and feedback were effective in preventing a decline in CPAP use in the first two months of CPAP treatment. While comparable effects were observed on CPAP use for the tailored and untailored education and feedback, a higher impact of tailored materials on the subjectively reported intention to use CPAP was observed.

0515 INCREASED ENGAGEMENT AND ADHERENCE IN ADULTS WITH OBSTRUCTIVE SLEEP APNEA
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Introduction: Adherence to PAP therapy is a profound challenge in management of OSA. Self management approaches have been successful in the treatment of a variety of chronic conditions, yet there is limited documentation in regard to OSA. This study was designed to test
the effect of a self-management approach including instruction on data access and monitoring in adults new to PAP therapy for OSA.

**Methods:** A randomized controlled two-group design was used to test the effects of an intervention that included instruction to access and monitor therapy data on adherence, Patient Activation (PAM), Epworth Sleepiness score, subjective well-being, and satisfaction with the PAP experience. A diverse sample of 38 adults newly diagnosed with moderate to severe OSA and for whom APAP was prescribed was recruited. Following informed consent, each was set up with a DeVilbiss IntelliPAP and given identical educational information. Those in the experimental group also were taught how to access and monitor therapy data using the device's SmartCode. All setup and follow-up appointments were conducted by the PI. At the conclusion of participation, an interview was conducted by a research assistant to explore perceptions of the intervention and the initial PAP experience.

**Results:** Adherence rates for those taught to access their data surpassed 88%. All participants showed a substantial decrease in ESS, increase in PAM score, and reported overall satisfaction with the intervention and the PAP therapy. The ability to access and understand therapy data was described as an important component of satisfaction for some, and many without such instruction indicated they would have liked access and instruction.

**Conclusion:** A comprehensive and supportive program of education including easy access to therapy data and instruction on data interpretation can lead to high levels of adherence and overall satisfaction with therapy in people new to OSA and PAP therapy.

**Support (If Any):** This study was funded by DeVilbiss Healthcare.

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**0516**

**IMPROVEMENT IN PHYSICAL ACTIVITY IN PATIENTS WITH OBRSTUCCIVE SLEEP APNEA (OSA) TREATED WITH CONTINUOUS POSITIVE AIRWAY PRESSURE**

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**Introduction:** The quality of life and physical activities among patients with obstructive sleep apnea (OSA) are poor due to daytime sleepiness, fatigue, and impaired concentration. Very little is known about the effect of continuous positive airway pressure (CPAP) treatment on physical activity (PA). The aim of this study was to prospectively evaluate the effect of CPAP on PA.

**Methods:** We performed a prospective longitudinal study, in which patients with a recent diagnosis of OSA by polysomnography (PSG) and an apnea/hypopnea index (AHI) > 5 were studied between Mar 2012 – July 2014, from a sleep clinic, in New York City. Demographics, anthropometric data, PA, sleep questionnaires, and pedometer steps were evaluated on 3 visits: before and after CPAP: median 3 months (visit 1) and 7.4 months (visit 2).

**Results:** 62 patients were prospectively enrolled. Mean age was 53 ± 13 yrs, and the study cohort comprised of 42% women, had moderate to severe OSA and for whom APAP was prescribed was recruited. Following informed consent, each was set up with a DeVilbiss IntelliPAP and given identical educational information. Those in the experimental group also were taught how to access and monitor therapy data using the device's SmartCode. All setup and follow-up appointments were conducted by the PI. At the conclusion of participation, an interview was conducted by a research assistant to explore perceptions of the intervention and the initial PAP experience.

**Results:** Adherence rates for those taught to access their data surpassed 88%. All participants showed a substantial decrease in ESS, increase in PAM score, and reported overall satisfaction with the intervention and the PAP therapy. The ability to access and understand therapy data was described as an important component of satisfaction for some, and many without such instruction indicated they would have liked access and instruction.

**Conclusion:** A comprehensive and supportive program of education including easy access to therapy data and instruction on data interpretation can lead to high levels of adherence and overall satisfaction with therapy in people new to OSA and PAP therapy.

**Support (If Any):** This study was funded by DeVilbiss Healthcare.

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**0517**

**PREDICTION OF CONTINUOUS POSITIVE AIRWAY PRESSURE IN OBRSTUCCIVE SLEEP APNEA**

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**Introduction:** Researcher was interested in finding out if there is a significant relationship between the BMI and CPAP required and also between AHI and CPAP needed. Continuous positive airway Pressure (CPAP) prediction formulas are difficult to derive and validate since the variation can depend on different factors like age, sex, BMI, Epworth sleepiness scale and many other factors.

**Methods:** 126 patients, who were diagnosed to have OSA (AHI > 5), underwent CPAP titration in a sleep lab. BMI and CPAP pressure needed to correct OSA was recorded. Researcher tested a statistical method to find the correlation between CPAP and BMI and CPAP and AHI in this sample of 126 patients.

**Results:** Correlation coefficient using Excel program revealed r between BMI and CPAP as 0.25154 and between AHI and CPAP as 0.4283 which suggested that there may be linear relationship between the two variables. So Linear regression was performed which resulted the following multiple regression equation as y = 8.66 + 0.030 X1 + 0.029 X2 where Y is the CPAP predicted value using X1 as the BMI and X2 as the AHI score. The std error was 2.60 which represents the std deviation of the observed values from the predicted values. Coefficient of determination R^2 was 0.1564 which expresses the 15% variation due to BMI and AHI, while 85% variation is due to unexplained factors. F value of 11.408

**Conclusion:** Though this equation is not a perfect formula for prediction of the CPAP needed, to correct OSA, this will help to set higher and lower limits on AUTO PAP.

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**0518**

**ADHERENCE TO POSITIVE AIRWAY PRESSURE THERAPY IN U.S. MILITARY PERSONNEL WITH SLEEP APNEA IMPROVES SLEEPINESS, SLEEP QUALITY AND DEPRESSIVE SYMPTOMS**

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**Introduction:** Obstructive sleep apnea (OSA) is frequently diagnosed in U.S. Military Personnel. OSA is associated with sleepiness, poor sleep quality and service-related illnesses of insomnia, depression, post-traumatic stress disorder (PTSD) and traumatic brain injury.

**Methods:** Design: Observational study. Setting: Sleep Clinic. Participants: Active duty military personnel recently returned from combat, diagnosed with OSA by an attended overnight polysomnogram. Intervention: Usual clinical care of positive airway pressure (PAP) therapy. Measurements: Adherence to PAP assessed with smart chip technology. Validated clinical instruments assessed sleep quality, sleepiness, depression, PTSD and quality of life.
I. Sleep Disordered Breathing

Results: Fifty-eight men with mean age 36.2 ± 7.7 y, mean BMI 31.4 ± 3.7 were diagnosed with OSA, mean apnea-hypopnea index 19.1 ± 19.0. Twenty-three (39.7%) participants were adherent (AD) to PAP and thirty-five (60.3%) were non-adherent (NAD). There were no significant differences in baseline demographics, apnea-hypopnea index, service-related illnesses or clinical instrument scores. Military personnel adherent to PAP had significantly improved sleepiness (p = 0.007), sleep quality (p = 0.013), depressive symptoms (p = 0.01), energy/fatigue (p = 0.027) and emotional well-being (p = 0.024). Participants with moderate to severe OSA were more likely to be in the AD group when compared with participants diagnosed with mild OSA.

Conclusion: Military personnel with OSA have low adherence to PAP. Adherence is associated with improved depressive symptoms, sleepiness, sleep quality, energy/fatigue, emotional well-being and social functioning. Future research should focus on interventions to improve the management of OSA in military personnel.

0519

OBSTRUCTIVE SLEEP APNEA (OSA) REMAINS EFFECTIVELY TREATED IN MORE THAN A THIRD OF PATIENTS WHEN SKIPPING NASAL CPAP FOR THREE NIGHTS

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Introduction: Continuous Positive Airway Pressure (CPAP) is the most effective treatment for OSA but is not acceptable to a substantial proportion of patients. As an alternative to nightly CPAP we explored intermittent CPAP (4 nights/week) on an acute basis for one week, which may be a more acceptable regimen to some patients.

Methods: Fifteen (13 Male) patients with moderate to severe OSA (AHI: mean = 32.9, range, 16.6 to 53.6) on chronic CPAP treatment skipped CPAP for 3 nights and were re-assessed. The mean interval between the diagnostic and re-assessment studies was 7.3 months and BMI did not differ between the two studies (n = 13, BMI: diagnostic vs. re-assessment, 28.95 vs. 28.56, NS).

Results: Skipping CPAP for 3 nights: OSA severity was reduced by more than half when skipping CPAP for 3 nights (n = 15, mean AHI: diagnostic vs. re-assessment, 32.9 vs. 16.2, p < 0.005). Three of the 15 patients had an AHI < 5, and 3 patients had an AHI > 5 to < 10. AHI reduction was also significant when analyzing AHI for supine (p < 0.01), non-supine (p < 0.05) and NREM sleep (p < 0.01). REM AHI reduction approached significance (p = 0.052). In one patient studied on 4 occasions, AHI on the diagnostic study (27.8) was reduced when skipping CPAP for 3 nights on two studies (3.3 and 2.3) but not when CPAP was skipped for 3 weeks (27.4).

Conclusion: It has been previously shown that skipping CPAP for 1 night reduces Respiratory Disturbance Index. Nightly CPAP use has been shown to reduce edema and increase upper airway caliber in OSA. It is likely that these changes in the airway are not reversed when skipping CPAP for 1 to 3 nights and is the mechanism of the sustained improvement in OSA.

0520

A NEW PARADIGM FOR TREATMENT OF THE CPAP INTOLERANT

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Introduction: For patients with obstructive sleep apnea (OSA) who are CPAP intolerant, dental oral appliances have provided the number one non-surgical alternative treatment. A 2007 study by Victor Hoffstein, Medical Director of the University of Toronto Sleep Center, showed in a review of the literature of 3027 appliances that the initial apnea-hypopnea index (AHI) was reduced 42%. In our research and studies we utilized an FDA approved oral appliance that serves as an intermediary medical device to deliver oxygen from a concentrator to the oropharynx. The appliance also comfortably depresses the tongue and opens the oropharyngeal airway similarly to the method employed by an MD with a tongue depressor.

Methods: 22 patients were fitted with this O2 appliance. They had pre-treatment (tx) baseline PSGs and post-tx PSGs with the oral appliance. In the post-tx PSG their appliance was connected to an oxygen concentrator that delivered 92% O2 at 1.5 LPM.

Results: Post-tx PSGs showed an apnea-hypopnea index (AHI) reduction of 65% from the baseline AHI’s. 21 of the 22 had final mean Spo2 of 95%-99%. The 22nd had a final mean Spo2 of 94%. 12 of the 22 (54%) had final AHI of 4 or < 4. The other 10 had AHI above 8.7, with 9 of the 10 having mean Spo2 of 95% or > 95. The 10th had the 94% mean Spo2. 22 patients pre-tx mean AHI 33.5, ± St Dev 25.8. Post-tx mean AHI 11.4, ± St Dev 15.6. Pre-tx mean Spo2 91.1%, ± St Dev 3.33 Post-tx mean Spo2 96.5% ± St Dev 1.46

Conclusions: Based on this initial study, O2 delivery via an oral appliance that opens the oropharyngeal airway by depressing the tongue can successfully treat CPAP intolerant patients with OSA, improving AHI and hypoxemia. Further studies are needed to corroborate these findings.

0521

RACE DIFFERENCES IN PREDICTORS OF CPAP USER PROFILES AMONG VETERANS

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Introduction: Previous studies have shown that continuous positive airway pressure (CPAP) adherence among African Americans is lower than other racial groups. Recent findings identified three subgroups of CPAP user profiles (non-adherers, attempters, and adherers), as well as predictors of the CPAP subgroup membership. The current study examined differences in the prevalence and predictors of these three CPAP use profiles between African Americans and other racial groups.

Methods: This cross-sectional, retrospective study consisted of 206 veterans who returned to clinic for CPAP download. At this this follow-up visit, subjects completed questionnaires on daytime sleepiness, insomnia, and self-efficacy for using CPAP. Demographics, AHI, CPAP pressure, and psychiatric and medical comorbidities were collected from patient medical record.

Results: A multi-group (by race) latent profile analysis model was used to extract latent classes of CPAP users with covariates. Regarding the prevalence of latent classes, African Americans were more likely to be non-adherers (48%) and attempters (36%), than adherers (16%) than
Caucasians and Hispanics. Regarding the covariates, and similar to our previous findings, more insomnia and decreased self-efficacy significantly predicted being a non-adherer vs. an adherer for both racial groups. However, unlike Caucasians and Hispanics, we observed in African Americans that the absence of depression, less daytime sleepiness, and lower CPAP pressure more likely to be non-adherers than an adherer. **Conclusion:** Insomnia and self-efficacy were found to predict the likelihood of non-adherence to CPAP, irrespective of race. However, in African Americans, in addition to insomnia and self-efficacy, those without depression, with less daytime fatigue and with lower CPAP pressure were more likely to be non-adherers. These results indicate that more specific interventions may be needed to improve CPAP use in African Americans.

0522 **EFFECTIVENESS OF POSITIVE AIRWAY PRESSURE ON SLEEPINESS IN TYPE 2 DIABETES AND OBSTRUCTIVE SLEEP APNEA VARIES BY GLYCEMIC CONTROL** Donovan LM, Nuzhad A, Basu N, Seigler AN, Choi A, Rueschman M, Bakker JP, Bertisch SM, Patel SR
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**Introduction:** Obstructive sleep apnea (OSA) is extremely common in type 2 diabetes (T2DM). The effectiveness of positive airway pressure (PAP) in a diabetic population has not been well studied.

**Methods:** We established a program at our hospital-based primary care practice to screen and treat patients with T2DM for OSA. T2DM patients underwent screening with the STOP-BANG questionnaire and those scoring ≥ 3 (/8) were invited to undergo a sleep study. Patients with an apnea hypopnea index ≥ 5 events/hour were offered treatment. Sleepiness was assessed using the Epworth Sleepiness Scale (ESS), and adherence to PAP was monitored for 3 months.

**Results:** Of the 190 patients who underwent sleep studies, OSA was present in 84% (45% mild, 18% moderate, and 21% severe). In those scoring ≥ 3 (/8), 84% (45% mild, 18% moderate, and 21% severe). In those scoring ≥ 3 (/8) were invited to undergo a sleep study. Patients with an apnea hypopnea index ≥ 5 events/hour were offered treatment. Sleepiness was assessed using the Epworth Sleepiness Scale (ESS), and adherence to PAP was monitored for 3 months.

**Results:** Of the 190 patients who underwent sleep studies, OSA was present in 84% (45% mild, 18% moderate, and 21% severe). In the 91 patients who accepted PAP and have already progressed to 3 months follow up, baseline hemoglobin A1c (HbA1c) was 6.5–7.9% in 69%, 8.0–9.9% in 20% and ≥ 10.0% in 11%. Baseline AHI and ESS did not differ across HbA1c categories (AHI 25.5 ± 24.4, 21.4 ± 15.0, 23.4 ± 18.1 p = 0.72; ESS 8.5 ± 4.4, 9.2 ± 5.7, 8.0 ± 6.0, p = 0.78). Over 3 months of PAP, ESS improved to a greater extent in those with HbA1c of 8.0–9.9%. The change in ESS by HbA1c category was −1.1 ± 3.6, −3.7 ± 4.2, −1.3 ± 3.5 (p = 0.04). PAP adherence was also greatest in the intermediate HbA1c group (3.6 ± 2.6, 3.8 ± 2.6, 3.1 ± 2.1 hrs/night) although this difference was not statistically significant.

**Conclusion:** In a cohort of patients with T2DM, OSA severity was similar across categories of glycemic control; however improvement in sleepiness was greatest in those with HbA1c of 8.0–9.9%. One hypothesis for this finding is that the HbA1c 8.0–9.9% group may have experienced greater sleepiness improvements due to effects of PAP on glycemic control in addition to direct effects of apnea reduction.

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0524 **ACHIEVING 90% POSITIVE AIRWAY PRESSURE (CPAP) ADHERENCE** Sangal RB
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**Introduction:** According to the Cochrane Database, with usual care, CPAP adherence rates are 57–59%, with increase to 70–75% with educational intervention or supportive ongoing intervention.

**Methods:** Patients with symptoms of OSA were tested using PSG or OCST. After testing, patients with OSA (AHI ≥ 15/h sleep, and AHI 5–14.9/h sleep with sleepiness or comorbidities) were educated about OSA risks and treatment options with focus on CPAP. Patients were titrated on CPAP during a PSG or treated with APAP. Unlimited mask exchanges were allowed in the first 30 days. Patients with comorbid insomnia were offered H1/5HT2A antagonist medicines (trazodone, doxepin or mirtazapine). Patients were seen at least once 30–90 days after. If data download revealed lack of adherence (defined as CPAP use ≥ 4 h/night for ≥ 70% nights), there were continuing visits with supportive intervention, and H1/5HT2A antagonists for PAP related sleep difficulties. Resmed Easycare Online (but not Respironics Encore Anywhere) allows adherence data of all patients to be output into a spreadsheet. Data from all patients set up on Resmed PAP devices from January 1, 2013 to August 1, 2014 was output.

**Results:** Of 87 new patients set up on CPAP, 1 was excluded as the data could not be downloaded. 4 did not return and were considered non-adherent. 82 returned with data downloads. 77 (90%) of 86 patients achieved ≥ 70% adherence. There were no significant differences between adherent and non-adherent patients in age, BMI, AHI, lowest saturation, ESS, General Wake Inability/Fatigue or Driving Wake/Inability Fatigue scores, or CPAP pressure. Ten patients needed treatment with H1/5HT2A antagonists and 9 became adherent. Without treatment, if these 9 had been non-adherent, only 68 (79%) of patients would have been adherent.
I. Sleep Disordered Breathing

0525
EFFICACY OF AUTOADJUSTING PAP (APAP) TREATMENT WITH DIFFERENT TECHNOLOGIES OF EXPIRATORY PRESSURE RELIEF: A BENCH EVALUATION
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Introduction: The technology of pressure relief during expiration (PRE) is aimed at improving the patient comfort during the CPAP treatment for obstructive sleep apnea (OSA). However, the effect of PRE on the efficacy of APAP treatment is not well determined.

Methods: Five modes of PRE applied by three APAP devices were included in our study (A-Flex3, P-Flex for PR1 Remstar Auto, Philips-Respironics, denoted as D1; EPR3 for S9 Autoset, Resmed, denoted as D2; SoftPAP2 and SoftPAP3 for Prisma 20A, Weinmann, denoted as D3). Each APAP device was subjected to a 30-minute bench-simulated breathing sequence of obstructive apnea (initial AHI = 48/h). For each device, the bench-assessed residual AHI and treatment pressure, and device-reported pressure were compared with and without PRE.

Results: Except SoftPAP2, bench-assessed residual AHI increased with all the PRE modes. For D1, residual AHI and mean pressure changed from 20/h and 8.2 cmH2O without PRE, to 43.3/h and 7 cmH2O with A-Flex3, and to 48/h and 6 cmH2O with P-Flex (p < 0.001 each). For D2, residual AHI and median pressure changed from 10/h and 10.8 cmH2O without PRE, to 12/h (p < 0.01) and 10.2 cmH2O (p < 0.001) with EPR3. For D3, residual AHI and median pressure changed from 35.3/h and 9.3 cmH2O without PRE, to 30.7/h (p < 0.05) and 8.6 cmH2O (p < 0.001) with SoftPAP2, and to 45.3/h (p < 0.05) and 8.1 cmH2O (p < 0.001) with SoftPAP3. The device-reported treatment pressures were overestimated by 20% and 30% with A-Flex3 and P-Flex respectively for mean pressures, and by 28%, 10%, and 17% with EPR3, SoftPAP2 and SoftPAP3 respectively for median pressures (p < 0.001 each).

Conclusion: With most modes of PRE, our bench evaluation showed reduced efficacies of APAP treatment for OSA, owing to ineffective treatment pressure which was overestimated in the APAP device reports.

Support (If Any): DeVilbiss Healthcare

0526
RESOLVING FLOW-LIMITATION AND PERIODIC BREATHING CONFLICTS IN AN AUTO CPAP ALGORITHM
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Introduction: Upper airway narrowing and flow-limitation frequently co-exist with periodic breathing (PB), challenging automated algorithms, such as that in positive pressure devices, to accurately quantify and respond to the various respiratory phenotypes.

Methods: PB detection sensitivity was developed using over 200 hours of high altitude polysomnogram/respiration data. If patterns at sea level are similar to those at high altitude, high loop gain sleep apnea can be inferred and identified. The DeVilbiss auto-CPAP algorithm we have developed uses parallel and independent event detection of PB versus discrete respiratory events, allowing simultaneous generation of all data types. Pressure response decisions are prioritized, with periodic breathing taking precedence. A clinical assessment of 28 subjects with a spectrum of sleep apnea phenotypes used a primary endpoint of expert human reviewer agreement, every 20 minutes, with decisions made by the device (increase, decrease, no change).

Results: 16/28 were male, mean age of 54.2 years (range: 27–75), mean BMI 35.0 kg/m2 (range 19.6 to 53.3 kg/m2). Entry minimum diagnostic AH1% was 15. On the test device, mean PSG vs. machine AH13% or arousal for all subjects was not significantly different, 15.9 ± 10.6 vs. 15.8 ± 9.7. Time in none, and grades 1–3 periodic breathing were 11768, 820, 242, and 29 minutes respectively (91.5, 6.4, 1.9 and 0.2%). Detection of obstructive and central apnea were at the level of 87–88% sensitivity and specificity. Overall, 630 pressure response determinations at 20-minute intervals for 28 subjects were recorded and reviewed by an expert reviewer. In 581 decision points (92.2%, 95% CI 89.9%–94.2%), the reviewer agreed with the algorithm’s decision.

Conclusion: It is possible to algorithmically reconcile the conflict between periodic breathing and flow limitation, with a clinically effective pressure response. Prospective clinical evaluation will be required to assess performance of the algorithm in treatment naïve patients, especially those with high loop gain coexisting with obstructive features, and over the long term.

Support (If Any): DeVilbiss Healthcare

B. Clinical Sleep Science

0527
THE RELATIONSHIP BETWEEN NIGHTLY HOURS OF CPAP USE AND BLOOD PRESSURE RESPONSE IN PATIENTS WITH OBSTRUCTIVE SLEEP APNEA AND HYPERTENSION
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Introduction: Obstructive sleep apnea (OSA) is an independent risk factor for hypertension; however, the blood pressure response to CPAP is not clear. We aim to analyze the relationship between nightly hours of CPAP use and ambulatory blood pressure measurements in patients with OSA and hypertension.

Methods: We performed a retrospective chart review of patients at an academic sleep center between 2011 and 2013. The electronic medical record was used to identify patients with both hypertension and OSA who initiated CPAP and returned for follow-up after 10 weeks. Patients were aged 18–75, with a desaturation-based AHI > 5 and an arousal-based AHI > 15. Subjects were excluded for CPAP use under 70% of nights or for any change in blood pressure medications. Blood pressure measurements from two visits prior to CPAP initiation were averaged and compared with the measurement taken at the follow-up visit. A linear regression analysis was performed to compare average hours of CPAP use with the change in diastolic (DBP) and systolic blood pressure (SBP) measurements.

Results: The search criteria yielded 296 charts; 41 subjects were included. Subjects used CPAP 94% of nights with average use of 6.4 hours/night (SD ± 1.8). The mean change in SBP and DBP was −3.9 mmHg (p-value 0.03) and −2.9 mmHg (p-value 0.02), respectively. Regression analysis showed a drop of 0.97 in SBP and a drop of 0.74 in DBP for every hour of CPAP use. However, the correlation coefficients were low indicating that the hours of CPAP use explains very little of the observed variation in blood pressure.

Conclusion: A small improvement in blood pressure was seen in our subjects with hypertension and OSA who were initiated on CPAP.
With increasing hours of CPAP use, small incremental improvements in blood pressure were seen; however, the effect is weak.

0528 COMPARISON OF THE UPPER AIRWAY DYNAMICS OF ORONASAL AND NASAL MASKS WITH POSITIVE AIRWAY PRESSURE TREATMENT USING CINE MAGNETIC RESONANCE IMAGING

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Introduction: It is known that oronasal masks are not as effective at opening the upper airway compared to nasal only continuous positive airway pressure (CPAP) masks in patients with sleep disordered breathing. However, the physiological mechanism for this difference in efficacy is not known; although, it has been hypothesized to involve the retroglossal and/or retropalatal region of the upper airway. The objective of this study was to investigate differences in retroglossal and retropalatal anterior-posterior space with the use of oronasal vs. nasal CPAP masks using real-time cine Magnetic Resonance Imaging (cMRI).

Methods: 10-Subjects (8-men, 2-women) with obstructive sleep apnea (OSA) were given cMRI with both nasal and oronasal CPAP masks. Each subject was imaged with each interface at pressures of 5, 10 and 15 cm of H2O, while in the supine position along the sagittal plane.

Results: The oronasal mask produced significantly less airway opening in the retropalatal region of the upper airway compared to the nasal mask interface at CPAP of 10 and 15 cm of H2O. P-values of the significant paired t-tests ranged from 0.016 to 0.001 depending on the pressure and the point of measurement in the respiratory cycle. No differences were found in the retroglossal region between mask styles at any tested pressure.

Conclusion: Our study confirmed previous findings showing differences in treatment efficacy between oronasal and nasal mask styles. We have shown anatomic evidence that the nasal mask is more effective in opening the upper airway compared to the oronasal mask at CPAP of 10 and 15 cm of H2O.

0529 DOES POSITIVE AIRWAY PRESSURE Adherence REFLECT MEDICATION Compliance?

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Introduction: Positive airway pressure (PAP) therapy is the first-line treatment for obstructive sleep apnea (OSA). Despite evidence that treatment improves sleep quality, enhances quality of life, and assists in mitigating the increased risk for cardiovascular events, adherence remains poor. It is unclear if non-adherence is a result of the treatment modality itself or if it is reflective of overall compliance (or lack thereof) with general medical therapy. The purpose of this study is to determine if there is a correlation between PAP and general medical therapy adherence as measured by outpatient medication compliance.

Methods: We conducted a retrospective review of patients newly diagnosed with OSA initiating PAP therapy in the Walter Reed Sleep Disorders Clinic. Baseline demographic, polysomnographic data, and PAP adherence for the first six months of use were recorded. Outpatient medications were reviewed manually within our closed electronic medical record system for the six months following the initiation of PAP treatment. Investigators were blinded to the polysomnographic results and PAP adherence data at the time of medication data retrieval.

Results: One-hundred consecutive patients were included in the study. Of these patients, 62% were prescribed chronic medications and were included in the final analysis. Seventy-six percent of the cohort were male with an average age of 42.5 ± 13.5 years. The mean body mass index and apneahypopnea index were 28.5 ± 5.0 kg/m² and 18.1 ± 6.2 events/hour, respectively. Overall, PAP and medication adherence for the cohort was 75.4% and 56.9%, respectively. There was a significant correlation between medication compliance and PAP adherence ($r^2 = 0.724$). Patients non-adherent with PAP therapy were more likely to be non-compliant with outpatient medications (71.4% vs. 26.7%, p = 0.01).

Conclusions: In our cohort, PAP adherence and outpatient medication compliance were closely related. This suggests that PAP adherence may be indicative of overall compliance with general medical therapy. Further studies are necessary to better characterize this association.

0530 LONG-TERM THERAPY Adherence TO UPPER AIRWAY Stimulation IN A CPAP InTolerant OSA STUDY COHORT

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Introduction: Upper airway stimulation (UAS) using implantable cranial nerve XII neurostimulation is a safe and effective therapy for obstructive sleep apnea (OSA) patients unable to use CPAP. We present 24- and 30-month UAS therapy adherence, and compared this with the usage and to historical yearly estimated adherence to prior therapy over the prior 3 years.

Methods: In the Stimulation for Apnea Reduction (STAR) trial, subjects with moderate to severe OSA and CPAP intolerance received an UAS system (Inspire Medical Systems, Minneapolis, MN). Self-report historical CPAP (n = 126) and oral appliance therapy (OAT; n = 24) start and last use dates and estimates of yearly use over the past 36 months were collected at the time of enrollment. Self-reported UAS nightly usage was collected at ~6 month intervals starting at 12-months after implant through the 30-month follow-up (last available complete dataset).

Results: All STAR subjects (83% male, 55 ± 10 years old; M ± SD) were CPAP intolerant or non-compliant, by study design. All had attempted CPAP for 3.5 ± 4.1 years. OATs were attempted by 25%, and used for 0.8 ± 1.4 years. Historical self-report adherence to CPAP was 73% at 12-, 54% at 24-, and 47% at 36-months. In the smaller group trying OAT, adherence was 42% at 12-, 23% at 24-, and 10% at 36-months. In comparison, UAS daily usage was 86% at 12-, 81% at 24-, and 81% at 30-months after implantation. The remaining 19% used the therapy ~2.7 ± 1.9 nights per week from 12- to 30-months.

Conclusion: Retrospective patient history showed lower rates of CPAP and OAT use and higher rates of abandonment estimated over 3 prior years vs. therapy adherence to UAS over 30-months of follow-up after implantation.

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0531
UPPER AIRWAY STIMULATION FOR OBSTRUCTIVE SLEEP APNEA: CORRELATION OF OBJECTIVE AND SUBJECTIVE OUTCOMES
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Introduction: Upper airway stimulation has been shown to improve both objective and subjective outcomes in participants with moderate-to-severe obstructive sleep apnea in a large cohort study after 12 months of follow-up. It is unclear if there is correlation between the objective and subjective measures, and whether therapy non-responders reported subjective improvement. This report explores these interactions.

Methods: A total of 126 participants received an implanted upper airway stimulation system (Inspire Medical Systems, Minnesota, USA) in a prospective phase III trial. The objective outcome of the apnea hypopnea index (AHI) was measured and averaged from in-lab PSG studies at 12 and 18 months. The subjective outcome measures included Epworth Sleepiness Scale (ESS) and the Functional Outcome of Sleep Questionnaire (FOSQ) were also measured and averaged from 12 and 18 months post-implant follow-up. Data are presented as mean (SD).

Results: A total of 124 participants completed follow up at 12 months and 121 participants at 18 months. Among therapy responders (N = 78) with AHI less than 20 and ≥50% reduction from baseline, the AHI was reduced from 30.3 (11.2) to 6.8 (4.1), with an increase of the FOSQ of 2.6 (2.8) and decrease of the ESS of 4.2 (4.4) from baseline. Among non-responders (N = 46), AHI was reduced from 34.1 (11.9) to 28.4 (14.6), with an increase of the FOSQ of 3.4 (3.7) and a decrease of the ESS of 5.0 (5.6). The correlation coefficient between AHI reduction (%) and FOSQ and ESS change was 0.08 and 0.02, respectively, among all participants.

Conclusions: Subjective outcomes improved consistently among participants that received upper airway stimulation for OSA, with or without objective improvement in AHI.

0532
DURABILITY OF STIMULATION THRESHOLDS AND AMPLITUDES AT 24 AND 30-MONTHS OF UNILATERAL CRANIAL NERVE XII STIMULATION FOR OBSTRUCTIVE SLEEP APNEA
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Introduction: Upper airway stimulation (UAS) using an implantable cranial nerve XII neurostimulation system is a safe and effective therapy for CPAP-intolerant patients with obstructive sleep apnea (OSA). Long-term stability of stimulation amplitudes is of potential concern for any neurostimulation therapy. Patient-specific stimulation thresholds at 12-months and 18-months post implant were previously reported, and stable. We present the stimulation durability at 24 and 30-months after implantation.

Methods: In the Stimulation for Apnea Reduction (STAR) trial, 126 subjects with moderate to severe OSA and CPAP intolerance received an implantable neurostimulation system (Inspire Medical Systems, Minneapolis, MN), with a programmable stimulation amplitude between 0 and 5 volts in 0.1 V increments. Patient-specific stimulation thresholds were categorized as sensation threshold when stimulation is first felt, functional threshold when bulk tongue motion was achieved, and sub-discomfort is the highest comfortable amplitude while awake. Therapeutic stimulation amplitude was last titrated (if needed) during the 18-month PSG, within a patient-controllable therapeutic range. Subjects were followed in-office at 6-month intervals after 18-months.

Results: At the 24-month follow-up, 115 subjects were seen, and at the 30-month follow-up, 112 subjects. The 18-month sensation, functional, and sub-discomfort thresholds were: 1.1 ± 0.6 volts; 1.8 ± 0.7; 2.7 ± 1.0, respectively. At the 24-months, thresholds were 0.9 ± 0.5; 1.5 ± 0.7; and 2.3 ± 0.9. At 30-months, thresholds were 0.9 ± 0.5, 1.5 ± 0.7, 2.3 ± 1.0. The 18-month therapeutic amplitude was 1.8 ± 0.9 Volts. The amplitude at 24-months was 1.8 ± 0.7 volts, (p = 0.10 vs. 18-month), and at 30-months, 1.7 ± 0.7 volts (p = 0.05 vs. 24-month). From 18 to 30 months, 78% of subjects had programmed amplitude within 3 steps (±0.3 volts) of the amplitude programmed at the 18 month visit.

Conclusion: UAS stimulation thresholds and amplitudes continue to be stable after 2.5 years of follow-up. Long-term management in the absence of symptoms may require only an annual follow-up for amplitude assessments.

Support (If Any): Study was sponsored by Inspire Medical Systems

0533
NASAL STRIP IS AN EFFECTIVE PLACEBO TREATMENT IN SEVERE OBSTRUCTIVE SLEEP APNEA
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Introduction: The aim of this study was to compare polysomnographic (PSG) parameters without and with nasal strip and the effect on symptoms after one month of nasal strip treatment in patients with severe obstructive sleep apnea (OSA).

Methods: Nine consecutive out-patients (mean ± standard error) (1 female; age = 49.9 ± 2.9 years; body mass index = 31.3 ± 1.6 kg/m²; Epworth Sleepiness Scale score = 15.8 ± 1.4) with severe OSA were evaluated. Paired T test (1,000 bootstrapped samples) was used. Patients underwent two full night PSG evaluations: without nasal strip (before beginning treatment with nasal strip) and with nasal strip (first night of treatment with nasal strip). Epworth Sleepiness Scale (ESS), Beck Depression Inventory (BDI), and Functional Outcomes of Sleep Questionnaire (FOSQ) were applied before and after one month of wearing nasal strip during sleep. A Satisfaction Treatment Questionnaire (STQ) was also applied after treatment.

Results: No statistically significant differences were found between PSG evaluations: apnea-hypopnea index (mean ± standard error; 95% Confidence Interval) (69.2 ± 5.2; 59.2–77.9 vs. 56.5 ± 7.3; 43.2–69.6) (p = 0.09), respiratory disturbances index (69.2 ± 5.2; 59.2–77.9 vs. 56.7 ± 7.4; 43.3–69.9) (p = 0.09), oxyhemoglobin saturation nadir (72.4 ± 2.6; 67.3–77.1% vs. 72.0 ± 4.4; 62.8–77.8%) (p = 0.9), and all other objective sleep parameters (p ≥ 0.12). ESS (15.8 ± 1.4; 13.3–18.1 vs. 13.4 ± 2.2; 9.4–17.4) (p = 0.12), BDI (10.8 ± 2.9; 6.2–16.7 vs. 8.5 ± 3.2; 3.2–14.9) (p = 0.24), and FOSQ scores (12.6 ± 0.9; 10.9–14.2 vs. 13.7 ± 1.3; 11.3–16.0) (p = 0.35) were also similar between evaluations. According to STQ, patients found no improvement in quality of sleep and life, daily activities, and daytime sleepiness after a month of the nasal strip treatment, but stated that the use and adherence were very easy.

Conclusion: Nasal strip was not effective in reduce objective sleep parameters and complaints (daytime sleepiness, depression complaints, and quality of life) of patients with severe OSA but wearing nasal strip.
and treatment adherence were very easy to be achieved. Nasal strip could be considered as an effective placebo treatment in those patients. **Support (If Any):** Fundação de Amparo a Pesquisa do Estado de São Paulo - FAPESP (#13/12301-5; #13/14025-5) and Núcleo Interdisciplin- ar da Ciência do Sono - NICS

## 0534
**NON INVASIVE ORAL PRESSURE THERAPY FOR OBSTRUCTIVE SLEEP APNEA: A CASE SERIES AT AN ACADEMIC SLEEP CENTER**
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**Introduction:** Recently an innovative noninvasive oral pressure therapy (OPT; Winx®, ApnICure) was approved as an alternative treatment of Obstructive Sleep Apnea (OSA). The concept of OPT is to apply negative intraoral pressure that reduces intraoral volume thereby stabilizing the velopharynx. We describe our experience at the Mayo clinic Sleep Center since the FDA approval of OPT in July 2012.

**Methods:** At a quaternary teaching medical center, we reviewed all patients that received a trial of the OPT device. All patients underwent an attended polysomnography using a split-night protocol, (initial diagnostic study and subsequent OPT trials on the same night.) We defined treatment success as tolerating treatment with a residual AHI < 5.

**Results:** were reported using means and proportions. Non-parametric testing (Wilcoxon rank test and Fisher's exact test) were used as appropriate.

**Results:** A total of 9 patient received an OPT trial. OPT success was observed in 33% of the patients. Patients with OPT success were significantly younger (54.3 ± 4.5 vs 66 ± 2.1, p = 0.02), and tended to have a lower AHI (19.0 ± 16 vs 32.8 ± 26, p = 0.6). There was no difference between those with successful and unsuccessful trails when comparing gender (male: 66% vs 66%), BMI (31.8 ± 6.4 vs 32.4 ± 8.4, p = 0.99), comorbidities (DM2, HTN, CHF, CAD) or medication usage (Opioids, Benzodiazepines, sleep aids). Of those with OPT failure, 5 (83%) were due to lack of OSA control and 1 patient with a history of high-frequency radioablation had severe soft palate bleeding.

**Conclusion:** In this small series, few patients achieved treatment success with OPT. Treatment success was associated with younger age. Severe soft palate bleeding can be experienced by patients with oral surgeries.

## 0535
**ORAL APPLIANCE AND PHARMACOLOGIC AGENTS IN TREATMENT OF OBSTRUCTIVE SLEEP APNEA: A PILOT CLINICAL STUDY**
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**Introduction:** Oral appliances such as the mandibular advancement device (MAD) have not been deemed fully therapeutic in moderate to severe obstructive sleep apnea (OSA). As such, we conducted a pilot study to investigate augmentation of the MAD by pharmacotherapy in these patients. The objectives of this study were: 1) to investigate the feasibility of combined treatment by MAD with pharmacotherapy in patients with moderate to severe OSA; 2) to estimate the treatment effects of MAD only and MAD with pharmacotherapy; and 3) to differentiate these treatment effects according to respiratory event frequency (apnea-hypopnea index).

**Methods:** A prospective, placebo-controlled, blinded crossover study of 11 subjects with moderate- severe OSA was conducted. Treatment was a MAD plus placebo medication for two weeks, followed by a combination regimen of ondansetron (24 mg/day) and fluoxetine (10 mg/day) with continued use of the MAD for another two weeks. The primary outcome measure was Apnea-Hypopnea Index (AHI).

**Results:** Paired samples t test indicated: AHI MAD (19.1 ± 4.8) was significantly lower than the AHI baseline (33.4 ± 3.3) and AHI MAD + Drug (14.4 ± 3.0) was significantly lower than the AHI baseline. Specifically, NREMAHI MAD (13.9 ± 4.1) was significantly lower than the NREMAHI baseline (29.8 ± 3.5) and NREMAHI MAD + Drug (9.6 ± 2.3) was significantly lower than the NREMAHI baseline. Although not statistically significant, AHI MAD + Drug was lower than AHI MAD. Both variables AHI MAD and AHI MAD + Drug were highly correlated r = 0.8, p < 0.05. No significant differences among treatment modalities were found when assessing AHI in various sleep positions and REM stage sleep.

**Conclusion:** Combination of pharmacotherapy and oral appliance may be a viable option in treating patients with moderate-severe OSA.

**Support (If Any):** University of Illinois at Chicago Chancellor's Discovery Fund for Multidisciplinary Research (IRB protocol: 2011-0629)

## 0536
**INDICATION CRITERIA OF ORAL APPLIANCE FOR OSA IN JAPAN-RETROSPECTIVE STUDY**
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**Introduction:** Obstructive Sleep Apnea (OSA) is known as a common disease. It develops Cardiovascular disease, endocrine disease, metabolic disease and more by disordered breathing during sleep. Continuous Positive Airway Pressure (CPAP) and Oral Appliance (OA) is the standard for the treatment of OSA. OA is usually used for mild to moderate cases. It has been adapted for some severe cases of OSA when CPAP cannot be used because of discomfort for the patient. However, Indication criteria of OA is not clear. In this study, we examined the indication criteria of OA from the database retrospectively.

**Methods:** We enrolled consecutive 427 OSA patients who diagnosed by Polysomnography (PSG) and treated by OA, from July 2004 to December 2011 in Ota memorial sleep center (Kawasaki, Japan). Success criteria are less than 50% reduction after treatment in mild group (baseline AHI < 20) and AHI < 20 and less than 50% reduction after treatment in moderate-severe group (baseline AHI ≥ 20). Response variable was success and non-success. Explanatory variables were age, BMI, result of cephalometric analysis and AHI. Then, we analyzed using multiple logistic regression.

**Results:** In mild group, Success rate of OA is 50.3% And 61% in moderate-severe group. SNB angle of cephalometric analysis (Cut off < 79°, Odds ratio 3.05) and BMI (Cut off < 26 kg/m², Odds ratio 2.75) are independent factors in mild group. And facial axis of cephalometric analysis (Cut off < 86°, Odds ratio 2.02), AHI (Cut off < 60/h, Odds ratio 3.19) and age (Cut off < 70, Odds ratio 2.24) in moderate-severe group.

**Conclusion:** OA treatment has been shown to be effective to case of small lower jaw, non-obese, non-elderly and non-severe OSA.
I. Sleep Disordered Breathing

B. Clinical Sleep Science

0537
CHRONIC EFFECTS OF RAMELTEON ON SLEEP DISORDERED BREATHING IN PATIENTS WITH OSA AND INSOMNIA: A PRELIMINARY STUDY
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Introduction: Obstructive sleep apnea (OSA) combined insomnia can be encountered in clinical practice. In such a case, we need to be careful about prescribing hypnotics since upper-airway muscle relaxation due to hypnotics may worsen OSA. In the current study, we investigated the chronic effects of Ramelteon, which is a selective MT1/MT2 melatonin receptor agonist, on sleep disordered breathing (SDB) in patients with OSA and insomnia.

Methods: So far 5 patients with OSA and insomnia participated in a randomized, double-blinded, placebo-controlled, crossover trial. Inclusion criteria for patient’s enrollment were that patients with suspected OSA and suffering from insomnia including a difficulty of falling and/or staying asleep were eligible. The patients who have been already treated with hypnotics were excluded, but patients who agreed with the cessation of current hypnotics for 2 weeks were eligible to enroll in this study. Participants took Ramelteon (8 mg/day) or placebo before sleep for 3 weeks, and then diagnostic PSG was performed taking the same agent. For the next 3 weeks, the same protocol was repeated using another agent.

Results: The age and body mass index (BMI) of the enrolled 5 patients were 66.6 ± 14.2 yr. and 28.6 ± 3.5 kg/m², respectively. The apnea-hypopnea index (AHI) was not different between under taking Ramelteon and placebo (26.2 ± 17.7, 22.9 ± 12.1, p = 0.74, respectively). Regarding the sleep structure, 3 weeks of administration of Ramelteon did not affect sleep latency, sleep efficiency, and sleep stages. However, all participants wanted to continue the treatment of Ramelteon for their insomnia.

Conclusion: Current preliminary study demonstrated that chronic administration of Ramelteon did not affect SDB, which implies Ramelteon would be one of the candidates as a safety treatment for patients with OSA and insomnia. Even though sleep parameters did not improve with Ramelteon, all participants have been still taking Ramelteon by their own intention.

0538
SLEEP APNEA MANAGEMENT EFFECT SIZES: OBJECTIVE VS. SUBJECTIVE MEASURES
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Introduction: It is well known that objective measures of sleep apnea severity only correlate modestly with self-reported measures of sleep apnea symptoms at baseline. This has been thought to be largely a function of issues associated with self-reported questionnaires. What has not been examined to date is the extent of this discrepancy over time while on treatment.

Methods: Data from an existing clinical trial on a positive airway pressure (PAP) therapy adherence were examined. Baseline AHI was obtained from diagnostic sleep testing. Follow-up AHI was an average of the residual AHI provided by the PAP device over the treatment period. Epworth Sleepiness Scale was used as a proxy for sleep apnea symptoms and was self-reported. Effect size (ES) was calculated using Cohen’s d.

Results: Baseline AHI was 28.0 (SD = 7.5) and residual AHI was 1.9 (SD = 1.3). The effect size for AHI reduction was 4.85. Baseline ESS was 10.7 (5.2) and follow-up was 8.4 (4.9). The effect size for ESS reduction was 0.45. There are a number of ways to interpret effect size with one being to put it in terms of the correlation coefficient: an ES of 0.45 is equivalent to an r correlation of 0.22 while an ES of 4.85 is equivalent to an r correlation of 0.92.

Conclusion: In this sample of OSA patients, sleep apnea was very well controlled (with mean residual AHI of 2.5). However, while the effect size for change in AHI is extremely large, the effect size for change in sleepiness level is modest in comparison. A number of reasons might account for this difference, including the time period over which the residual AHI applies and the baseline self-report response bias in sleep-deprived patients. Future research should determine the factors and their contribution in helping to explain this discrepancy in effect sizes.

Support (If Any): Veterans Affairs

0539
MANDIBULAR ADVANCEMENT DEVICE (MAD) TREATMENT OF SLEEP APNEA IN CPAP-INTOLERANT MILITARY VETERANS IMPROVES SLEEPINESS, QUALITY OF LIFE AND PTSD SYMPTOMS
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Introduction: CPAP (continuous positive airway pressure) non-adherence hinders adequate treatment of obstructive sleep apnea (OSA). Although adverse consequences of untreated OSA are numerous and well-known, discomfort from CPAP limits its use. Adherence is especially reduced in the military veterans due to high incidence of post-traumatic stress disorder (PTSD) and claustrophobia. The purpose of this study is to assess whether veterans that cannot tolerate CPAP will tolerate MADs, and whether their OSA can be effectively treated with MADs.

Methods: A non-randomized, prospective, cohort study was performed with subjects who were non-adherent with CPAP by the CMS definition (4 hours per night greater than 70% of nights). After dental evaluation, they were fitted with MADs which were advanced to a goal protrusion. "Elbow sign", which is a bed-partner reported presence of snoring/apnea, Epworth Sleepiness Scale (ESS) and Sleep Apnea Quality of Life Index (SAQLI) were recorded at baseline and 6–12 weeks after MAD use. Improvement in PTSD symptoms was also assessed after MAD use.

Results: In this ongoing study, 14 patients completed repeat questionnaires after device use. All 14 subjects who were non-adherent with CPAP were adherent with MAD by CMS criteria. All 14 had positive “Elbow sign,” prior to MAD, which disappeared in 13 subjects with MAD. Subjective sleepiness improved from ESS mean ± SD of 10.4 ± 5.6 to 5.1 ± 2.8 (p = 0.0005). Quality of life by Short SAQLI mean ± SD improved from 2.7 ± 1.6 to 6.0 ± 0.9 after MAD (p < 0.0001). Of the patients with PTSD (n = 11), 64% (n = 7) of patients reported improved PTSD symptoms, 36% (n = 4) were unchanged. None reported worsening PTSD or claustrophobia with MAD.

Conclusion: Treating CPAP-intolerant OSA patients with MAD improves symptoms and quality of life. MADs are well-tolerated by veterans with PTSD, and their use in patients with OSA may improve PTSD symptoms.

B. Clinical Sleep Science

0540
THE EFFECT OF DONEPEZIL ON SLEEP APNEA IN PATIENTS WITH OBSTRUCTIVE SLEEP APNEA AND SYMPTOMS OF INSOMNIA
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Introduction: Donepezil is an acetylcholinesterase inhibitor commonly used to treat Alzheimer’s disease. Some previous studies have shown that donepezil might improve obstructive sleep apnea (OSA) and decrease sleep efficiency. The changes of arousal threshold and/or muscular compensation are possible mechanisms that Donepezil affect sleep apnea. The hypothesis of this study is a single dose of donepezil 10 mg might lower apnea hypopnea index (AHI) in OSA patients with symptoms of insomnia, whom are considered to be hyperarousal.

Methods: In a randomized, double blind cross-over study, five participants with OSA underwent two overnight polysomnograms 14 days apart. All of them frequently/always have difficulty falling asleep, staying asleep or feel that their sleep is unrefreshing in the past one month. Either 10 mg of donepezil or placebo (in blinded, arbitrary order) were received.

Results: AHI changed from 43.5 to 27.3, 116.9 to 89.5, 35.2 to 55.7, 19.0 to 18.8 and 9.9 to 28.5 events/hr in the five subjects respectively. The nadir SpO2% were 78% and 82%, 80% and 71%, 81% and 82%, 79% and 76%, 90% and 89%. Percentage of rapid eye movement stage changed from 8.1 ± 8.9%, 3.1 to 11.6%, 21.5 to 27.8%, 20.6 to 22.9%, 29.8 to 18.6%. Sleep efficiencies were 56.6 and 46.5, 42.2 and 54.5%, 65.5 and 70.7%, 71.4 and 76.0%, 76.1 and 81.8% respectively.

Conclusion: Donepezil may impact OSA severity and sleep efficiency in patients with symptoms of Insomnia, but further data are required to determine whether association between severity of the symptoms of insomnia and treatment outcomes. Whether donepezil is a viable approach to therapy in selected groups of OSA patients need be investigated.

Support (If Any): This study was funded by NIH K24HL093218 (PI:Malhotra), 1P01HL095491 (PI:Malhotra). Dr. Yanru Li is supported by The National Natural Science Foundation of China (81200735)

0541
EFFECTS OF ONE WEEK TONGUE ELEVATION-TASK TRAINING ON SLEEP APNEA SEVERITY: A PILOT STUDY
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Introduction: Sleep disordered breathing improve following daily exercise involving upper airway muscles. Genioglossus corticmotor excitability has been found to enhance following tongue task training (TTT) where subjects are asked to develop low intensity (1 N) protrusion efforts for 1.5 s every 10 s for 1 hour daily during 1 week. Preliminary results from our laboratory demonstrate that such TTT decreases AHI by 23%, with a 48% decrease in AHI in REM sleep. AHI decreased from the moderate to mild range in 40% of patients. The aim of the present study was to assess if the completion of such task training using tongue elevation efforts (TTTe) would provide similar improvements in sleep disordered breathing.

Methods: TTTe was performed with the same algorithm as described above but elevation replaced protrusion efforts by pushing the tongue against the hard palate. The target effort intensity corresponded to ≈ 4% of maximal voluntary contraction force (MVCF). It was assessed by changes in palatal pressure measured with a plastic bulb positioned on the hard palate. The proportion of time where subjects actually maintained the force inside the target window in relation to the total tongue elevation task time was defined as the success rate. An ambulatory polysomnographic recording was completed immediately before and the day following TTTe. Genioglossus muscle mechanical performances were assessed before and after TTTe by measuring MVCF and completing a fatigue protocol assessing endurance time and time for force recovery.

Results: Five sleep apnea male subjects (age 56 ± 12 y, BMI: 28.0 ± 1.5 kg/m²) participated in the study. TTTe success rate increased from the first to the last day of the training program (21 ± 9% to 48 ± 16%). AHI did not change following TTTe (24.6 ± 12.6/h to 25.4 ± 12.7/h). Sleep efficiency, arousal index and SaO2 features (oxygen desaturation index, % sleep below 90% SaO2) were not improved following TTTe. However, AHI during REM improved from 24.6 ± 21.3/h to 18.0 ± 12.4/h. TTTe did not influence baseline MVCF but endurance improved from 5.2 ± 2.6 min to 8.6 ± 3.4 min with no difference in time for force recovery.

Conclusion: A 1-week TTTe program consisting in tongue elevation improves genioglossus endurance and REM-related breathing disorders. The present results differ from those obtained with a protrusion TTTe. These ones could be accounted for by differences in success rate between the two TTTe programs.

Support (If Any): Canadian Institutes of Health Research, Grant 89985
Support (If Any): The Capital Health Research and Development Special Grant, Government of China. JMP received funding from the National Institute on Aging.

0543 THE EFFECT OF ACUPUNCTURE ON UPPER AIRWAY FUNCTION AND PHYSIOLOGY AND SUBJECTIVE OUTCOMES IN OBSTRUCTIVE SLEEP APNEA

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Introduction: Obstructive sleep apnoea (OSA) involves repetitive obstruction of the upper airway during sleep. Continuous positive airway pressure (CPAP) is the most common treatment, however, many patients cannot tolerate CPAP and adherence rates are low. Recent research has suggested that acupuncture can reduce the severity of OSA. The aim of the present study was to determine whether acupuncture is an effective alternative treatment, and to identify any underlying physiological changes occurring in the upper airway as a result of acupuncture treatment.

Methods: Twenty OSA patients were randomly assigned to receive 12 weeks of active acupuncture (n = 10 (3 F); mean AHI = 23.38 events/hour; mean age = 56.3 years) or placebo acupuncture (n = 10 (3 F); mean AHI = 20.89 events/hour; mean age = 45.3 years) treatments. Prior to and following the treatment period subjects underwent detailed polysomnography, including measurement of epiglottic pressure, calibrated airflow and genioglossus muscle activity. In addition, subjective health and wellbeing, sleepiness and mood were assessed.

AHI, waking nasopharyngeal resistance, arousal threshold and genioglossus muscle activity were analysed while blinded to treatment type and study time.

Results: As data analysis is not complete, physiological data has not yet been unblinded. There were no significant differences within the active treatment or placebo treatment groups, nor between groups across time on the Functional Outcomes of Sleep Questionnaire (active: p = 0.086; placebo: p = 0.187; between: p = 0.913), the Epworth Sleepiness Scale (active: p = 0.115; placebo: p = 0.320; between: p = 0.861), the Short form 36 (active: p = 0.065; placebo: p = 0.989; between: p = 0.143) or the Profile of Mood States (active: p = 0.844; placebo: p = 0.695; between: p = 0.951).

Conclusion: The preliminary data analysis shows that there are no differences between active- versus placebo-acupuncture in subjective health and wellbeing, sleepiness, or mood. Further data analysis of objective changes in AHI and upper airway physiology is in progress.

Support (If Any): Eirene Lucas Foundation Philanthropic Grant

0544 TEMPERATURE CONTROLLED RADIOFREQUENCY ABLATION AT DIFFERENT SITES FOR TREATMENT OF OBSTRUCTIVE SLEEP APNEA SYNDROME: A SYSTEMATIC REVIEW AND META-ANALYSIS

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Introduction: Obstructive Sleep Apnea (OSA) is an increasingly prevalent condition that remains underdiagnosed and undertreated. Our objective was to determine the efficacy of temperature controlled radiofrequency tissue ablation (TCRFTA) to alleviate symptoms of OSA and reduce polysomnographic measures of OSA post-treatment.

Methods: We performed two independent searches of MEDLINE, EMBASE bibliographic databases and Evidence Based Medicine Reviews to identify publications relevant to OSA and TCRFTA. Effectiveness of TCRFTA was measured separately for application of TCRFTA at the base of tongue (BOT), soft palate and for multilevel intervention using the Respiratory disturbance index (RDI), lowest oxygen saturation (LSAT), Epworth sleepiness scale (ESS) and bed partner’s rating of snoring using a visual analogue scale (VAS snoring). The most recent search was conducted in April 2013. Statistical analysis was performed using Review Manager Version 5.2 using a relative measure of effect i.e., ratio of means (RoM). We pooled data using inverse variance weighting and random effects model. The overall quality of evidence was graded using the Grading of Recommendations, Assessment, Development and Evaluation (GRADE) approach.

Results: Our initial search resulted in 29 eligible studies, and subsequent 20 studies were included in the meta-analysis. Significant improvement in polysomnography and subjective outcomes were observed post-TCRFTA in the BOT and multilevel surgery groups only. Application of TCRFTA at the BOT was associated with a significant reduction in RDI (RoM 0.60, CI 0.47–0.76), ESS (RoM 0.59, CI 0.51–0.67), VAS snoring (RoM 0.48, CI 0.37–0.62) and increase in lowest oxygen saturation (RoM 1.05, CI 1.01–1.10). Similarly, a significant reduction in RDI (RoM 0.61, CI 0.47–0.80) and ESS (RoM 0.79, CI −0.71 to 0.88) was observed after multilevel TCRFTA, but substantial heterogeneity between these studies was noted.

Conclusion: TCRFTA is clinically effective in reducing RDI levels and symptoms of sleepiness in patients with OSA syndrome when directed at the base of tongue or as a multilevel procedure.

0545 COMPLIANCE, EFFECTIVENESS, SIDE EFFECTS AND CONTINUOUS POSITIVE AIRWAY PRESSURE (CPAP) USE WITH MANDIBULAR ADVANCEMENT SPLINT (MAS) THERAPY FOR OBSTRUCTIVE SLEEP APNEA (OSA) AND SNORING

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Introduction: MAS therapy is a well recognised treatment option for OSA and snoring, which is often preferred over CPAP. Effectiveness may be comparable between these two treatments with some patients using both therapies, although data on this is sparse. MAS compliance data is also limited. We examined MAS compliance, effectiveness, side effects and combined use with CPAP in patients with sleep disordered breathing.

Methods: A questionnaire-based survey was sent (via mail or email) to 1460 patients who had used MAS for the management of OSA or snoring.

Results: There were 403 respondents (total response rate was 28%; mail response rate 33.6% and email response rate 25.0%). Median MAS usage was 1.6 years (range 0.5 to 9.0 years) with 82% of respondents still using the device for > 6 hours/night. Baseline polysomnography revealed mild OSA in 29.3%, moderate OSA in 42.0%, severe OSA in 21.5%, primary snoring in 0.6% and 6.6% not specified. MAS therapy resulted in overall improvements with the majority of patients (55.2%) having only mild OSA. Eighty-nine percent of patients felt the MAS was comfortable and improved sleep quality. 24.8% had minor side effects (temporomandibular joint discomfort being the commonest) and only 1.4% had major adverse events. Thirty percent of patients used the combination of MAS and CPAP, generally choosing MAS therapy when travelling and using CPAP when at home. Only rarely were both treatments used simultaneously.
**0546**

**CO-ADMINISTRATION OF CPAP AND GAL-160 AT SUB-THERAPEUTIC LEVELS DECREASES OBSTRUCTIVE APNEA SEVERITY IN RATS**

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**Introduction:** GAL-160 (> 100 ng/mL plasma) alone or CPAP (≥ 4 cmH2O) alone were efficacious at decreasing obstructive apnea (OA) severity in rats. Here, we evaluated sub-therapeutic levels of GAL-160 (40 ng/mL plasma) and CPAP (1 cmH2O) to determine if their effects in combination on OA are superior to either agent alone.

**Methods:** Urethane anesthetized supine rats were instrumented to record ventilation, trans-esophageal pressure, arterial blood pressure, pulse rate, genioglossus EMG (EMGGG), and transcutaneous pulse oximetry. Rats expressed spontaneous intermittent OAs (frequency: 30/hr; apnea duration: 11 sec) with clinically meaningful (> 10%) decreases in oxy-Hb saturation (SpO2,10% = 20 hr-1). First, we administered CPAP (1 cmH2O) or GAL-160 (15-min @ 0.005 then 60-min @ 0.003 mg/kg/min; 40 ng/ml plasma) alone to separate groups of rats. Thereafter, the sub-therapeutic modalities were co-administered to a separate group of rats.

**Results:** Single mode therapy: CPAP did not decrease apnea frequency, apnea duration, or SpO2,10% frequency. GAL-160 also did not reduce apnea frequency or SpO2,10% frequency but did decrease apnea duration (baseline 11 ± 1 sec; GAL-160: 7 ± 1 sec; means ± SEM). Decreased apnea duration may reflect GAL-160-mediated augmentation of EMGGG responses to OAs (60% larger cf. baseline). Combined mode therapy: GAL-160 + CPAP reduced apnea frequency (Baseline 23 ± 4 hr-1; GAL-160 + CPAP: 7 ± 4 hr-1), apnea duration (Baseline 12 ± 1 sec; GAL-160 + CPAP: 5 ± 1 sec), and SpO2,10% frequency (Baseline 15 ± 3 hr-1; GAL-160 + CPAP 3 ± 2 hr-1). GAL-160 augmented the EMGGG response to apnea as described above.

**Conclusions:** When sub-therapeutic levels of GAL-160 and CPAP are co-administered to rats they interact to become superior to either approach alone in decreasing OA severity. Further studies are required to determine whether this interaction is additive or synergistic.

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**B. Clinical Sleep Science**

**I. Sleep Disordered Breathing**

**Conclusion:** This is the largest study to examine MAS compliance, effectiveness, side effects and combination therapy with CPAP. Compliance in respondents was high and side effects were low. A subset of MAS patients also used CPAP therapy.

**Support (If Any):** Mr. Peter Field is an employee of Somnomed Ltd. The MAS device is supplied by Somnomed Ltd.

**0547**

**AIRWAY ANALYSIS AND MANDIBULAR ADVANCEMENT TREATMENT IN OBSTRUCTIVE SLEEP APNEA**

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**Introduction:** Obstructive Sleep Apnea (OSA) is an extensive public health problem that imposes considerable morbidity. While nasally applied Continuous Positive Airway Pressure (CPAP) is highly efficacious, its effectiveness in practice is limited by problems with treatment adherence. One well-tolerated alternative involves the use of oral appliance therapy, such as a mandibular advancement splint (MAS), but success rates are difficult to predict. Our objective was to investigate the associations between oropharyngeal airway dimensions, dental protrusion with MAS, sleep characteristics, and treatment response in an OSA patient sample.

**Methods:** Thirty-three adults were assessed retrospectively. Pre-treatment CBCTs were used to measure the airway. Airway volume, length, and minimal cross-sectional area (CSA) were calculated, as well as transverse and A-P dimensions and minimal CSA location. Pre- and post-treatment polysomnograms (PSGs) assessed OSA severity via RDI, and changes in minimal SaO2, supine and non-supine RDI, and NREM and REM RDI.

**Results:** This study included 23 males and 10 females. Ten, fifteen, and eight initially presented with mild, moderate, and severe OSA, respectively. Oropharyngeal 2D and 3D airway variables were associated with treatment response. Multivariate models explained treatment response, wherein initial OSA severity was a primary predictor in four models, and the combination of total airway volume and initial BMI were predictors in two models.

**Conclusion:** Patients with higher initial OSA severity and smaller airway volumes may have increased response to MAS therapy. Decreases in airway volume due to skeletal rather than soft tissue obstruction may enable better MAS treatment response. Since MAS targets upper airway, patients with superior airway constriction illustrate increased treatment response potential as well as decreased titration to achieve desirable outcome.

**Support (If Any):** UIC College of Dentistry

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**0548**

**SELECTION OF PATIENTS FOR ORAL APPLIANCE THERAPY USING AN AUTO-TITRATING MANDIBULAR POSITIONER IN THE HOME**

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**Introduction:** We have recently described a test that predicts outcome with oral appliance therapy using a mandibular positioner under technician remote control in a polysomnographic setting. The present study evaluated the accuracy of a comparable, but unattended, test using an auto-titrating mandibular positioner in the home.

**Methods:** Of 151 patients with OSA (AHI > 10 hr-1) enrolled in the study, 9 discontinued participation and 14 are currently in progress. The remaining 128 had a broad range of severity of OAS (mean AHI = 24.7 ± 12.9 hr-1). Each participant was studied for two nights at home using a temporary dental appliance attached to a computer-controlled actuator. Apneas and hypopneas were identified in real-time from respiratory airflow and oxyhemoglobin saturation. The first study involved continuous repositioning of the mandible driven by the occurrence of respiratory events. In the second, the mandible was held at a position predicted to be efficacious by the first study and protruded only when the AHI exceeded 10 hr-1. Using prospectively rules, each study predicted therapeutic outcome (therapeutic success: outcome AHI < 10 hr-1 & 50% of baseline AHI). Studies predicting success were assigned an effective protrusive position (EPP) derived from the study, and those predicting failure received a sham value of 70% maximal protrusion. Each participant received a custom appliance (G2, Somnomed) which was set to EPP or the sham value. Baseline and outcome AHI values were the mean of two nights each of home sleep testing.
I. Sleep Disordered Breathing

WITH OBSTRUCTIVE SLEEP APNEA
Sevilla Berrios RA, Irfan M, Nannapaneni S, Rishi MA, with oral appliance therapy with substantial accuracy. A retrospective classification tree analysis with two derived predictors and an imposed trunk branch criterion (baseline AHI = 16.7 hr⁻¹) reduced the incorrect prediction rate to 11%, and yielded positive and negative predictive values of 91% and 82%, respectively, and sensitivity and specificity of 93% and 77%.

Conclusion: We conclude that mandibular protrusion titration with a home-based auto-adjusting mandibular positioner predicts outcome with oral appliance therapy with substantial accuracy. A retrospective classification decision tree analysis shows higher predictive accuracy.

Support (If Any): This research was supported by grants from NRC-IRAP, Alberta Innovates-Technology Futures, and Zephyr Sleep Technologies.

0549
DOCUMENTATION OF WEIGHT REDUCTION INTERVENTION AT EVALUATION OF OBSESE PATIENTS WITH OBSTRUCTIVE SLEEP APNEA
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Introduction: Obesity is a modifiable risk factor for OSA, and it is well recognized that weight reduction is a valid intervention with therapeutic and prognostic benefits for patients with OSA. Physician counselling has been shown to increase the likelihood of weight loss, but may be underutilized.

Methods: As part of a quality improvement (QI) project at a quaternary academic medical center, we aim to determine the frequency and degree of assessments/interventions performed by sleep medicine fellows to promote weight reduction in patients with a new diagnosis of OSA and concomitant obesity. Results are reported using mean (± standard deviation), median (interquartile range, IQR) and proportions.

Results: Fifty of 86 patients seen for initial consultation for suspected OSA were diagnosed with OSA (Apnea/hypopnea index AHI ≥ 5) and had a body mass index (BMI) ≥ 30. Average age was 61 ± 12 years, 68% were males, and the BMI was 36.4 ± 4.9. The median AHI was 22 [12–49], and 92% were treated with Positive Airway Pressure (PAP). Sixteen of the 50 patients with diagnosis of OSA, had documentation of weight reduction counseling at the initial consultation or at the return visit after undergoing polysomnography. Weight reduction interventions were instituted in 8 of these patients: nutrition evaluation (2), endocrine evaluation (2), bariatric surgery (2) and exercise prescription (1); however none of these interventions were initiated by physicians.

Conclusion: There is a low level of engagement of the sleep medicine physicians regarding weight reduction strategies in spite of the knowledge about the impact of weight reduction in patients with obesity and OSA. Based on the baseline data, interventions utilizing evidence based methodologies will be developed and implemented to standardize the process of managing weight reduction protocols for our patients.

0550
OUTPATIENT DELIVERY OF BI-MAXILLARY ADVANCEMENT AS A FIRST CHOICE FOR THE TREATMENT OF MODERATE TO SEVERE OSA
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Introduction: Bi-Maxillary Advancement has traditionally been reserved for patients who suffer from severe OSA and have failed treatment with traditional Stage 1 Procedures. Over the past 10 years we have perfected a delivery system for outpatient Bi-Maxillary Advancement, with over 500 patients having been treated successfully with a return to normal activities within 7–10 days. No unplanned hospital admissions have been experienced and our success in eliminating symptoms and need for CPAP is over 95%. We propose that Bi-Maxillary Advancement be considered as a treatment of first choice for those patients desirous of CPAP elimination, or those whom are non-compliant. Traditional Stage 1 procedures are reserved as secondary interventions.

Methods: We retrospectively evaluated all patients over a 10 year time frame who underwent Orthognathic or Telegnathic Surgery with our outpatient delivery model. All surgical treatment was delivered in a Certified Office Based Ambulatory Surgical Facility with overnight observation, and discharge the following morning. Patients were evaluated pre and post op with 3D airway CT, pre and post op symptom assessment, attended sleep studies pre op and in most cases at home studies postop. Follow up ranged from 3 months to 10 years.

Results: No unplanned hospital admissions were experienced. Over 95% of patients experienced complete improvement in symptoms, and none were using CPAP. 5 patients exhibited home sleep parameters that show mild residual OSA, but no symptoms, snoring or witnessed apnea or hypopnea by sleep partners. all patients exhibited subjective satisfaction and improvement.

Conclusion: Bi-Maxillary Advancement should be considered as a surgical option of first choice in those patients who are CPAP dependent and wish to eliminate such, or are non-compliant. The high success rates of this operation render it a “curative” procedure. Long term results of up to 10 years show no recurrence of symptoms suggestive of OSA.

Support (If Any): Bi-Maxillary Advancement is recognized by the AASM as acceptable for the treatment of OSA, and the procedure is well documented in the scientific literature with success rates of 85–99%. The barriers to recommending the procedure have to do with the long postop recovery, morbidity and expense. Our delivery model addresses these barriers allowing us to promote consideration of this procedure in all cases of CPAP dependent OSA where elimination of CPAP is desired.

0551
EFFECTS OF COMBINED MAXILLO-MANDIBULAR ORAL APPLIANCE THERAPY IN ADULTS WITH MILD TO MODERATE OSA
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Introduction: Mandibular advancement devices (MADs) have been deployed for the management of mild to moderate OSA, but there are some concerns about bite changes. Biomimetic oral appliance therapy (BOAT) differs from MAD as it aims to correct the nasal airway through midfacial redevelopement in combination with mandibular repositioning. In this investigation, we tested the hypothesis that mild to moderate cases of OSA can be addressed using a combined maxillo-mandibular oral appliance protocol.
Methods: We included 19 consecutive adults aged > 21 yrs that had been diagnosed with mild to moderate OSA, following an overnight home sleep study that had been interpreted by a Medical physician. Each subject in this pilot study was treated by a dentist with advanced training in dental sleep medicine. At each monthly follow-up visit, examination for progress and adjustments of the devices were performed. The mean apnea-hypopnea index (AHI), respiratory disturbance index (RDI) and oxygen desaturation index (ODI) of the study sample was calculated prior to and after BOAT. The findings were subjected to statistical analysis.

Results: Prior to treatment the mean AHI of the study subjects was 12.8 ± 5; the mean RDI was 18.6 ± 8.2, and the ODI was 6.3 ± 3.5. A further follow home sleep study was done 9 mos. after BOAT. At this time, the AHI decreased significantly (p < 0.001) to a mean value of 6.2 ± 2.9, which represents a fall in the mean AHI by 51.5% for the study sample. The mean RDI fell to 12.3 ± 6.9 (p < 0.001), and the ODI was improved to 2.6 ± 1.7 (p < 0.001).

Conclusion: A combined maxillo-mandibular oral appliance protocol may be useful for managing mild to moderate cases of OSA in adults, and represents an alternative to MAD and CPAP therapy, where there might be compliance issues.

0552
DURATION FOR OPTIMIZING ORAL APPLIANCES FOR THE TREATMENT OF OBSTRUCTIVE SLEEP APNEA
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Introduction: The practice parameters for the treatment of obstructive sleep Apnea (OSA) with oral appliances do not include guidelines for the amount of time needed to fit, acclimate, or determine the optimal mandible advancement (MA) setting. During the multicenter Comparative Outcomes Management with Electronic Data Technology (COMET) Study, the conventional practices of dentists were assimilated for optimizing the oral appliance (OA) for each participant. The variability in duration for optimization is investigated.

Methods: The COMET Study was conducted at four institutions (Harvard, University of Madison-Wisconsin, University of Pennsylvania, and Stanford) to compare the treatment of OSA with positive airway pressure and OA therapy. The number of days from the date of regular use to the date of optimal MA setting of the OA was compared based on institution and baseline characteristics (sex, age, body mass index [BMI], apnea hypopnea index [AHI], and Epworth Sleepiness Scale [ESS]).

Results: Data were available for 41 of the 98 participants that were randomized to OA. There was a statistically significant difference between institutions (F = 3.0, P < 0.05), but not for sex (F = 0.45, P = 0.51). Correlations for continuous variables revealed a statistically significant correlation between BMI and days to optimization (r = 0.37, p < 0.05). However, there were no correlations for age, ESS, or AHI.

Conclusion: Variation within clinical practices at institutions is likely the largest determinant for duration from regular use of an OA to the time in which the dental professional subjectively concludes treatment is optimal. However, further exploration is merited to determine whether BMI is a factor in obtaining an optimal MA setting.

Support (If Any): COMET is funded by grant 1-ROI-HS-019738 from the Agency for Healthcare Research and Quality (AHRQ).

0553
FUNCTIONAL RESPIRATORY IMAGING TO PREDICTION TREATMENT OUTCOME OF FIXED MANDIBULAR ADVANCEMENT IN OSA PATIENTS
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Introduction: The severity of obstructive sleep apnea (OSA) correlates with the morphology of the patient’s upper airway (UA) lumen and skull. Furthermore, the response to a given treatment has been reported to correlate with gender, baseline OSA severity and UA morphology. Finally, both changes in upper airway lumen and boney structures do correlate with changes in OSA severity. In spite of such correlations until now no single parameter was reported that predicts the outcome of a given treatment. This work aims to develop and test a binomial linear model to predict treatment response to mandibular advancement in a large population of OSA patients.

Methods: 100 OSA patients were consecutively enrolled (83% male; age: 47.4 ± 11.5 years; BMI: 26.9 ± 3.3 kg/m2; apnea/hypopnea-index (AHI) at inclusion, 21.0 ± 11.2 events/hour) and started oral appliance treatment with mandibular advancement (OAm) in a fixed mandibular protrusion of 75% of the individual maximal advancement. 77 patients had both functional CT scan analysis (FRI) without and with OAm, and polysomnography at baseline and with OAm. From the polysomnography data baseline OSA severity (AHI and oxygen desaturation index) was used for the analysis. From the FRI analysis upper airway collapsibility (collapse without or with MRA), lumen (change in UA volume and resistance) and skeletal response (movements of the mandible and hyoid bone) were analysed. Treatment was considered positive (response = 1) when the AHI decreased with at least 50%, or if the post-OAm AHI was below 5 (with a baseline AHI of at least 5).

Statistical analysis was performed in R. A binomial generalized linear (bgl) model predicting response by all aforementioned parameters and the patient’s gender was constructed using a bidirectional stepwise approach considering each parameter separately and the interaction between each parameter and the baseline AHI. Fitted response values of at least 0.5 were considered to result in a positive response.

Results: The success rate in terms of AHI of the OAm treatment in the 77 patients used for model building was 47%. The fitted bgl model was significantly (p < 0.05) better predicting treatment outcome as compared to no prediction. The model has a positive predictive value = 0.82; negative predictive value = 0.81; accuracy = 0.82; sensitivity = 0.78 and specificity = 0.85.

Conclusion: A combination of OSA severity, gender, UA collapsibility, and the lumen and skeletal response to mandibular advancement can be used to predict the outcome of OAm treatment with an accuracy above 80%.

Support (If Any): study funded by IWT (Flemish government)

0554
FUNCTIONAL RESPIRATORY IMAGING TO EVALUATE TREATMENT EFFECT OF FIXED MANDIBULAR ADVANCEMENT IN OSA PATIENTS
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Introduction: The severity of obstructive sleep apnea (OSA) correlates with the morphology of the upper airway (UA). However, the UA collapsibility does not respond to mandibular advancement in an ho-
mogeneous way. This study investigates the regional effects in the UA of therapy with a mandibular repositioning appliance (MRA) and its correlation with MRA treatment response.

**Methods:** One hundred OSA patients were consecutively enrolled in the study (83% male; age: 47.4 ± 11.5 years; BMI: 26.9 ± 3.3 kg/m²; AHI at inclusion: 21.0 ± 11.2 events/hour sleep) and started MRA therapy in a fixed mandibular protrusion of 75% of the individual maximum advancement. In patients with residual OSA under MRA therapy in this protrusion, the MRA was titrated until 90% of the maximal advancement. For 84 out of 100 patient, functional CT scan analysis (FRI) is performed without and with MRA in the fixed 75% protrusion of the mandible. UA volume (iVua), resistance (iRua) and the minimal area (Amin) are assessed, for the top (velopharynx), central (oropharynx) and bottom (hypopharynx) part of the UA. Statistical analysis was performed to test the correlation between FRI and effect of MRA on AHI as compared to baseline AHI.

**Results:** The results of the FRI analysis showed a significant effect of the MRA on the total iVua (p = 0.0001), the effective iVua (p = 0.0008) and more in detail of the upper part (velopharynx) of the UA (effective iVua top, p < 0.0001). In addition, the MRA does increase the minimal area of the UA (p = 0.0342). In 67 patients, the results of both the CFD and a polysomnography with the MRA in situ in the 75% protrusion were available. A simple linear regression model in those patients revealed that the difference in UA volume at the level of the velopharynx (iVua top) was significantly correlated with the decrease in AHI (R = −0.18 and p = 0.0421). In the 31 patients that underwent additional titration to 90% protrusion, the correlation between iVua top and decrease in AHI became more significant (R = −0.31 and p = 0.0014).

**Conclusion:** MRA therapy does increase the UA volume, especially at the level of the velopharynx, as well as the minimal area of the UA. The difference in UA volume at the level of the velopharynx is significantly correlated with the decrease in AHI under MRA therapy in both 75% and 90% of the individual maximal mandibular advancement.

**Support (If Any):** Study funded by IWT (Flemish government)

0555

**ADAPTIVE SERVO VENTILATION (ASV) FOR MANAGEMENT OF TREATMENT-EMERENT AND PRIMARY CENTRAL SLEEP APNEA**

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**Introduction:** The evidence to confirm the superior efficacy of Adaptive Servo-Ventilation (ASV) in the treatment of complex sleep apnea (i.e., treatment-emergent central sleep apnea), relative to other treatment modalities, has been limited by the heterogeneity of the syndrome.

**Methods:** In this retrospective case series, we identified 220 adult patients who underwent baseline polysomnogram (PSG) and CPAP titrations that were diagnostic of either primary central sleep apnea or treatment-emergent central sleep apnea. The patients were treated with either ASV (n = 120) or other non-ASV alternatives (n = 76), such as BiPAP-ST, BiPAP, or CPAP. ASV and non-ASV groups were followed at a median interval of 3 months.

**Results:** Primary endpoints analyzed were compliance rate (defined as percentage of days with PAP use ≥ 4 hours at initial follow up), change in Epworth Sleepiness Scale (ESS), and change in apnea-hypopnea index (AHI). Paired t-test demonstrated statistically significant improvement in AHI and ESS for patients in both treatment groups. Adherence rates were 63.0% and 59.6% for ASV and non-ASV groups, respectively, at time of follow up. There were no statistically significant differences among the two treatment groups for any primary endpoint alone, although the patients treated with ASV had a significantly higher rate of treatment success (defined as both compliance rate ≥ 70% and residual AHI ≤ 10).

**Conclusion:** Both ASV and the non-ASV modes of positive airway pressure (PAP) were effective for our group of patients with both complex sleep apnea and primary central sleep apnea. However, there was a higher rate of treatment success in the patients treated with ASV.

0556

**SLEEP DISORDERED BREATHING IN PATIENTS WITH HEART FAILURE WITH PRESERVED EJECTION FRACTION (HFPEF)**

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**Introduction:** Patients with chronic heart failure frequently suffer from sleep disordered breathing (SDB). Obstructive sleep apnea (OSA) as well as central sleep apnea with Cheyne-Stokes pattern (CSR) have been observed, even though quite often these patients do not show typical symptoms of SDB. Most studies were conducted on patients with heart failure with reduced ejection fraction (HFREF). As there are few evidence based options for treating patients with HFPEF, we want to investigate if therapy of SDB has a benefit regarding HFPEF.

**Methods:** We screened 98 patients with HFPEF by portable monitoring for SDB (ApneaLink plus, ResMed). Patients with suspicious findings underwent polysomnographic examination. We are aiming at a total of 50 patients (so far n = 33). If they show relevant SDB, we will initiate positive airway pressure (PAP) therapy or oxygen treatment if PAP-intolerance occurs. Furthermore we perform physical exercise testing, echocardiographic examination of diastolic parameters (E/A-ratio, E/E’-ratio, left atrial volume), measurement of NT-pro-BNP and use several questionnaires. Patients are followed up after 6 months performing all mentioned examinations again.

**Results:** So far 33 patients underwent polysomnographic examination, 7 did not show relevant SDB, 17 showed OSA and 9 CSR. Of those patients, 20 now receive PAP therapy and 6 oxygen treatment. The first follow-up patient showed promising results (e.g. relevant changes in NT-pro-BNP). More results will be available at Sleep congress 2015.

**Conclusion:** We hope to show that therapy of SDB in patients with HF-NEF does not only better sleep disordered breathing, but also improve parameters concerning underlying HFPEF.

0557

**ADAPTIVESERVOVENTILATION (ASV): A COMPARISON OF THE TWO COMMERCIALY AVAILABLE DEVICES**

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**Introduction:** Adaptive Servo-Ventilation (ASV) is an advanced mode of non-invasive ventilator support that provides variable pressure support in response to the patient’s breathing. ASV is indicated for conditions associated with central sleep apnea (CSA) of various etiologies. The two commercially available devices (Resmed S9 VPAP Adapt™, ASV1 and Respironics BiPap autoSV Advanced, ASV2) have different proprietary algorithms for patient respiration detection. We compared the two available ASV devices for control of central sleep apnea.

**Methods:** Retrospective chart review study was performed at an urban academic AASM-accredited sleep center. Medical charts and polysomnograms of all patients titrated with ASV between 2010 and 2011 were reviewed. ASV choice was based on the sleep lead technologist or the ordering physician, and titration was guided by manufacturer pro-
tocols. Successful titration was defined as reduction in AHI by 50% or more and residual AHI ≤ 10. Differences in patient and study characteristics were compared by t-tests, Chi-squared tests, or Fisher’s exact tests, as appropriate.

Results: Of 68 patients who underwent ASV studies, average age 60 years (SD 12), primarily male (61.8%), and BMI 36.0 kg/m² (SD 10). Primary indication for the majority of patients was for treatment emergent CSA (TECSA) 59%; CheyneStokes respiration (CSR) 19%; narcoptic related CSA (NCSA) 1.3%; primary central sleep apnea (PCSA) 20.5%. Five out of 68 patients were studied using both ASV devices on different occasions. For the 73 studies, both ASV devices had comparable success rate (ASV1 [N = 37] 73% and ASV2 [N = 36] 69%, p = 0.80). Mean residual AHI was similar between both groups (ASV1: 9 vs. ASV2: 11 p = 0.52) When compared by individual indications, results were comparable.

Conclusion: Comparison of the control of sleep disordered breathing treatment of the two commercially available ASV devices show comparable efficacy to control CSA across all conditions.

0558
SERUM POTASSIUM LEVELS MAY INFLUENCE THE SLEEP ARCHITECTURE IN PATIENTS WITH HYPERTENSION
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Introduction: Hypokalemia (serum potassium < 3.5 mmol/L), resulting from multiple causes such as excessive aldosterone secretion, diuretic use and low potassium (K) intake, is common in hypertensive patients. A few data have proposed changes in serum K⁺ levels may influence sleep architecture and REM sleep homeostasis, though to date the emollient direct proof to prove the case is still lacking.

Methods: A retrospective cross-sectional study was performed in 753 hypertensive individuals who underwent polysomnography (PSG) examination. The serum K⁺, Na⁺, Cl⁻, Ca²⁺, Mg²⁺ and CO₂ CP were measured. The relationship between PSG-related sleep parameters and serum electrolytes levels were discussed.

Results: 111 patients (14.74%) were diagnosed as hypokalemia, the mean BMI was 28.04 kg/m² and the age was 46.42 yr. Patients with hypokalemia showed significantly higher Na⁺ [(141.97 ± 2.09) mmol/L vs. (141.41 ± 2.22) mmol/L, P = 0.015], CO₂ CP [(25.27 ± 2.43) mmol/L vs. (24.64 ± 2.79) mmol/L, P = 0.027] but lower Mg²⁺ [(0.87 ± 0.07) mmol/L vs. (0.92 ± 0.10) mmol/L, P = 0.001]. As to the OSA-related parameters, the sleep stage 1 [(7.53 ± 5.22)% vs (9.39 ± 8.68%), p < 0.001] and stage 2 [(63.54 ± 8.97)% vs (65.76 ± 8.58%), p = 0.027] in hypokalemia group were significantly higher, but sleep stage 3 [(4.08 ± 3.23%) vs 2.95 ± 2.64%, p < 0.001] and stage 4 [(6.77 ± 6.72% vs 5.39 ± 5.9%, p = 0.027] decreased greatly when compared to normokalemic group. The prevalence analysis showed weak but significant correlation between serum K⁺ and sleep latency (r = 0.095, p = 0.009), light sleep stage (r = 0.134, p = 0.001), deep sleep stage (r = -0.114, p = 0.002) and REM sleep (r = -0.075, p = 0.04). Multiple linear regression analyses revealed that the serum K⁺ level was associated with light sleep stage and REM sleep, even after adjusting for age, BMI, smoking history, AH1, systolic blood pressure, diastolic blood pressure, Na⁺, Cl⁻, Ca²⁺, Mg²⁺ and CO₂ CP as potential confounders.

Conclusion: The association between serum K⁺ and light sleep stage and REM sleep suggested that hypokalemia may disturb sleep architecture and REM sleep homeostasis in hypertensive individuals.

0559
SLEEP DISORDERED BREATHING, OBESITY AND POST-CARDIAC SURGERY ATRIAL FIBRILLATION
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Introduction: Sleep disordered breathing (SDB) appears to be related to post-cardiac surgery atrial fibrillation (PCSAF), however, prior studies have not incorporated objective sleep testing nor taken into consideration obesity. We hypothesize that SDB is associated with PCSAF and that obesity modifies this relationship.

Methods: In this case control study, patients with cardiac surgery (coronary artery bypass surgery and/or valvular surgery) between January 2009 and January 2014 and polysomnography (PSG) within 3 years were identified excluding those with known AF. Logistic models were used to determine the association between SDB defined by apnea hypopnea index (AHI) and PCSAF. Alternative predictors were central sleep apnea (CSA) (central apnea index > 5) and obstructive sleep apnea (OSA, obstructive apnea hypopnea index > 5). Models were adjusted for age, sex, race, body mass index (BMI) and self-reported positive airway pressure use. Interaction with and stratification by median BMI was performed. Odds ratios and 95% confidence intervals are presented.

Results: 190 patients comprised the analytic sample; age: 60.6 ± 11.4 years, 36.1% females, 80% white, BMI 33.3 ± 7.5 kg/m². 177 (93.2%) had an AHI > 5. PCSAF occurred in 57 patients (30%). SDB was associated with a 6% increased odds of PCSAF for every 5 unit AHI increase; OR = 1.06 (1.01, 1.12). After adjustment, this relationship was slightly attenuated: OR 1.05 (0.98, 1.12). Neither CSA nor OSA alone was associated with PCSAF. A significant interaction with median BMI was noted (p = 0.015). Effect modification by median BMI (32 kg/m²) was observed such that those with a higher BMI (but not lower BMI) had an 11% increased odds of PCSAF for every 5 unit AHI increase: OR = 1.11 (1.04, 1.20).

Conclusion: SDB was significantly associated with PCSAF and this relationship was slightly mitigated after obesity consideration. Those with both SDB and obesity may represent a vulnerable subgroup in order to reduce PCSAF and its associated morbidity.

0560
PREVALENCE OF CARDIAC ARRHYTHMIAS AMONGST PATIENTS WITH OBSTRUCTIVE SLEEP APNEA IN THE ASIAN CONTEXT: A SINGAPORE SLEEP CENTRE STUDY
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Introduction: Obstructive sleep apnea (OSA) is a prevalent sleep-disordered breathing. The most significant medical consequence of OSA is its association with raised cardiovascular morbidity and mortality. Cardiac arrhythmias are common in OSA patients but the true prevalence and clinical relevance of cardiac arrhythmias remains to be determined. The prevalence and incidence of cardiac arrhythmias in Asian OSA patients are not well studied and this study offers a broad perspective of OSA patients with arrhythmias in the Asian context. The aim of this study was to determine the prevalence of cardiac arrhythmias in OSA patients in an Asian context and to evaluate factors that may predispose patients with existing OSA to arrhythmias.

Methods: A retrospective study of 2,025 patients was carried out in patients during in-laboratory overnight polysomnogram from January 2011 to December 2012 at a Sleep Centre in a tertiary academic medi-
I. Sleep Disordered Breathing

THE EPWORTH SLEEPINESS SCALE ON PATIENTS IN SLEEP LABORATORY REFERRAL POPULATION

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Introduction: Obstructive sleep apnea (OSA) is a major public health problem in North America. Epworth Sleepiness Score (ESS) and Berlin questionnaire (BQ) have been used to identify high risk population for OSA. This study aimed at comparing these two questionnaires used in sleep laboratory with the polysomnography (PSG) data.

Methods: A chart review was conducted at a regional sleep lab to collect the data. It involved a sleep study questionnaire, sleep study report, physicians’ report and technologists’ worksheet. Information including ESS, Berlin, physician diagnosed OSA, history of snoring, sex, blood pressure, body mass index and occupation was extracted from these charts. Study population consisted of patients who were older than 18 years and who were referred for a PSG by a pulmonologist. A total of 1000 charts was extracted, of which 870 met the inclusion criteria.

 Logistic regression analysis was conducted to examine the relationship between OSA and other covariates.

Results: Out of 870 adults, 86.3% had physician diagnosed OSA. ESS screened 41.7% of adults at higher risk as compared to BQ i.e. 74.4% (Men (M): 41.9% and 75.1%; Women (W): 41.3% and 73.2 respectively). After adjusting for individuals’ smoking status and high blood pressure, for men and women, OSA diagnosis was statistically significantly associated with BMI, age, snoring, sex, blood pressure, age, body mass index and occupation extracted from these charts. Study population consisted of patients who were older than 18 years and who were referred for a PSG by a pulmonologist. A total of 1000 charts was extracted, of which 870 met the inclusion criteria.

Conclusion: In this referral population, the Berlin questionnaire was better in predicting OSA than ESS.

0561 INTRA-INDIVIDUAL AND ETHNIC VARIABILITY OF THE EPWORTH SLEEPINESS SCALE ON PATIENTS EVALUATED IN A TERTIARY SLEEP CLINIC

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Introduction: The aim of this study was to evaluate differences between self- and physician completed Epworth sleepiness scales (ESS) in a diverse race-ethnic sample of patients in South Florida.

Methods: The sample consisted of 197 consecutive patients referred to an academic sleep center for evaluation of sleep disorders from September to November 2014. The patients self-completed a ESS handed out as a questionnaire in the waiting room and a physician-taken ESS was then obtained during a face-to-face clinic visit. Demographic data, in-lab polysomnography and self-reported race-ethnicity information were determined. Race-ethnicity was categorized into Hispanic/Latinos, non-Hispanic white and non-Hispanic black. We compared the scores of the self-reported ESS and the physician-taken ESS and then compared the ESS scores across race-ethnic groups with chi-square and ANOVA for proportions and means.

Results: The mean age was 55 ± 14 years with 55% males. The sample consisted of 66% Hispanic/Latinos, mainly of Cuban descent, 20% non-Hispanic whites and 12% non-Hispanic blacks. The mean BMI was 33 (kg/m²). The majority of the participants had sleep apnea (85.1%), with a mean apnea-hypopnea index of 42.4 per hour sleep. There were differences in ESS with a mean self-completed ESS of 7.4 ± 5.8 and mean physician-taken ESS of 6.7 ± 5.6 (p < 0.01). Self-completed excessive daytime sleepiness (ESS ≥ 10) differed among the race-ethnic groups with sleepiness reported by 27% of non-Hispanic whites, 59% of Hispanics and 14% of non-Hispanic blacks (p = 0.02). The physician-taken ESS did not statistically differ across the ethnic groups with lower number of Hispanics (53%) endorsing sleepiness.

Conclusion: We observed lower mean scores on the physician-taken Epworth sleepiness scale compared to self-completed ESS. This discrepancy could partly explain the significant race-ethnic differences observed in the ESS scores in Hispanic/Latinos.

0562 COMPARISON OF SCREENING TOOLS USED IN A SLEEP LABORATORY REFERRAL POPULATION

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University of Saskatchewan, Saskatoon, SK, Canada

Introduction: Obstructive sleep apnea (OSA) is a major public health problem in North America. Epworth Sleepiness Score (ESS) and Berlin questionnaire (BQ) have been used to identify high risk population for OSA. This study aimed at comparing these two questionnaires used in sleep laboratory with the polysomnography (PSG) data.

Methods: A chart review was conducted at a regional sleep lab to collect the data. It involved a sleep study questionnaire, sleep study report, physicians’ report and technologists’ worksheet. Information including ESS, Berlin, physician diagnosed OSA, history of snoring, sex, blood pressure, body mass index and occupation was extracted from these charts. Study population consisted of patients who were older than 18 years and who were referred for a PSG by a pulmonologist. A total of 1000 charts was extracted, of which 870 met the inclusion criteria.

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Conclusion: In this referral population, the Berlin questionnaire was better in predicting OSA than ESS.
B. Clinical Sleep Science

0564
INCREASED BODY MASS INDEX FOLLOWING INITIATION OF CPAP USE

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Introduction: Treatment for obstructive sleep apnea (OSA) with continuous positive airway pressure (CPAP) can improve alertness, mood, and vigor. These effects are commonly assumed to positively influence physical activity and caloric expenditure, and thus, can reduce body weight. However, it is plausible that CPAP use may reduce energy expenditure during sleep due to reduced work of breathing or unanticipated changes in appetite behaviors. We explored the association between CPAP use and change in BMI using data from two randomized clinical trials comparing CPAP with alternative treatments.

Methods: Analyses were performed on data from the Best Apnea Interventions in Research (BestAIR) and Heart Biomarker Evaluation in Apnea Treatment (HeartBEAT) clinical trials (169 and 212 participants, respectively). Participants had either established or significant risk factors for cardiovascular disease and moderate to severe OSA. Subjects were randomized to active CPAP or a control treatment (sham CPAP; healthy lifestyle education) over durations from 3 to 12 months. BMI was calculated from weight and height measured at baseline and follow-up. Change in BMI was analyzed by trial using linear mixed effects models.

Results: Baseline characteristics were similar for the CPAP and control groups. In both trials, mean BMI increased from baseline to follow-up in the CPAP group but remained nearly unchanged in the control group. The difference in treatment effect by arm (CPAP – controls) on change in BMI from baseline was 0.34 kg/m² (95% CI: 0.05, 0.62) for HeartBEAT at 3-month follow-up and 0.41 kg/m² (0.03, 0.79) for BestAIR (mean of 6- and 12-month follow-ups), suggesting BMI increases over time with CPAP treatment.

Conclusion: The increase in BMI with use of CPAP supports the value of nutritional and exercise interventions to be implemented along with CPAP therapy. Furthermore, increased BMI may alter PAP pressure requirements, suggesting a role for ongoing monitoring of body weight and PAP needs.

Support (If Any): NIH/NHLBI (U34105277); NIH/NHLBI (1RC2HL101417-01)

I. Sleep Disordered Breathing

0565
AGGRESSIVE MONITORING OF CONTINUOUS AIRWAY PRESSURE COMPLIANCE IN PATIENTS WITH OBSTRUCTIVE SLEEP APNEA

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Introduction: Obstructive sleep apnea (OSA) is a common sleep disorder that is characterized by episodes of interrupted breathing during sleep. OSA exhibits several comorbidities including inflammation, insulin resistance, dyslipidemia, high blood pressure, and potential heart failure. To date, the administration of continuous positive airway pressure (CPAP) remains the gold standard treatment for OSA as it utilizes positive air pressure to maintain patency of one’s airways. Despite its beneficial use, long term compliance for CPAP users ranges from only 40–60%. Patients cite various reasons for noncompliance including a lack of understanding of OSA, claustrophobia, and reluctance to wear the CPAP interface. The goal of our study was to determine if more frequent monitoring of CPAP users would help to improve patient compliance as well as understanding of OSA and its associated complications.

Methods: A prospective study was conducted at a sleep center in South Carolina. The study was composed of 234 patients with a history of obesity (BMI > 30 kg/m²) and a diagnosis of moderate to severe OSA (apnea-hypopnea index ≥ 15). After the initiation of CPAP therapy, patients were followed by certified sleep medicine specialists and polysomnographic technologists. Follow up was conducted after one week of therapy and then monthly for twelve months. Data from the CPAP machine was analyzed at each visit. Cognitive behavioral therapy and desensitization protocols were initiated, as needed, to improve patient compliance. All patients were educated on OSA and the importance of CPAP compliance at each visit.

Results: CPAP compliance rate was found to be 92% after twelve months (n = 234). Compliance criteria were defined as a minimum usage of 70% over a twelve-month period for greater than 4 hours/night. Additionally, patients’ blood pressures were recorded at each follow up visit. We noted an average reduction in mean arterial pressure (MAP) of 4 mmHg over twelve months.

Conclusion: We conclude that for our patient population of 234 with a history of obesity and diagnosis of moderate to severe OSA, CPAP compliance was 92% over a 12-month period. Additionally, we noted an average reduction in MAP of 4 mmHg. In summary, the combination of aggressive monitoring and patient education including CBT and desensitization protocols resulted in a significant improvement of CPAP compliance and reduction in mean arterial pressure. Further randomized trials are recommended to assess the significance of possible confounding variables such as improved exercise regimen, dietary modifications, and reduction in mean arterial pressure.

0566
PREDICTING CPAP COMPLIANCE BASED ON SLEEP ARCHITECTURE

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Introduction: CPAP therapy has been shown to be effective in treating sleep-disordered breathing. However, compliance with CPAP is disappointingly low, with studies showing variable results related to patient characteristics and psychological factors. Predicting CPAP compliance has proven problematic. We aimed to create a model for predicting CPAP compliance based on sleep architecture characteristics of baseline PSG (study 1) and CPAP titration PSG (study 2) and...
0567
PREDICTION OF EARLY CPAP COMPLIANCE
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Introduction: Continuous Positive Airway Pressure (CPAP) is the most effective treatment for patients with Obstructive Sleep Apnea (OSA). However, CPAP effectiveness depends on patients’ adherence to treatment. The aim of this study was to determine if there are any factors that predict patients’ compliance to CPAP on the first follow-up visit.

Methods: Patients’ medical records from the University of Maryland Sleep Disorders Center were retrospectively analyzed from 2012–2014. All patients were diagnosed with OSA and were given CPAP counseling prior to prescription of therapy. A follow-up visit 6–8 weeks later was done to review compliance over the initial treatment period measured from adherence cards. We examined whether demographic, or polysomnographic factors, as well as scores on standard questionnaires would predict compliance on the initial follow-up visit.

Results: We reviewed records from 30 patients—17 men, age 57.3 ± 11.3 (9 ≥ 65), 14 Caucasians (C), and 16 African-Americans (AA). Only 46.7% were compliant (≥ 4 hours per night for 70% of nights). At initial follow-up 81.2% AA were non-compliant compared with 21.4% C (P = 0.004). Factors not predicting initial compliance included: age, sex, neck-circumference, Epworth Scale, BMI, STOP-BANG pretest probability, apnea-hypopnea index, CPAP pressure, mask type, and expressed post CPAP titration willingness to use CPAP. Further, no polysomnographic variables (sleep efficiency, slow wave sleep, REM sleep) on diagnostic or CPAP titration predicted early compliance.

Conclusion: Initial adherence to CPAP therapy (CMS criteria) was poor among AA despite prior extensive education and counseling. Efforts to ensure compliance should explore the role of socio-economic status, education, and medical co-morbidities in determining early CPAP compliance and its relationship to long-term compliance.

0568
POSITIVE AIRWAY PRESSURE ADHERENCE IN PATIENTS WITH OBSTRUCTIVE SLEEP APNEA AND SYMPTOMATIC BPH
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Introduction: To determine the 3-month and 1-year adherence rates with Positive Airway Pressure (PAP) therapy in sleep apnea patients with Benign Prostatic Hyperplasia (BPH) compared to matched controls.

Methods: A case-control retrospective analysis was performed in a Veterans Affairs hospital. All symptomatic patients with BPH (n = 269) ever started on PAP therapy between 2006–2012 were compared with controls matched for severity of sleep apnea (AHI), BMI & age at the time of diagnosis. Compliance measures were obtained at the third and twelfth month visits. The cases included symptomatic BPH patients on active medical therapy. Diuretic use among cases and controls and severity of nocturia among the cases were also obtained.

Results: In the BPH group, mean AHI among cases and controls was 37 ± 27.3 and 36.7 ± 28.4 (p = 0.94), mean BMI 35 ± 6 and 36.7 ± 6.5 (p = 0.06) and mean age at diagnosis 64 ± 9.7 and 62 ± 7 (p = 0.12) respectively. The population was predominantly male and Caucasian. There was no statistically significant difference in PAP use between symptomatic BPH patients and controls at 3 month (percent days device use > 4 hrs. 54.9 ± 38.7 vs. 52.7 ± 34.8; p = 0.72) and 1 year (percent days device use > 4 hrs. 61 ± 42.6 vs. 67.9 ± 30.7; p = 0.28) visits. Analysis of variance (ANOVA) based on diuretic use (p = 0.10) and severity of nocturia (p = 0.5) did not influence compliance with PAP therapy.

Conclusion: BPH or diuretic use does not affect compliance with PAP therapy in obstructive sleep apnea. Severity of nocturia did not have any influence on compliance among the cases. BPH, regardless of the severity of nocturia, and diuretic use does not influence CPAP adherence in patients with OSA.

0569
POSITIVE AIRWAY PRESSURE ADHERENCE IN PATIENTS WITH OBSTRUCTIVE SLEEP APNEA WITH DEPRESSION OR ANXIETY
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Introduction: To determine the 3-month and 1-year adherence rates with Positive Airway Pressure (PAP) therapy in sleep apnea patients with depression or anxiety compared to matched controls.

Methods: A case-control retrospective analysis was performed in a Veterans Affairs hospital. All symptomatic patients with depression or anxiety ever started on PAP therapy between 2006–2012 were compared with controls matched for severity of sleep apnea (AHI), BMI & age at the time of diagnosis.

Results: In the depression group (n = 263), mean AHI among cases and controls was 37.6 ± 26.5 and 36.02 ± 28 (p = 0.64), mean BMI 35.2 ± 6.7 and 35.5 ± 6.2 (p = 0.83) and mean age at diagnosis 56.8 ± 11.3 and 58.4 ± 11.7 (p = 0.21) respectively. In the anxiety group (n = 166), mean AHI among cases and controls was 29 ± 22 and 29.9 ± 23.8 (p = 0.80), mean BMI 34.1 ± 6.2 and 34.4 ± 6.1 (p = 0.75) and mean age at diagnosis 56.8 ± 13.6 and 55.6 ± 11.6 (p = 0.54) respectively. The population was predominantly male and Caucasian. There was no statistically significant difference in PAP use between depressed patients and controls at 3 months (percent days device use > 4 hrs. 51.6 ± 33.8 vs. 48.5 ± 35.2; p = 0.51) and 1 year (percent days device use > 4 hrs. 62.7 ± 35.9 vs. 64 ± 30; p = 0.77) visits. Patients with anxiety had similar adherence.
rates compared to controls at 3 month (percent days device use > 4 hrs, 51.2 ± 35 vs. 43.8 ± 33.6; p = 0.23) and 1 year (percent days device use > 4 hrs, 61.6 ± 33.9 vs. 57 ± 34.8; p = 0.49) visits. 

**Conclusion:** PAP adherence is not significantly different among patients with anxiety or depression on active medical therapy compared to matched controls. Depression and anxiety do not influence CPAP compliance.

**0570**

**NIGHT TO NIGHT VARIABILITY OF APNEA HYPOPNEA INDEX IN PATIENTS TREATED WITH POSITIVE AIRWAY PRESSURE THERAPY**

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**Introduction:** The current study is aimed to look at the short term night-to-night variability (NNV) in residual apnea hypopnea index (rAHI) after the initiation of positive airway pressure (PAP) therapy. Variability has been investigated in other chronic diseases such as hypertension. Short and long-term variability in blood pressure measurements in patients with hypertension has been shown to independently increase cardiovascular disease. The NNV patterns of patients with obstructive sleep apnea (OSA) after PAP therapy initiation are unknown.

**Methods:** Retrospective study at a university sleep center between August 2013 and March 2014. Statistical analysis included baseline descriptive characteristics, Spearman’s correlation and logistic regression.

**Results:** Of 201 patients, 88 patients (BMI 37.7 ± 8.7, Age 53.4 ± 13.2, baseline polysomnography [bPSG] AHI 37.3 ± 29.3, lowest desaturation, bPSG 79.7 ± 12, male 45.4%) were included. The mean number of days PAP device used was 60.6 ± 20.5 (minimum 20) days, mean daily usage was 228.9 ± 103.1 minutes. Coefficient of variation (CV) was calculated to identify the variability in the rAHI. The CV ranged from 31.9 to 462.8 and the mean ± SD was 85.3 ± 55.6. The Spearman correlation of CV with minutes of usage (rho = 0.14, p = 0.2), number of days of usage (rho = −0.09, p = 0.4) average nightly leak (rho = −0.07, p = 0.5), age (rho = −0.12, p = 0.2), BMI (rho = −0.04, p = 0.6) and bPSG AHI (rho = 0.03, p = 0.8) was not statistically significant. The probability of high CV decreases with age (beta = −0.0620, p = 0.015) and increases in African American race vs Caucasian (our reference class) (beta = 1.79, p = 0.016) as well as those with COPD or asthma (beta = 2.18, p = 0.005).

**Conclusion:** These data demonstrate that among OSA patients treated with PAP therapy, a wide range of inter-individual NNV in rAHI is present. The high NNV cannot be correlated to daily patient usage factors or baseline demographics and is likely an independent factor. Further studies are needed to understand the prognostic significance of NNV of rAHI.

**0571**

**ESZOPICLONE VERSUS ZOLPIDEM FOR POLYSOMNOGRAPHY**

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**Introduction:** Several studies and a recent meta-analysis have shown that non-benzodiazepine sedative hypnotics (NBSH) do not alter the apnea hypopnea index (AHI). Both eszopiclone and zolpidem have been studied but they have not been directly compared to each other.

Our goal was to compare the effect that these two drugs have on positive airway pressure (PAP) titration and subsequent compliance.

**Methods:** Providers at our clinic frequently provide NBSHs to patients for their diagnostic polysomnogram (PSG). We abstracted data for all patients who had PAP started during the 2nd half of their PSG. We also obtained 30-day PAP compliance data for all patients. We compared results by the medication they received during their PSG. Mann-Whitney U, Fisher’s Exact and Independent sample t-tests were used as appropriate with SPSS 20.0.

**Results:** A total of 56 patients had split night PSG and 30 day adherence data available for analysis, 44 took zolpidem and 12 took eszopiclone. During the diagnostic portion the mean apnea hypopnea index (AHI) for all patients was 42.7 ± 23.1 and there was no significant difference in AHI, age, total sleep time (TST) or sleep efficiency (SE) between groups. During the PAP portion there was no significant difference in TST, SE, percentage REM sleep or AHI in supine REM. At 30 days post PAP initiation there was no difference in percentage days greater than four hours or hours per nights used. At 30 days 8/36 (18.2%) and 3/12 (25.0%) used PAP for > 4 hours for > 70% of nights in the zolpidem and eszopiclone groups respectively (p = 0.69).

**Conclusion:** There is no difference in the diagnostic and PAP-titration portions of the PSG when eszopiclone is given instead of zolpidem. There is also no difference in PAP compliance at 30 days.
Conclusion: Among an urban cohort of PLWH, fatigue, excessive daytime sleepiness and OSA symptoms were highly prevalent. Witnessed apnea was the strongest independent predictor of fatigue in this population. Our data support the need for more research regarding OSA screening and treatment in PLWH.

0573
SLEEP ARCHITECTURE CORRELATES OF SUBJECTIVE SLEEP QUALITY PERCEPTION
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Introduction: Assessment of sleep architecture with polysomnography (PSG) is often used to grade the severity of the breathing disorder, and assess sleep quality. We studied the correlation between changes in sleep architecture with CPAP treatment, and changes in subjective sleep quality as assessed by a questionnaire (Post PSG Sleep Assessment; PPSA).

Methods: We prospectively analyzed the sleep architecture variables of a cohort of 100 patients with OSA, and compared them with changes in PPSA between baseline (night 1) and CPAP titration (night 2) PSG. General linear models were used to examine prediction models for PPSA for night 1 and 2, and the improvement from night 1 to night 2. Predictors having p > 0.10 were removed at each step. A CPAP sleep quality risk score was computed using a final regression model.

Results: The final regression model predicting night 2 self-reported sleep quality was significant (p = 0.0001) with R² = 0.20. Predictors included African American race, N3 percent, and the night 2 Quality composite [Total Sleep Time + Sleep Efficiency – WASO + N2abs_time]. Based on the regression parameters the following risk model was used to calculate each subject’s risk of having poor sleep quality on night 2: risk = round(1.3 – 0.3123*N3perc_time + 0.0662*qual2 + 0.86*AA, 0.1). The odds of having self-reported sleep problems on night 2 were 5.07 (95% confidence interval: 2.13–12.06) for those with high, compared to low, risk scores (p = 0.0002). The model predicting change in sleep quality was significant (p = 0.0007) with R² = 0.14. The predictors in the final model were improved SE (p = 0.001) and increased N1 percent time (p = 0.036) where risk = 21.22 + 0.21 * increase in SE + 0.127 * increase in N1 percent time.

Conclusion: In our model, we were able to predict perceived sleep quality based on variables objectively measured in the sleep lab. Future studies are needed to validate this model in different sleep disorders.

0575
HYPERTENSION AND OBSTRUCTIVE SLEEP APNEA: DOES OBJECTIVE SLEEPINESS MODIFY THE ASSOCIATION?
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Introduction: Obstructive sleep apnea (OSA) patients with subjective sleepiness are at a greater risk of hypertension, but little is known about the relationship between objective sleepiness and hypertension. We aimed to determine whether objective sleepiness modifies the relationship between OSA and prevalent hypertension.

Methods: A total of 2035 patients with apnea-hypopnea index (AHI) ≥ 5/h and 319 patients with habitual snoring but an AHI < 5/h as control were recruited into this study. Overnight polysomnography (PSG) and the following Multiple sleep latency test (MSLT) were conducted. Epworth Sleepiness Scale (ESS) was also collected.

Results: Hypertension was found in 7.5% of control group and 26.3% of OSA patients. After controlling for age, BMI, AHI, neck circumference, waist circumference, drinking, and smoking in logistic regression model, we found that the odd ratio (OR) for hypertension significantly increased across the different groups as divided by ESS total score, (1.0 for control; OR (95% CI) = 2.30 (95% CI: 1.37–3.85) for ESS 0–4; 2.90 (95% CI: 1.75–4.82) for ESS 5–8; 1.88 (95% CI: 1.08–3.22) for ESS 9–13; 3.02 (95% CI: 1.76–5.17) for ESS 14–24). In addition, we also found a dose-response association between mean sleep latency (MSL) and hypertension in OSA patients when reference to control group (1.0 for control; OR (95% CI) = 1.77 (95% CI: 1.02–3.08) for MSL < 5 min;1.88 (95% CI: 1.10–3.23) for MSL 5–6 min; 2.33 (95% CI: 1.40–3.87) for MSL8–13 min; 2.89 (95% CI: 1.74–4.79) for MSL 13–20 min) in the fully adjusted model.

Conclusion: We found that OSA patients with a higher ESS score are at a higher risk for hypertension. However, longer MSL but not shorter MSL was associated with increased risk of hypertension, which indicated that hyperarousal rather than objective sleepiness plays a role in the occurrence of hypertension in patients with OSA.

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B. Clinical Sleep Science

0574
NASAL CYCLE DURING SLEEP
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Introduction: The phenomena of periodic cycles of vascular engorgement on the nasal cavity mucosa that alternate between right and left sides are termed the “nasal cycle.”The physiologic mechanisms underlying this cycle have not been entirely clarified, even more so during sleep. In this study, we measured the periodic patterns of the normal nasal cycle, not only during wakefulness but also during sleep.

Methods: Our team utilized a method for functional rhinologic assessment, the portable rhinoflowmeter (Rhinocycle, Rhinometrics, Lyngby, Denmark), measuring airflow independently through each nostril during 24 hours on 20 healthy subjects aged 20 to 56 years, and without any nasal pathology or diagnosed medical, psychiatric, or sleep disorders. In addition, a nocturnal polysomnogram was simultaneously performed during sleep.

Results: Nineteen of 20 subjects showed a detectable nasal cycle, and 16 of 19 subjects presented a change of the cyclic phase during sleep. The mean nasal cycle duration was 234.26 ± 2.4 minutes (median, 164.1 minutes), although variation was considerable. The mean cycle duration time during sleep was significantly longer than that in wakefulness (P < 0.005). The reversal of cyclic phase during sleep tended to be associated with REM sleep (68.8%) and postural changes (18.8%). It never occurred in slow-wave sleep.

Conclusions: Nasal cycle duration during sleep is longer than in wakefulness. Changes in laterality of nasal cycle frequently coincide with switches in posture, tend to occur in REM sleep, never occur in slow-wave sleep, and may be absent in subjects with severe nasal septal deviations.
**0576**

**SLEEP APNEA RISK AND SUBCLINICAL ATHEROSCLEROSIS IN FORMER NATIONAL FOOTBALL LEAGUE PLAYERS**

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**Introduction:** Limited data from former National Football League (NFL) players suggest that obstructive sleep apnea (OSA) may be more prevalent after retirement. It remains unclear whether the high prevalence of OSA in retired players is comparable to similarly obese non-athletes. This study compared sleep apnea risk in former NFL players to community controls, the Coronary Artery Risk Development in Young Adults (CARDIA) ancillary sleep study, and examined associations between sleep apnea risk and cardiovascular risk factors, including subclinical atherosclerosis.

**Methods:** Former NFL players (n = 140) were matched on age ± 2 (45.4 ± 4.4 years) and BMI ± 2 (30.5 ± 3.9). Cardiovascular risk factors including blood pressure, lipids, fasting glucose, and sleep apnea risk (Berlin Questionnaire) were assessed during screening visit. Subclinical atherosclerosis was measured by computed tomography as coronary artery calcium (CAC). The presence of CAC was defined as an Agatston score > 0. Comparisons between groups were performed using Student’s t test or chi-square test. The association of sleep apnea risk with cardiovascular risk factors among the players was examined using linear and logistic regression adjusted for age, BMI, and race.

**Results:** Former NFL players had a greater prevalence of high sleep apnea risk than the matched CARDIA sleep cohort (34.3% vs 10%, p < 0.001). Compared to the CARDIA sleep cohort, former players had fewer smokers, higher blood pressure, lower fasting glucose levels, and lower prevalence of diabetes (p's < 0.05). There was no difference in the prevalence of detectable CAC (33.6% vs 34.3%, p = 0.90). In former NFL players, sleep apnea risk was not significantly associated with any of the cardiovascular risk factors after controlling for age, race, and BMI.

**Conclusion:** Despite being former elite athletes, former NFL players have similar risk for subclinical atherosclerosis but greater risk for sleep apnea compared to a well matched community cohort.

**Support (If Any):** National Football League; POI AG011412; The CARDIA study was supported by US Public Health Service contracts NOI-HC-48047, NOI-HC-48048, NOI-HC-48049, NOI-HC-48050, and NOI-HC-95095 from the National Heart, Lung, and Blood Institute. Dr. Luyster's work is supported by NIH K23 HL105887.

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**0577**

**RESEARCH ON MENTAL CHARACTERISTICS OF CHINESE PATIENTS WITH OBSTRUCTIVE SLEEP APNEA HYPOPNEA SYNDROME**

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**Introduction:** Most of the studies on patients with obstructive sleep apnea hypopnea syndrome focus on the quality of sleep and life. Research on mental characteristics were rarely. This study was design to explore the personality and character of obstructive sleep apnea hypopnea syndrome (OSAHs) patients.

**Methods:** Subjects were divided into the severe OSAHS group (50 cases), mild-moderate OSAHS group (53 cases) according to apnea hypopnea index (AHI). 42 normal people were acted as contrast group. The Minnesota multiphasic personality inventory (MMPI) were used to evaluate the psychological aspects of subjects.

**Results:** Comparing OSAHS group and the contrast group, 6 clinical scales depression (D), hysteria (Hy), masculinity (Mf), paranoia (Pa), anxiety (A), ego strength (Es) were different significantly (t value was respectively 2.609, 2.133, 2.294, 2.520, 2.041, 2.675, all P < 0.05). The score of OSAHS group are higher than the contrast group on five clinical scales, including depression (D), hysteria (Hy), paranoia (Pa), anxiety (A), ego strength (Es). The score of OSAHS group are lower than the contrast group on clinical scale masculinity (Mf). Further comparing of severe OSAHS group and mild-moderate OSAHS group disclosed that differences of 6 clinical scales depression (D), paranoia (Pa), psychasthenia (Pt), anxiety (A), manifest anxiety scale (MAS), dependency (Dy) were significantly (t value was respectively 2.460, 2.086, 2.181, 2.121, 2.954, 1.982). Especially the scores of severe OSAHS group are all higher than the mild-moderate OSAHS group on these six clinical scales.

**Conclusion:** Comparing with healthy people, OSAHS patients have special personality and character. The degree of OSAHS can infects the personality and character of OSAHS patients, such as depression, discomfort, somatopsychic, extrasensitvity and nervous. It was related with the severe of OSAHS.

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**0578**

**LONG DURATION OF LONGEST OBSTRUCTIVE SLEEP APNEA AND POLYCYTHEMIA AMONG HIGHLANDERS**


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**Introduction:** The duration of the longest sleep apnea (LSA) is routinely determined in polysomnography (PSG) examinations in screens for obstructive sleep apnea (OSA) patients, but we presently have no real understanding of clinic significance of longer LSA.

**Methods:** We report an OSA patient case with an extremely long duration LSA and a retrospective analysis of LSA in 7352 OSA patients.

**Results:** 1) A 34-years-old-highland man with chief complaints of chronic headache and dizziness was found having a 6.3 min duration LSA with severe polycythemia. During three months of follow-up continuous positive airway pressure (CPAP) therapy, the headaches, dizziness and polycythemia disappeared. 2) Of 7352 OSA patients we examined, none had LSA longer than 4 min; for four LSA durations of 3–4 and 2–3 min, the significant rankings in the percentage were Tibetan (6%, 15%) > Han highlanders (0.7%, 4.2%) = sea level Han (0%, 4.7%) respectively; for 1–2 min, Tibetan (37%) > Han highlanders (34%) > sea level Han (27%); and for < 1 min, Tibetan (40%) < Han highlanders (60%) < sea level Han (67%). 3) Seven patients were found with LSA of 3–4 min; all were highlanders. Five had blood routine test records at the time of PSG and four (80%) had polycythemia.

**Conclusion:** Highland OSA patients, particularly Tibetan highlanders, have a much greater proportion of long LSA and as well as polycythemia. Our study suggests that the relationship of the duration of LSA and polycythemia should be critically evaluated in OSA patients.

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THE INCIDENCE OF RIGHT TO LEFT SHUNTING IN PATIENTS WITH SLEEP APNEA
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Introduction: The most common cause of right to left shunting (RLS) is due to intermittent flow through a patent foramen ovale (PFO). PFO occurs more frequently in patients with obstructive sleep apnea (OSA), and may be involved in the exacerbation of OSA in some patients. The goal of this study was to assess the presence of RLS in patients with OSA, and compare clinical characteristics and parameters of the sleep studies of patients with and without RLS.

Methods: Patients with an abnormal polysomnogram seen at UCLA-Santa Monica Sleep Medicine Clinic were enrolled. A diagnosis of RLS was made using a transcranial Doppler (TCD) bubble study. Gender and age-matched controls were drawn from patients referred for cardiac catheterization who underwent a TCD. The frequency of RLS in OSA patients and the controls was evaluated. Clinical characteristics and polysomnogram parameters were compared between OSA patients with and without a RLS.

Results: A total of 100 OSA patients and 200 controls participated in the study. The prevalence of RLS was higher in patients with OSA compared to the control group (42% vs. 19%; p < 0.0001). Patients with OSA and a RLS had a lower apnea-hypopnea index (AHI), less obstructive apnea and fewer hypopnea episodes than patients with OSA without a RLS. The degree of desaturation for a given respiratory disturbance as measured by oxygen desaturation index (ODI)/AHI ratio was higher in the OSA group with RLS versus the group without RLS (0.85 ± 0.07 vs. 0.68 ± 0.04; p < 0.0001). The baseline and nadir SaO2 were similar in both groups and did not correlate with the level of RLS assessed by TCD.

Conclusion: RLS, most commonly due to a PFO, occurs 2.2 times more frequently in OSA patients compared to a control population that was matched for age and gender. The severity of sleep apnea is not greater in patients with OSA and a PFO. However, patients with OSA and PFO are more likely to become symptomatic at a younger age with an equivalent decrease in nocturnal SaO2 and greater desaturations in proportion to the frequency of respiratory disturbances.

NEUROPSYCHOLOGICAL PERFORMANCE AND SERIAL POSITION PROFILES IN OLDER ADULTS WITH AHI ≥ 15 AS COMPARED TO AHI < 15
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Introduction: The serial position effect occurs when individuals must recall a list of words that exceed normal attention span (e.g., 10 words over four repeated trials). Examining serial position profiles may provide insight into whether inefficient processing can adversely affect recall. Healthy older adults demonstrate a U-shaped learning curve, whereas individuals with neurodegenerative disorders (e.g. Alzheimer’s disease) demonstrate prominent recency effect (the preferential recall of most recent events over primacy events). Serial position profiles were examined in two groups of older adults with different Apnea Hypopnea Indices (AHI ≥ 15 and AHI < 15).

Methods: 28 adults with an AHI ≥ 15 (M = 32.87 ± 16.17; mean age 72.09; n = 11), were compared to those with an AHI < 15 (M = 6.39 ± 3.88; mean age 73.47; n = 17) on neuropsychological tests (MMSE, Trails A & B, Verbal Fluency, and Repeatable Battery for the Assessment of Neuropsychological Status (RBANS)). Serial position scores were calculated (number of items recalled/possible number of items present) for three regions in four RBANS List Learning Trials (LLTs). Independent sample t-tests were used to test for group differences.

Results: There were no group differences in age, gender, income, marital status or years of education. Despite the fact that the AHI ≥ 15 group showed better cognitive function based on having fewer subjects with MCI, they showed the expected primacy effect (p < 0.05) only in List Learning Trial 1 but not in the final trial.

Conclusion: Elderly subjects with previously undiagnosed obstructive sleep apnea may demonstrate a pattern of list learning, consistent with presumed neuropathology frontal/attentional systems.
more likely to snore, and OSAHS severity and longer snoring duration was associated with a higher PSFDR.

0582
LEGAL OUTCOMES OF ADVERSE PERIOPERATIVE EVENTS IN OSA PATIENTS: A SURVEY STUDY
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Introduction: Obstructive sleep apnea (OSA) has been associated with adverse perioperative outcomes which has led to an increasing number of malpractice lawsuits. We hypothesized that the majority of these cases are settled out of court.

Methods: We designed a national survey regarding malpractice claims relating to OSA and post-operative complications. The survey was sent to members of American Society of Health Risk Managers (ASHRM). The survey was emailed to 1000 members of ASHRM in 3 different email blasts. The survey was completed in RED CAP and responses were collated and are described.

Results: There were 145 respondents (14.5% response rate) with 4 incomplete surveys. The majority of respondents were nurses and risk managers. 18% (25) reported at least one malpractice case related to OSA in the perioperative setting filed at their institution within the past 15 years. 80% were filed due to the death of the patient and 16% were due to chronic vegetative state. 85% of the lawsuits were settled out of court, 10% favored the plaintiff, and none favored the defendant. Compensation was mostly in the $100,000–500,000 range (33.3%) and $500,000–1,000,000 range (33.3%). Regarding the cases, the majority of the lawsuits related to postoperative complications following transferred to the floor (64%). 79.2% of the patients were taking narcotics at the time of complication. Most of the cases involved general (42%) or orthopaedic (40%) surgery. The majority of the lawsuits happened in community hospitals (72%), 40.4% of respondents reported they have an OSA perioperative protocol in place, 39.7% reported no protocol was in place and 19.9% were unsure.

Conclusion: This study survey suggests that malpractice suits involving complications related to OSA in the perioperative time period are primarily settled out of court and would not be searchable in legal databases. Settlements carried significant financial penalties.

0583
IS NOCTURNAL GROANING (CATATHRENA) A PARASOMNIA OR SLEEP RELATED BREATHING DISORDER?
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Introduction: Sleep related groaning (catathrenia) is characterized by episodes of nocturnal groaning (NG) during sleep. Although catathrenia was classified as a parasomnia in the International Classification of Sleep Disorders (ICSD) 2nd edition, catathrenia was re-classified as one of normal variants in sleep related breathing disorders in the ICSD 3rd edition. The aim of this study was to describe incidence and the polysomnography (PSG) characteristics of catathrenia patients with special emphasis on sleep stages that NG occurs in and temporal relationship between NG and EEG arousal, and other events of data.

Methods: The subjects were consecutive 23,052 patients who presented with sleep and/or wake problems at our sleep center from April 1998 to October 2014. Diagnosis of catathrenia was based on ICSD-2 criteria.

Results: We found 47 cases (0.20%) with catathrenia. Thirty-three of 47 cases who presented episode of NG on video-PSG were studied. The mean age at presentation in 33 patients (17 men and 16 women) was 40.0 ± 14.8 years. Number of NG events among patients during PSG varied from 1 to 3,490 episodes. In 7 of 33 cases (21.2%), NG was exclusively or predominantly observed during REM sleep (REM sleep cluster), but the others showed groaning during stage 1 and 2 (non-REM sleep cluster). The relationship between NG and EEG arousal was further investigated. More than 50% of the NG episodes occurred after arousal in twenty of thirty-three cases, but the causes of arousal were heterogeneous.

Conclusion: Our findings suggest that catathrenia is unlikely to be caused by a single pathophysiology. Catathrenia may be divided into ‘REM sleep cluster’ catathrenia and ‘non-REM sleep cluster’ catathrenia. Detailed analysis of PSG data and long-term follow up of patients are needed to clarify the differences of two groups and the pathophysiology of catathrenia.

0584
USING HRV METRICS TO PHENOTYPE OSA PATIENTS WHO DEVELOP POSTOPERATIVE RESPIRATORY FAILURE
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Introduction: Postoperative respiratory failure (PRF) is associated with increased mortality and hospital costs. Patients with obstructive sleep apnea (OSA) are at an increased risk of PRF requiring reintubation. OSA is characterized by dysregulation of arousal efferent loops associated with underlying autonomic nervous system (ANS) disturbances. Heart rate variability (HRV) is a parameter that provides a measurement of ANS responses. The aim of this study is to explore the value of frequency domain HRV metrics in phenotyping OSA patients who develop PRF.

Methods: Frequency domain metrics for normalized low frequency (nLF) and high frequency (nHF) were analyzed using a retrospective case-control design. HRV metrics were calculated using ECG channels from either a preoperative or postoperative overnight polysomnogram. The differences in HRV metrics between two groups of patients with a diagnosis of OSA were examined in (1) patients who did not have a PRF and (2) patients who required reintubation. Patients in (1) were case-matched to patients in (2) based on gender, age, OSA severity, and surgical service providing procedure.

Results: Each group included 20 patients of whom, 7 were on beta-blockers. In patients not treated with beta-blockers, the nHF was significantly increased for (2) compared to (1) by 11.40 (52.01 ± 9.45 vs. 63.41 ± 10.55, p-value: 0.01). Additionally, the nLF was significantly decreased for (2) compared to (1) by 11.44 (47.81 ± 9.49 vs. 36.37 ± 10.55, p-value: 0.01). Furthermore, the ratio of LF and HF power decreased for (2) compared to (1) by 0.38 (1 ± 0.61 vs. 0.62 ± 0.25, p-value: 0.04).

Conclusion: Patients with PRF were found to have HRV profiles indicating vagal predominance and decreased sympathetic influences. However, there was overlap of metrics, limiting its use as a classification tool at this stage. These results suggest that HRV metrics may inform development of novel prediction indices for PRF in OSA.

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0585
OUTCOMES OF INTENSIVE CARE UNIT ADMISSIONS WITH OBESITY HYPOVENTILATION SYNDROME
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Introduction: Patients with Obesity hypoventilation syndrome (OHS) often present with exacerbations of their respiratory symptoms requiring hospitalization that may require ventilatory support. Tracheostomy may be utilized initially for respiratory failure but can also serve as therapy for underlying sleep disordered breathing. We sought to determine the outcome of patients with OHS admitted with acute hypercapnic respiratory failure in a closed medical intensive care unit (ICU).

Methods: All consecutive patients admitted to the medical ICU at Ben Taub General Hospital between 2006–2012 were screened. Patients between the ages of 18–64 years with diagnosis of OHS and hypercapnic respiratory failure requiring mechanical ventilation for > 24 hours were included. A retrospective chart review was conducted.

Results: Primary outcome was defined as time to liberation from mechanical ventilation, either by extubation or after tracheostomy. Secondary outcomes included ICU length of stay (LOS) and total hospital LOS. Analysis was performed using two sample t-test and results are expressed as ± SEM. After exclusion of patients with other causes, 80 patients met criteria. 59 patients were included in the mechanical ventilation without tracheostomy group. Mean age was 49.7 ± 1.2. The time to primary outcome was 4.6 ± 0.48 days. ICU LOS was 6.7 ± 0.77 and hospital LOS was 13.8 ± 1.8 days. 19 patients were included in the tracheostomy group. Mean age was 43.9 ± 2.1. The time to primary outcome was 13.8 ± 1.4 days. ICU LOS was 24.2 ± 3.6 and hospital LOS 37 ± 5.6 days. There were no differences in co-morbid conditions however, hypotension, vasopressor use and renal dysfunction were worse in the tracheostomy group with statistically significant difference noted in coagulopathy (p = 0.06) and thrombocytopenia (p = 0.008). Echocardiogram findings showed worsened right side dysfunction in the tracheostomy group.

Conclusion: Our data indicates that patients with OHS who underwent tracheostomy were younger, more critically ill and had worse rightsided dysfunction. As no objective data was identified, physician’s clinical judgment appears to be a predictor for timing of tracheostomy. The tracheostomy group had longer duration of mechanical ventilation, ICU and hospital LOS but this could affected by the smaller number of patients and the timing of this intervention. A prospective study is needed to identify OHS patients in a timely manner to avoid adverse outcomes and to evaluate long term outcome after tracheostomy.

0586
ASTHMATIC PATIENTS AND OSAS SHOW HIGHER BLOOD PRESSURE IN THE EMERGENCY ROOM
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Introduction: OSAS and asthma are independent risk factor for high blood pressure and both diseases promote inflammation. There is no information in the literature about the effect of sleep apnea over patients with acute asthma in the emergency room. This study aims to determine whether OSAS influence the blood pressure in moderate/severe asthmatic patients during their evaluation and treatment in the emergency room.

Methods: 23 patients, age ranged from 21 to 90, mean BMI 28 kg/m², with moderate to severe asthma had measured blood pressure at the emergency room of the Hospital São Paulo, Escola Paulista de Medicina, and underwent polysomnography after 15 days of treatment. Patients admitted to treatment in the ER received standard procedure according to the global initiative for asthma and received corticosteroid and bronchodilator drugs. They were followed at least for 4 hours in the ER and had their blood pressure measured every 60 minutes.

Results: Eleven patients had OSAS on polysomnography and 12 had AHI < 5. Asthmatic patients with OSAS had higher blood pressures than asthmatic patients without OSAS in the 4th hour after the beginning of the treatment for his/her asthma crises. OSAS: systolic 132 and diastolic 84; non-OSAS: systolic 112 and diastolic 73 (p < 0.05).

Conclusion: Even in this small sample of patients it was possible to demonstrate that asthmatic OSAS patients had higher blood pressure than those without OSAS, suggesting that OSAS, a frequent co-morbid disease in patients with asthma can add an additional and important health problem to this population.

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0587
EVALUATING BASELINE CHARACTERISTICS AND RESPONSE TO THERAPY IN HYPOVENTILATION SYNDROMES ASSESSED IN THE SLEEP CENTER

Introduction: Polysomnography is increasingly performed for hypoventilation often requiring ventilation during sleep. This study aims to characterize different hypventilation syndromes.

Methods: We retrospectively reviewed hypventilators that underwent PSG at our sleep center (Kaiser Permanente, Fontana), assessing baseline characteristics and response to therapy.

Results: 116 consecutive hypventilators (68 male, 48 female) were evaluated: 101 obesity hypoventilation syndrome (OHS), 31 COPD, 10 neuromuscular weakness (NMW); 30 had both OHS and COPD, 4 had other causes (ie. Scoliosis). OHS (age 57.8 ± 13.1, BMI 45.6 ± 10.5): Baseline PSG parameters were AHI 45.7 ± 46.4 (P < 0.05 vs COPD and NM), T90% 66.3 ± 31.5%, SATmin 68.7 ± 15.0% (P = 0.15 vs. COPD, P < 0.001 vs. NM), average sleep CO2 50.1 ± 4.8. Mean FVC 70.0 ± 20.9%, FEV1/FVC 78.7 ± 14.6%; DLCOadj 64.7 ± 18.8%, 21% had CHF. Mean ABG pH 7.39 ± 0.07 and CO2 51.4 ± 15.7. 71.6% were prescribed bilevel PAP (primarily AVAPS), 24.2% CPAP and 4.2% O2; 30 (30%) required addition of O2 to PAP therapy. Serum bicarbonate decreased with therapy (30.9 ± 3.4 to 29.6 ± 3.2; P < 0.01). COPD (age 62.5 ± 9.1, BMI 39.1 ± 9.3): baseline AHI 28.4 ± 39.1, T90% 55.15 ± 32.7%, SATmin 72.0 ± 9.9%, average sleep CO2 52.2 ± 4.1. FVC 63.1 ± 17.4%; FEV1/FVC 66.3 ± 18.6%; DLCOadj 62.3 ± 19.3%. 21% had CHF. ABG pH 7.34 ± 0.08 and CO2 63.4 ± 20.8. 70.0% were prescribed BPAAP (all AVAPS) and 30.0% CPAP; 11 (35.5%) required addition of O2. Bicarbonate change was non-significant (32.2 ± 3.8 to 31.5 ± 3.5; P = 0.06). NMW (age 63.7 ± 8.9, BMI 23.7 ± 5.8): baseline AHI 17.2 ± 26.0, T90% 58.7 ± 45.6%, SATmin 83.2 ± 8.45%. FVC 63.7 ± 29.4%; FEV1/FVC 83.9 ± 9.5%; DLCOadj 57.0 ± 32.2%. 10% had CHF. ABG pH 7.39 ± 0.05 and CO2 48.6 ± 16.6. 100% were prescribed BPAAP (88.9% AVAPS) without requiring O2. Bicarbonate change was non-significant (28.2 ± 2.2 to 29.9 ± 2.7; P = 0.10).

Conclusion: COPD hypventilators at time of initial PSG had the most severe baseline pulmonary function abnormalities and more often required O2 supplementation. Evaluating impact of therapy adherence and hospital utilization rates are pending.
0588
HOME DIM LIGHT MELATONIN ONSETS: IMPROVING ACCURACY WITH OBJECTIVE MEASURES OF COMPLIANCE
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Introduction: The dim light melatonin onset (DLMO) is the gold standard in the measurement of circadian timing in humans. However, the accurate assessment of the DLMO is often limited to the clinic/laboratory setting, where staff has to monitor sample collection. Here we tested a novel kit for unattended home saliva sampling, with objective measures of compliance to (1) dim light via a photosensor, (2) correct sample timing with a monitoring device, and (3) a streamlined labeling system to reduce sample labeling errors.

Methods: Thirty-five healthy adults (21–62 years) participated in a 10-day protocol. Each subject participated in back-to-back home DLMO and laboratory DLMO assessments twice, in counterbalanced order, with 5-days between the assessments on their usual sleep schedule.

Results: The average light intensity during the home DLMO assessments was 4.5 lux, and subjects received less than 50 lux for more than 98% of the 8.5 hour home DLMO assessments. Most subjects were able to collect half-hourly samples within 5 minutes of the scheduled sample times. Cross-checking of light recordings and sample times with salivary melatonin results revealed 92% of home DLMOs were not affected by light or sampling errors. There was no significant difference between the home DLMOs and laboratory DLMOs (p > 0.05), and average home DLMOs occurred only 9.6 minutes before the laboratory DLMOs. The home and laboratory DLMOs were highly correlated (r = 0.91, p < 0.001).

Conclusion: People can complete home DLMO assessments with reasonable compliance to the light and sampling requirements. The great majority of home DLMOs were unaffected by light or sample errors, and they compared favorably with the laboratory DLMOs. These results suggest that with the addition of objective markers of compliance, the accurate assessment of the DLMO outside of the clinic/laboratory is possible. This will reduce cost and increase the availability of DLMO assessments for clinicians and researchers alike.

Support (If Any): Support:RO1 AT007304 to HJB.

0589
GREAT PHASE SHIFTS DURING NIGHT WORK DO NOT IMPROVE DAY SLEEP AND VIGILANCE AT NIGHT IN EVENING TYPES
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Introduction: Shift workers’ circadian phase does not habitually adjust to the night schedule, with consequent reduced sleep and vigilance. Chronotype is considered as a potential mediator in shift work adaptability, as eveningness has been suggested as a facilitating factor. As part of a naturalistic longitudinal study on shift workers, we compared circadian phase, sleep, vigilance, and sleepiness between chronotypes.

Methods: Thirty-three patrol police officers (10 women) aged 22–35 years on rapidly rotating shift schedules completed the Morningness-Eveningness Questionnaire. Sleep was monitored with actigraphy during 4 consecutive night shifts. To assess circadian phase, salivary melatonin was collected hourly between 19:00–01:00 h and 20:00–04:00 h the night before and the night after the 4 shifts, respectively. A 10-min Psychomotor Vigilance-Task (PVT) was administered at the beginning (23:00 h) and the end (07:00 h) of each shift. Subjects completed the Karolinska Sleepiness Scale (KSS) 5 times during each night shift (23:00 h, 01:00 h, 03:00 h, 05:00 h, 07:00 h). Mixed models were used for statistical analysis.

Results: No subject was categorized as Morning-type. Phase shifts ranged from 00:30 h to 06:36 h, with Evening-types (E-types, n = 9) having greater phase shifts than Intermediate-types (I-types, n = 24) (03:38 ± 01:41 h vs. 02:17 ± 01:14 h; p < 0.05). E-types exhibited lower sleep efficiency (81.8% vs 86.1%, p < 0.01) and higher levels of sleepiness (p < 0.01) than I-types, for all 4 nights. No between-groups difference was found as regard PVT parameters.

Conclusion: Circadian phase was delayed more significantly after 4 days of night work in E-types than in I-types. Surprisingly, even with this seemingly larger circadian phase shift, E-types had lower sleep quality and higher sleepiness. These results altogether suggest that improving sleep and waking hours in shift work necessitates more than the sole adjustment of the circadian phase to the night shift. Further studies are needed to clarify the role of chronotype in shift work adaptability and to specify which other mechanisms are at play.

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0590
THE EFFECTS OF A SCHEDULED NAP ON SELF-REPORTED SLEEPINESS AND VIGOR DURING THE NIGHTSHIFT IN FEMALE NURSES WORKING ROTATING 8-HR SHIFTS: A PROSPECTIVE FIELD STUDY
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Introduction: Sleepiness during nighttime shift-work in nurses affects safety of nurses and their patients. Evidence suggests that napping may be an effective countermeasure for the negative consequences of nighttime shift-work on nurses’ functioning, yet few field studies have been done. We examined the effectiveness of a scheduled nap during the nadir of alertness, for reducing sleepiness and maintaining vigor in nurses during night shifts.

Methods: In an experimental field study, 122 female nurses (mean age 39.0 ± 9.1) working 8-hr rotating shifts were recruited by cluster sampling from two hospitals in Israel. All had an appointment ≥ 75% and worked ≥ 1 night shift per week, were not pregnant, and had no diagnosed sleep or chronic medical condition. The protocol was conducted during nurses’ usual work schedule and included two nights with and two nights without a scheduled nap, in randomized orders. During nap nights, nurses napped in a dark quiet bedroom between 04:00–04:40. On non-nap nights they worked as usual. Sleepiness was evaluated hourly (Karolinska Sleepiness Scale, KSS) and vigor was assessed at 03:00, 05:00 and 07:00 (6-item scale). Mixed models tested nap condition, time, and nap condition*time interactions, adjusting for age and workload.

Results: Nurses slept 29.55 (± 11.73) and 30.47 (± 13.03) minutes with 79% (± 19) and 76% (± 21) sleep efficiencies on nap nights one and two respectively. On nap nights, levels of sleepiness were lower at 05:00, 06:00 and 07:00 and vigor was higher at 05:00 and 07:00 (all p < 0.001), compared to non-nap nights. In the adjusted models, main effects for sleepiness and vigor were found for nap condition [F = 41.25, F = 60.87], time [F = 119.73, F = 17.82] and nap condition*time interaction [F = 12.07, F = 14.06], respectively (all p < 0.001).

Conclusion: Based on self-report, a planned nap reduces sleepiness and maintains vigor during the last hours of the night-shift, and may provide an effective, low-cost and simple strategy to improve occupational functioning of the nursing staff.

Support (If Any): Israel Ministry of Economy, 45715.
THE SHIFT WORK SLEEP DISORDER DIAGNOSIS: WHERE IS INSOMNIA?
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Introduction: The diagnosis of shift work disorder (SWD) is underused in the literature. Insomnia and sleepiness are the two main criteria of SWD and are not clearly distinguished, which creates a lack of clarity in the diagnostic process. The present study aims at clarifying SWD diagnosis by investigating both insomnia and sleepiness in a shift worker population.

Methods: 128 participants (mean age = 38.1, range = 21 to 70 years old; women = 78.4%) working in Quebec city hospitals were recruited. Among them, 84 were night shift workers and 44 were day shift workers. Night shift workers worked at least five nights out of 14 days and day shift workers worked at least seven days out of 14. Participants underwent a thorough evaluation including a semi-structured diagnostic interview for sleep disorders. They completed several self-report questionnaires, daily sleep diaries, and wore an actigraph for two weeks. Diagnoses were based on the clinical interviews and sleep diaries. Participants without diagnosis and those that were satisfied with their sleep were considered good sleepers (GS). Participants who were satisfied with their sleep but also presented insomnia and/or excessive sleepiness were considered in a “grey zone”.

Results: 43 night shift workers met criteria for SWD and 19 day shift workers met criteria for insomnia. Six night shift workers and eight day shift workers fell into the grey zone. Among night shift workers with SWD, 9.3% presented only excessive sleepiness, 53.5% presented only insomnia, and 37.2% presented both symptoms. Among day shift workers with insomnia, 36.8% presented excessive sleepiness. Insomnia related to work schedule appeared during three sleep episodes: the main sleep episode, the supplemental sleep episode, and during night sleep on days off. 16.3% of night shift workers had the three types of insomnia, 39.2% had only two, and 32.6% had only one.

Conclusion: The present results indicate that insomnia is an important symptom of SWD that may appear at each sleep episode. This finding implies that SWD diagnosis could be refined further by adding which type of insomnia is experienced by the night shift worker.

Support (If Any): Research supported by the Canadian Institutes of Health Research (191771).
ment. Outcomes of this study support the use of a vigorous and lengthy chronobiologic treatment including early evening exogenous melatonin and morning bright light therapy to keep DSPD patients entrained at their earlier socially necessary sleep times.

Support (If Any): This project is funded by the Australian Research Council.

0594
PREDICTING PHASE TIMING IN DELAYED SLEEP PHASE DISORDER: THE ACCURACY OF MELATONIN AND SELF-REPORTED SLEEP TIMING
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Introduction: The efficacy of Bright Light Therapy and melatonin administration for Delayed Sleep Phase Disorder is contingent upon an accurate clinical assessment of circadian phase timing. Although the timing of core body temperature provides the most accurate indication of circadian phase timing, the process is costly, time consuming and not clinically viable. The present study investigates whether more cost-effective and convenient estimates of circadian phase timing, including dim-light melatonin variables and self-reported sleep timing, can be used to predict circadian phase derived from core body temperature.

Methods: Twenty-five individuals (male = 17; mean age = 21.8, SD = 5.07) with DSPD were selected on the basis of ICSD-3 criteria from a community-based sample. Core body temperature minimum (cBTmin), dim-light melatonin onset (DLMO), and the midpoint of the melatonin secretion period (DLMmid = DLMoff−DLMO) were determined from the first 24-hours of a larger 80-hour constant laboratory ultradian routine which consisted on ultra-short ‘1hr days’, with alternating 20-min sleep opportunities and 40-min of enforced wakefulness. Hourly averages of core body temperature were derived from minute recordings, while salivary melatonin was sampled at half-hourly intervals. Subjective sleep timing was assessed using a seven-day sleep/wake diary kept by participants immediately prior to the laboratory session.

Results: Significant associations were observed between cBTmin and DLMO (r = 0.66), DLMoff−DLMO (r = 0.69) and midpoint of the melatonin secretion period (DLMmid = DLMoff−DLMO) (r = 0.50), wake up time (r = 0.53) and get up time (r = 0.56), whereby later cBTmin was associated with later timing on all other variables. cBTmin was not significantly related to bedtime, lights out time, age or gender. Regression analyses revealed cBTmin was best predicted by dim-light melatonin variables (DLMO B = 0.65; DLMoff−DLMO B = 0.68; DLMmid B = 0.65), but also strongly predicted by get up time (B = 0.58), wake up time (B = 0.52) and to a lesser extent sleep onset (B = 0.49; all ps < 0.05).

Conclusion: These findings suggest self-reported sleep timing and dim-light melatonin variables can be used clinically to predict the timing of core body temperature minimum in DSPD.

0595
LONGITUDINAL MEASURES OF SLEEP DIARIES CAN BE USED CLINICALLY TO ASSESS TASIMELTEON EFFECTIVENESS IN NON-24-HOUR SLEEP-WAKE DISORDER
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Introduction: SET and RESET trials demonstrated tasimelteon’s (HETLIJOZ®) effectiveness in treating Non-24-Hour Sleep-Wake Disorder (Non-24), by entraining the previously non-entrained rhythm of the circadian clock, and improving sleep-wake measures and global functioning. Here we examine the changes in sleep in the subset of tasimelteon patients who entrained.

Methods: SET and RESET trials were conducted in blind individuals with sleep-wake complaints and a Non-24 diagnosis as confirmed by urinary aMT6s. Patients received 20 mg tasimelteon or placebo at a fixed bedtime. Entrainment (r of < 24.1 with a 95% confidence interval including 24.0) was measured during month one of SET and after one month in RESET. Sleep diaries were collected via an Interactive Voice Recording System during baseline for a minimum of 6 weeks, and during treatment for 3 or 6 months. Sleep measurements included Nighttime sleep on worst nights (LQ-nTST), Daytime Sleep on worst days of sleep (UQ-dTSD), Nighttime Total Sleep Time (nTST), Daytime total Sleep Duration (dTSD), Sleep Quality (SQ), Number of Daytime Naps (DN), Latency (L), and Wake After Sleep Onset (WASO). Clinical measures were assessed in 28 individual who entrained with tasimelteon as a change from baseline.

Results: Clinical measures were assessed in 28 individual who entrained with tasimelteon treatment. Change from baseline improved for all sleep-wake measures (p’s < 0.01, paired t-tests) including LQ-nTST (1.44 ± 1.19 hours), UQ-dTSD (−1.20 ± 0.93 hours), nTST (1.0 ± 0.77 hours), dTSD (−0.49 ± 0.48 hours), SQ (−0.33 ± 0.30), DN (−0.30 ± 0.36), L (0.33 ± 0.58 hours), and WASO (−0.34 ± 0.53 hours) from an average of every day of data collected for 3 or 6 months.

Conclusion: Robust changes in sleep are observed in entrained patients treated with tasimelteon. Benefit from daily tasimelteon use, however, may take several weeks or months because of individual differences in circadian rhythms. Assessment of tasimelteon response is easily achieved through individual patient diaries and likely adequately assessed through clinician interview.

Support (If Any): Supported by funding from Vanda Pharmaceuticals

0596
PRELIMINARY ASSESSMENT ON THE EFFECTIVENESS OF THE LUMINETTE® IN ADOLESCENTS WITH A DELAYED SLEEP PHASE SYNDROME (DSPS): RANDOMIZED SINGLE BLIND PLACEBO-CONTROLLED STUDY
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Introduction: The aim of this pilot study was to test the effectiveness of a light therapy device (the Luminitette®) on the delayed sleep phase syndrome (DSPS) in a group of adolescents (n = 10) between 15 and 18 years old (three girls and seven boys, average age 16.3 years old) affected by this syndrome.

Methods: This study was conducted using an experimental single blind placebo-controlled design. The diagnosis of the DSPS among participants was established based on the criteria specified in the International Classification of Sleep Disorders—Second Edition (ICSD-2). The data were collected using two questionnaires: 1) Teen Sleep Diary (TSD) and 2) the Pediatric Daytime Sleepiness Scale (PDSS).

Results: The results indicated significant improvements in the experimental group (users of the real Luminitette®) compared to the control group (users of the placebo Luminitette®) with respect to the delay of sleep onset, the quality and the daytime sleepiness.

Conclusion: This study underlines the importance of conducting further research on the Luminitette® with a larger sample of adolescents with DSPS: quicker to fall asleep, longer sleep duration, improved sleep quality and reduced daytime sleepiness level. This study highlights the relevance to undertake later research on treatment using the Luminitette® with a larger sample of adolescents who have DSPS.
B. Clinical Sleep Science

II. Circadian Rhythms Sleep-Wake Disorders

0597 PHARMACOKINETIC CHARACTERISTICS OF TASIMELTEON
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Introduction: Tasimelteon (HETLIOZ®), a melatonin agonist with selective activity at the MT1 and MT2 receptors, has been developed for the treatment of Non-24-Hour Sleep-Wake Disorder (Non-24). Non-24 is a serious chronic circadian rhythm disorder that occurs when individuals are unable to entrain (synchronize) their endogenous master body clock to the 24-hour day-night cycle. Tasimelteon has demonstrated its ability to entrain the circadian clock and improve sleep-wake measures.

Methods: Data from 115 subjects from 5 phase I studies was analyzed to determine the pharmacokinetics of tasimelteon. Additionally, the absolute bioavailability of tasimelteon was determined in an open-label cross-over study. In this study, all 14 volunteers received a 20 mg capsule administered orally or a 2 mg IV dose infused over 30 minutes in a random order. Volunteers were treated with the alternate route after a 5 ± 2 days wash-out period. Blood samples for pharmacokinetic analysis were collected during each administration. Safety measures were also assessed.

Results: The Cmax, Tmax, AUC(inf), and t½ among the five studies analyzed were similar. Tasimelteon is rapidly absorbed with an average Cmax (± SD) of 235 ± 128 ng/mL occurring at a median Tmax of 0.50 hours. The average AUC (± SD) is 411.4 ± 327.8 h-ng/mL, and the average t½ (± SD) is 1.32 ± 0.431 hours. Tasimelteon’s absolute bioavailability was 38% and the total clearance from plasma after IV administration was 505 ± 135 mL/min. The mean t½ was similar for the oral and IV administration. The oral-to-IV exposure ratios for the most abundant metabolites were higher than 100%, suggesting presystemic or first-pass metabolism.

Conclusion: Low bioavailability could lead to variable therapeutic responses due to systemic exposure’s variability. Tasimelteon has a higher absolute bioavailability than other melatonin agonists which combined with its short half-life supports its profile as an effective treatment for Non-24.

Support (If Any): Vanda Pharmaceuticals Inc.

0598 PSYCHOLOGICAL CONDITIONS OF CIRCADIAN RHYTHM SLEEP DISORDER PATIENTS AND COMPARISON BETWEEN SUCH PATIENTS AND HEALTHY ADULTS USING MULTIPLE SLEEP LATENCY TEST AND POLYSOMNOGRAPHY
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Introduction: Circadian sleep disorder (CRSD) is caused by the malfunctioning of the biological clock, or a difference between the intrinsic circadian rhythm and external environmental factors that regulate the duration of sleep. CRSD is divided into several types, such as the delayed sleep-phase, irregular sleep-wake, and free-running types.

Methods: From 2010 through 2013, we had CRSD outpatients (male 13, female 16, average age; 17.8 ± 5.7 years old) attached Epworth sleepiness score (ESS), self depression scale (SDS), POMS wore actiwatches. Some of them were conducted PSG after admission. Some patients were admitted our psychiatry ward. We analyzed ESS, SDS, PSG comparing with healthy adults machined age and sex. We used one factor subject analysis of variance as a statistical analysis.

Results: The following results were obtained: 1) PSG revealed that there was no significant difference in sleep latency, sleep efficiency, or REM sleep latency between CRSD patients and healthy individuals; 2) POMS revealed that CRSD patients showed lower-level vigor (V) as well as higher-level fatigue (F) and confusion (C) compared with healthy individuals; and 3) according to the multiple sleep latency test (MSLT), CRSD patients showed a significantly longer sleep latency and significantly higher sleep efficiency compared with those with insufficient sleep syndrome.

Conclusion: These findings suggest that the sleep-wake rhythm of CRSD patients was normalized by the enhancement of synchronizing factors, which was achieved through hospitalization.

0599 CATARACT SURGERY, OBJECTIVE SLEEP QUALITY, AND COGNITION IN THE GENERAL ELDERLY POPULATION: A CROSS-SECTIONAL STUDY OF THE HEIJO-KYO COHORT
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Introduction: Sleep quality and cognition are both influenced by environmental light information to the retina. Cataract decreases light transmission to the retina and may cause circadian misalignment. Cataract surgery (CS) drastically increases the capacity for light reception and may improve sleep quality and cognition. However, the associations between CS, sleep quality, and cognition remain unclear.

Methods: In this cross-sectional study comprising 934 elderly individuals (mean age, 71.7 years), we evaluated the status of CS using a self-reported questionnaire and measured objective sleep quality using an actigraph over two consecutive nights. In addition, cognitive function was evaluated using the Mini-Mental State Examination (MMSE) by trained clinical psychologists, and cognitive impairment was defined as an MMSE score < 27.

Results: The mean age in the CS group (n = 154) was 6.3 years older than that in the no CS group (n = 780). Cognitive impairment was observed in 311 participants. Multivariate linear regression models adjusted for age, gender, body mass index, and sleep medication revealed that the CS group showed significantly higher sleep efficiency (SE) and shorter wake after sleep onset (WASO) than the no CS group (SE, 85.9% vs. 84.4%, P = 0.030; WASO 45.3 vs. 50.7 min, P = 0.039; respectively). Sleep onset latency did not significantly differ between the two groups. Furthermore, multivariate logistic regression models adjusted for age, gender, body mass index, and SE revealed that the CS group showed significantly lower odds ratio for cognitive impairment than the no CS group (odds ratio, 0.67; 95% confidence interval, 0.45 to 0.99; P = 0.047).

Conclusion: Our study demonstrated that receiving CS is significantly associated with better objective sleep quality and cognitive function in the general elderly population. The association between CS and cognitive function was independent of objective sleep quality.

0600 HIGHER WRIST SKIN TEMPERATURE IN EVENING TO INITIAL NIGHT-TIME AND BETTER ACTIGRAPHIC SLEEP QUALITY IN REAL LIFE: HEIJO-KYO STUDY
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Introduction: Previous experimental studies showed increase of distal skin temperature is associated with shorter sleep onset latency. In addition, intervention to warm distal skin region improved sleep quality. However, the association between distal skin temperature and sleep quality in real life situation remains unclear. We simultaneously mea-
sured wrist skin temperature and actigraphic sleep among 590 elderly in colder season from October to April.

**Methods:** Wrist skin temperature and physical activity were measured at 1-min interval for 48 hours using a temperature data logger (Thermochron iButton, Maxim, USA) fixed at wrist near the radial artery and actigraph worn on the non-dominant arm. Sleep onset latency and sleep efficiency were calculated from 1-min epoch physical activity, and bedtime and rising time according to self-administered sleep diary.

**Results:** Of 590 participants (71.0 ± 7.54 (SD) years), male was 279 (47.3%). Outdoor and living room temperature in evening (2 h before bedtime) were 6.1 ± 4.5°C, 16.3 ± 4.1°C, respectively. Wrist skin temperature in evening and initial-nighttime (2 h after bedtime) were 33.0 ± 1.6°C, and 34.4 ± 1.3°C, respectively. A multivariate mixed linear regression model revealed that higher evening wrist temperature is significantly associated with shorter log-transformed sleep onset latency (β = −0.052, P = 0.048). Furthermore, higher wrist skin temperature in initial night-time is associated with shorter log-transformed sleep onset latency (β = −0.25, P < 0.01), and higher sleep efficiency (β = 1.26, P < 0.01) independent of potential confounders such as age, gender, current smoking, alcohol intake (> 30 g), body mass index, house hold income (> 4 million JPY), education (≥ 13 year), insomnia medication, depression medication, diabetes, and bedtime.

**Conclusion:** We found significant association between higher wrist temperature in evening to initial night-time and better sleep quality in real life situation.

**0601 ASSOCIATION OF CLOCK 3111T/C POLYMORPHISM WITH DIURNAL PREFERENCE AND SLEEP QUALITY IN KOREAN ADULTS**

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**Introduction:** It was originally reported that CLOCK 3111T/C polymorphism was associated with evening preference, but most of the following studies did not replicate the original finding. This discrepancy might be resulted from the difference in study population. Although several studies suggested that the sleep quality was also influenced by genetic factors, such a relationship of CLOCK 3111T/C polymorphism has not been identified in general population. We aimed to examine whether there is a difference in CLOCK 3111T/C polymorphism according to the morningness-eveningness in Korean adults, and to find a difference in sleep quality according to this polymorphism.

**Methods:** The Korean version of the Morningness-Eveningness Questionnaire was administered and buccal DNA samples were obtained from visitors to the Chunchon National Museum in Korea. Forty-four type (MT) (age: 44.20 ± 12.52 yrs, M:F = 14:30), 59 neither type (NT) (age: 35.20 ± 9.53 yrs, M:F = 20:39), and 48 evening type (ET) (age: 28.79 ± 8.15 yrs, M:F = 13:35) subjects were finally selected after excluding those with sleep disorders or shift work. The CLOCK 3111T/C was analyzed by DNA sequencing or SNPshot assay.

**Results:** The genotype, allele frequency, and proportion of C allele positive subjects were significantly different between the MT, NT and ET groups, and those of ET subjects were significantly higher compared to the combined group of MT and NT subjects from a post hoc test. There was no significant difference in PSQI scores between the subjects with TT genotype and those with TC genotype (n = 16 for each group, paired t-test, p > 0.05).

**Conclusion:** It is difficult to say that our result replicates the previous finding that showed an association of CLOCK 3111C allele with evening preference, for there was no subject with CLOCK 3111CC homozygote in our study. And the hypothesis that CLOCK 3111T/C polymorphism may be associated with sleep quality was not supported by our study.

**Support (If Any):** Basic Science Research Program through the National Research Foundation of Korea (NRF) funded by the Ministry of Education, Science and Technology (2010-0003160).

**0602 LIGHT EXPOSURE AT NIGHT INCREASES THE RISK OF ABDOMINAL OBESITY: EFFECT INDEPENDENT OF MELATONIN SECRETION IN THE HEIJO-KYO COHORT**

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**Introduction:** Modern human life is accompanied by increased light exposure at night (LAN) because of artificial lighting use. Increased nighttime light levels may disturb circadian biological rhythmicity and its misalignment may cause metabolic abnormalities. Previous epidemiological studies have suggested a cross-sectional association between LAN exposure and obesity; however, a longitudinal effect of LAN on obesity has never been explored in humans.

**Methods:** This longitudinal study was conducted in the HEIJO-KYO cohort. At baseline survey among 1127 elderly individuals, we measured bedroom light intensity at 1-min intervals, waist circumference, actigraphic physical activity, and overnight urinary melatonin excretion (UME). Of these, waist circumference in 769 participants was followed up (median duration, 21 months). Association between bedroom light intensity at baseline and changes in waist circumference was evaluated with multivariate linear regression models.

**Results:** Compared with the dim group (average < 5 lux; n = 632), the LAN group (average ≥ 5 lux; n = 137) showed significant waist circumference gain (adjusted gain, 1.0 cm; 95% confidence interval, 0.1 to 1.9; P = 0.037), independently of potential confounding factors such as age, gender, waist circumference at baseline, duration in bed, actigraphic physical activity, day length, and UME. We observed consistent associations between LAN exposure and waist circumference gain in different cutoff values (i.e., 3 and 10 lux: adjusted gain, 0.8 and 1.3 cm; P = 0.046 and 0.017, respectively). Moreover, UME was significantly and inversely associated with waist circumference gain in these regression models (P < 0.05).

**Conclusion:** In the general elderly population, LAN increases the risk of abdominal obesity. The effect of LAN on waist circumference gain was independent of several potential confounding factors including melatonin secretion.

**0603 EFFECTS OF NIGHTTIME LIGHT RADIANCE ON THE SLEEP OF THE GENERAL POPULATION**

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**Introduction:** The objectives of this study is to verify if the exposure to greater nighttime radiance is associated with changes in the sleep/wake schedule and with greater sleep disturbances.

**Methods:** The target population was the adults (18 years and older) living in California, USA. This represents 24 million of inhabitants. A total of 3,104 subjects participated in the survey (participation rate
85.6%). The participants were interviewed by telephone using the Sleep-EVAL system. The interviews covered several topics including sleeping habits, sleep quality, sleep disturbances, physical symptoms related to menopause. Chronic insomnia was defined as difficulty initiating or maintaining sleep for at least 3 months. Global nighttime light emissions have been collected by the Defense Meteorological Satellite Program’s Operational Linescan System (DMSP/OLS) sensors. We extracted the radiance calibrated nighttime lights corresponding to the date of the interviews for a three by three window centered on each coordinate corresponding to an interview address.

**Results:** Dissatisfaction with sleep quantity and/or quality was associated with an increased nighttime radiance (p = 0.02). Similarly, excessive sleepiness accompanied with impaired functioning was significantly associated with an increased nighttime radiance (p < 0.0001). The association remained significant after controlling for age, gender and use of a night lamp in the bedroom. Confusional arousals were also significantly associated with an increased nighttime radiance (p < 0.0001). Bedtime hour was linearly increasing with the intensity of nighttime radiance: the later the bedtime, the greater the nighttime radiance (p < 0.0001). Similarly, wake up time became progressively later as the nighttime radiance increased (p < 0.0001). Both associations remained significant after controlling for age, gender and use of a night lamp in the bedroom. Circadian Rhythm Disorders were the only sleep disorder significantly associated with increased nighttime radiance (p < 0.0001).

**Conclusion:** Exposure to increased nighttime light radiance appeared to cause a shift in the sleep/wake schedule, excessive sleepiness and Circadian Rhythm Disorders.

**0604**
LIGHT EXPOSURE, CHRONIC FATIGUE, AND SLEEP BETWEEN WORKING AND OFF DAYS AMONG NURSES UNDER FIXED SHIFTS
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**Introduction:** Fixed rotation shift has been suggested as a better way for nurses’ health and performance. Light is important zeitgeber for the circadian system. This study investigated light exposure and sleep patterns for consecutive 6 days in nurses under fixed shifts.

**Methods:** Sixty female nurses (day shift DS = 18, evening shift ES = 21, night shift NS = 21) with a mean age of 31.0 ± 5.2 years completed sleep diary and actigraphy with light meter for 6 days. Mean actigraphic sleep with light exposure during sleeping time was calculated for working and off days, respectively. Standard shiftwork index chronic fatigue scale and Pittsburg Sleep Quality Index were indexed.

**Results:** 76.7% of nurses complained poor sleep (PSQI ≥ 5) with the worse sleep reported from NS nurses (F = 3.256, p = 0.046). Light exposure during sleeping time (LEST) was 6.1, 13.5, and 12.2 lux in DS, ES, and NS, respectively. No differences were found in chronic fatigue among nurses under three shifts. Compare their actigraphic sleep between working and off days, NS nurses spent less time in bed during working days (6.4 hrs vs. 7.0 hrs in DS and 7.6 hrs in ES; F = 4.38 p = 0.017) but slept more during off days (7.4 hrs vs. 5.7 hrs in working days; paired t = 2.79, p = 0.012). LEST in off days was associated with wake after sleep onset (r = 0.299, p = 0.033) and sleep efficiency (r = –0.306, p = 0.029).

**Conclusion:** Nurses under night shift sleep more during off days to compensate their less sleep during working days and to maintain their energy. More light exposure during sleeping time is associated with less sleep efficiency and more awakening time after sleep.

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**0605**
THE SLEEP QUALITY AND OCCUPATIONAL STRESS OF SHIFT WORKING AND REGULAR WORKING NURSES
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**Introduction:** The aim of this study is to investigate the sleep quality, depressive symptoms and occupational stress of registered nurses by comparing the shift working and regular working registered nurses.

**Methods:** 265 shift working registered nurses and 73 regular working registered nurses were recruited at St. Vincent’s hospital. All subjects fulfilled the questionnaires about demographic data, sleep quality, daytime sleepiness, mood and occupational stress. We used Pittsburg Sleep Quality Index, Epworth Sleepiness Scale, Beck Depression Inventory and Korean Occupational Stress Scale.

**Results:** Results indicated that shift work group showed significantly worse subjective sleep quality, total PSQI score, and more severe daytime sleepiness than regular work group. Depressive symptoms were not significantly different between groups. Shift work group showed significantly higher score in total occupational stress. Occupational stress due to physical environment, due to job demand, due to job insecurity, due to lack of reward were significantly higher in Shift work group.

**Conclusion:** Shift working nurses showed poorer sleep quality, more severe daytime sleepiness, and higher occupational stress than Regular working nurses. Poor sleep quality of shift working nurses would decrease the inner energy and concentration on work, which might lead them to suffer from higher occupational stress and lower their resilience to the occupational stress.

**0606**
THOUGHTS AND COGNITIVE ACTIVATION AMONG NIGHT SHIFT WORKERS
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**Introduction:** Studies have shown that nearly 32% of night shift workers, 10% of day shift workers, and 8% to 26% of rotating shift workers suffer from Shift Work Disorder (SWD). Insomnia and excessive sleepiness are the two main criteria of SWD. Cognitive activation and certain thoughts are known to contribute to insomnia. Moreover, very few studies have compared shift workers suffering from SWD with day shift workers suffering from insomnia. Therefore, the present study investigated whether similar thoughts patterns phenomena were also present among night shift workers with SWD.

**Methods:** 114 participants were recruited in Québec city hospitals (mean age = 38.1, range between 21 to 70 years old). 78 of them were night shift workers, of which 43 met the criteria for SWD according to the ICSD-II. Among the 36 day workers, 19 of them met criteria for insomnia. The Dysfunctional Beliefs and Attitudes about Sleep scale (DBAS-16), the Predisposition Sleep Arousal Scale (PSAS), and the Glasgow Content of Thoughts Inventory (GCTI) were completed by participants in order to assess cognitive activation.

**Results:** Anovas revealed that night shift workers with SWD and day shift workers with insomnia endorsed more dysfunctional beliefs and attitudes about sleep (p = 0.0001). They also presented more intrusive
thoughts at the time of falling asleep (p = 0.0001) and had more cognitive activation (p = 0.0001) than good sleepers. In addition, there was a significant interaction in DBAS-16 scores between insomnia symptoms and work schedule (p = 0.01), whereby day shift workers with insomnia had significantly more dysfunctional beliefs and attitudes than good sleepers (p = 0.0001). Furthermore, insomnia sufferers had significantly higher DBAS-16 scores than workers with SWD (p = 0.002). Conclusion: This study shows that intrusive thoughts before falling asleep, dysfunctional beliefs and attitudes about sleep, and cognitive activation are related to insomnia symptoms regardless of work schedule. However, these variables seem more present among day shift workers. The next step is to evaluate how cognitions and cognitive activation are related to sleep variables among night shift workers by comparing them to day shift workers.

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0607 SOCIAL JET LAG SLEEP DISORDER: PREVALENCE STUDY IN SOUTH KOREA

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Introduction: To investigate the prevalence of social jet lag sleep disorder in Korean adults and to find related characteristics.

Methods: A total of 2,762 participants from 2011 to 2012 completed questionnaire about the sleep-wake habit and sleep quality. Social jet lag is defined as ≥ 2 h differences in sleep between weekdays and weekends, in terms of total sleep time (TST). The subjects were divided into group of social jet lag (SJ), and non-social jet lag (NSJ).

Results: 512 subjects (18.9%) were in SJ, and 2241 subjects (81.1%) in NSJ group. SJ subjects revealed significant late bedtime and short TST during weekdays (bedtime; 0.1 ± 1.8 in SJ vs. 23.5 ± 1.9 in NSJ and TST; 6.7 ± 1.2 in SJ vs. 7.2 ± 1.3 in NSJ, p < 0.001) and weekends (bedtime; 0.3 ± 2.2 in SJ, vs. 23.7 ± 2.2 in NSJ and TST; 9.4 ± 1.4 in SJ, vs. 7.4 ± 1.3 in NSJ, p < 0.001). SJ subjects slept about 2.7 h longer during weekends. There was more frequent reports of moderate to severe daytime sleepiness (Epworth Sleepiness Scale > 10, 18.23% in SJ, 16.37% in NSJ), and poor sleep quality (Pittsburgh Sleep questionnaire index > 5, 52% in SJ, 43.9% in NSJ), but not much trouble sleeping (Insomnia severity scale) in SJ subjects. Shift work schedule had no significant association with social jet lag. White collar occupations compared to other occupation (white collar vs. other occupation, p < 0.001), higher monthly income (3 million won or more per month vs. less than 3 million, p < 0.001), and age less than 50 years old (p < 0.001) were more frequently seen in SJ subjects. The sex distributions, and place of residence, were not different in SJ, and NSJ.

Conclusion: 18.9% of Korean adults sleep ≥ 2 h less during weekdays than weekends. These subjects also report poor sleep quality along with daytime sleepiness. The social jet lag was highly prevalent in active working age of < 50 years, in-door occupational environment and higher work load measure by monthly incomes.

0608 SOCIAL JETLAG AND EVENINGNESS ARE ASSOCIATED WITH POOR ACADEMIC PERFORMANCE AND HEALTH IN ADOLESCENTS

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Introduction: Social Jetlag is the misalignment between sleep timing on weekdays and weekends. In previous studies, Social Jetlag was associated with obesity, depression and poor academic performance in adults. Here in this study, we evaluated the relationship between social jetlag, chronotype and grades at school and health in an adolescent population.

Methods: Subjects were adolescents (M:F = 123:113; Age M:F = 14.4 ± 2.2: 14.6 ± 2.0) recruited from the greater San Antonio area. Subjects filled out the School Sleep Habits Survey and questionnaires of anxiety, depression and childhood trauma. Social jetlag, chronotype, health and school grades were extracted from the School Sleep Habits Survey. Social jetlag was quantified by the difference between midsleep on weekends and weekdays. Multivariate analyses were conducted to identify the association between social jetlag and grades and health.

Results: There were no significant gender differences in Social jetlag duration and Chronotype scores. As observed in previous studies, social jetlag was positively correlated with evening type sleep patterns in both males (r = 0.298, p = 0.001) and females (r = 0.317, p = 0.001). Social jetlag was significantly associated with poor grades and poor health status. On further analyses in females, Social jetlag was associated with poor grades in school (F (1,106) = 3.38, p = 0.012) and poor state of health (F (1,106) = 4.39, p = 0.015) whereas chronotype was not associated with either grades or health in females. Interestingly, in males, Social jetlag (F (1,113) = 2.61, p = 0.021) and eveningness preference (F (1,113) = 2.98, p = 0.010) were associated with poor grades but not state of health.

Conclusion: The results suggest higher social jetlag in adolescents affects grades at school and health. Future research should focus on the independent role of social jetlag vs chronotype on health and academic performance in adolescence. The differential effects of social jetlag in male and female adolescents are interesting and will need further exploration.

Support (If Any): This research was supported by National Institutes of Health RO1AA01627 and the Baptist Health Foundation.

0609 WITHDRAWN
III. Insomnia

0610 PROSPECTIVE STUDY OF INSOMNIA WITH OBJECTIVE SHORT SLEEP DURATION AND RISK OF INCIDENT CARDIOVASCULAR DISEASE: SLEEP HEART HEALTH STUDY

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Introduction: Insomnia with objective short sleep duration has been associated with incident hypertension, diabetes, and mortality, suggesting it represents a more deleterious insomnia phenotype. We sought to quantify the association between insomnia symptoms with objective short sleep duration and incident cardiovascular disease (CVD).

Methods: We conducted a time-to-event analysis of Sleep Heart Health Study data. Baseline sleep questionnaires were administered and at-home polysomnography was performed between 1994 and 1998. Participants without CVD were followed for a median 11.4 years (IQR 8.8–12.4 years) until first nonfatal or fatal CVD event (i.e., myocardial infarction, revascularization procedure, or stroke), death, or date of last contact. The primary exposure was insomnia with short sleep duration defined as: self-report of difficulty falling asleep, getting back to sleep, or waking up earlier than desired; and total sleep time of < 6 hours on polysomnography. We used proportional hazards models to determine the cause-specific association between insomnia with short sleep duration and time to CVD.

Results: Among 4,496 participants (mean age 63.3 ± 11.1 years, 55.9% female), 14.1% reported insomnia, and 48.2% of these slept < 6 hours on at-home polysomnography. A total of 821 CVD events and 537 deaths (competing risk) were observed. In an unadjusted analysis, insomnia with short sleep duration was significantly associated with CVD (HR 1.5; 95% CI, 1.1–1.8) relative to other participants. After adjustment for age, sex, race, smoking, apnea hypopnea index, and antidepressant medications, insomnia with short sleep duration remained significantly associated with CVD (HR 1.3; 95% CI, 1.0–1.6). Results did not differ substantially with additional adjustment for hypertension.

Conclusion: Insomnia with objective short sleep duration conferred elevated risk for CVD, suggesting a biologically vulnerable phenotype. Future work is needed to elucidate mechanisms linking insomnia with short sleep duration to CVD.

0611 THE ASSOCIATION BETWEEN OBJECTIVE SLEEP DURATION AND SUBJECTIVE REPORTS OF NIGHTTIME AND DAYTIME INSOMNIA SYMPTOMS

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Introduction: Objective sleep duration has been proposed as a biological marker of insomnia severity, with two phenotypes derived from this conceptualization. Associated with higher physiological hyperarousal, a more persistent course and increased morbidity, insomnia with short sleep duration is thought to represent a more severe phenotype. Conversely, insomnia with near-normal sleep duration appears to be associated with increased psychological symptoms and more likely to remit over time. Given the importance of subjective symptoms in the assessment and diagnosis of insomnia, there is a need to examine potential differences in these symptoms across phenotypes.

Methods: Participants were 45 adults (24.9 ± 4.9 years; 72.1% women) without insomnia complaints. Based on the median score on the Ford Insomnia Response to Stress Test (FIRST = 20), age- and sex-matched participants were classified into high (HV; n = 21) and low vulnerability (LV; n = 22) groups. Participants wore an actigraph and completed daily questionnaires for 2 weeks. The Daily Stress Inventory assessed the frequency of stressful events and perceived impact. The Pre-Sleep Arousal Scale assessed somatic and cognitive arousal experienced at bedtime. Sleep efficiency (SE), deriving from sleep diaries and actigraphy, was used as an indicator of sleep disturbance.

Results: Correlational analyses between stress and arousal revealed that higher frequency and impact of stress were associated with higher cognitive and somatic arousal in LV group (r = 0.18), only the frequency of stressful events, but not stress impact was positively associated with cognitive arousal in HV group (r = 0.17). Analyses between arousal and SE revealed that higher cognitive and somatic arousal were associated with reduced subjective SE (r = 0.39, r = 0.24, respectively) in both groups and with objective SE (r = 0.15) only in HV group.
Conclusion: Results suggest that greater daily stress is associated with elevated pre-sleep arousal, which in turn is associated with increased sleep disturbances. The significant association between impact of stress and arousal was observed only in LV group. These preliminary findings warrant further research on the potential effect of sleep reactivity on sleep disturbance as a function of stress and arousal.

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**0614**

INSOMNIA IN THE MILITARY: PREVALENCE AND COMORBIDITIES

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**Introduction:** The objectives of this study were to examine the prevalence of insomnia in a large sample of active duty service members using a more rigorous definition of insomnia than previously reported and to comprehensively assess potential comorbidities as recommended by leaders of the field of insomnia research.

**Methods:** A total of 3763 active duty service members at the United States Army Post at Fort Hood in Killeen, TX were included in this study. Participants were included if they were scheduled for deployment in support of Operation Iraqi Freedom (OIF) or Operation Enduring Freedom (OEF) and completed the 7-item Insomnia Severity Index (ISI).

**Results:** Clinically significant insomnia was reported by 19.7% in this sample of active duty service members preparing for deployment. The insomnia group also reported greater levels of PTSD, depression, anxiety, anger, alcohol use problems, psychosomatic symptoms, history of stressful events, childhood trauma, and stress reactivity, and lower levels of social support and unit cohesion than the no insomnia group.

**Conclusion:** This study is consistent with previous research that indicates high rates of insomnia, although using the 7-item ISI to measure insomnia resulted in a lower prevalence rate than in studies using single self-report items. Insomnia is significantly related to numerous comorbidities and further research is needed to determine the prevalence of other sleep disorders and the efficacy of sleep interventions.

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**0615**

WITHDRAWN

**ASSOCIATION BETWEEN VULNERABILITY TO STRESS-RELATED INSOMNIA AND INSOMNIA SEVERITY MAY BE MODERATED BY 5HTTLPR GENOTYPE**

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**Introduction:** Serotonin is implicated in the control of sleep-wake behaviour. A functional polymorphism in the serotonin transporter gene (5HTTLPR) has previously been associated with insomnia, although results are mixed. The present study aimed to determine whether allelic variation in 5HTTLPR was associated with insomnia severity in the general population, and whether the association between vulnerability to stress-related insomnia and insomnia severity was moderated by 5HTTLPR genotype.

**Methods:** DNA from buccal swabs was genotyped for the 5HTTLPR polymorphism using polymerase chain reaction from 95 individuals from the general population. Of these, 77 also provided data on insomnia severity (Insomnia Severity Index) and vulnerability to stress-related insomnia (Ford Insomnia Response to Stress Test) (mean age: 25.79 years [SD = 9.22 years]; 76.6% female). High and low vulnerability groups were determined based on a median split of FIRST scores.

**Results:** There was no main effect of genotype on insomnia severity. However, the interaction between 5HTTLPR genotype and vulnerability to stress-related insomnia on insomnia severity showed a trend towards significance (F(1,73) = 2.93, p = 0.09). Follow-up t-tests revealed that individuals homozygous for the ‘short’ allele who also were categorised as high vulnerability to stress-related insomnia demonstrated greater insomnia severity compared to those categorised as low vulnerability to stress-related insomnia (mean insomnia severity scores for low vulnerability SS genotypes: 4.09 [SD = 4.66] and high vulnerability SS genotypes: 11.07 [SD = 6.04], t(23) = −3.16, p<0.00); whereas there were no significant differences in insomnia severity for individuals carrying at least one ‘long’ allele categorised as high or low vulnerability to stress-related insomnia (mean insomnia severity scores for low vulnerability SL+LL genotypes: 6.20 [SD = 5.56] and high vulnerability SL+LL genotypes: 8.86 [SD = 5.30], t(50) = −1.56, p=0.13).

**Conclusion:** The association between vulnerability to stress-related insomnia and insomnia severity appears to be moderated by 5HTTLPR genotype. Individuals carrying at least one ‘long’ allele appear to be protected from experiencing more severe insomnia despite possessing a trait-like vulnerability to insomnia.

**Support (If Any):** Northumbria University Faculty of Health and Life Sciences

**0617**

INSOMNIA AND ITS ASSOCIATION TO DEPRESSED MOOD IN A COMMUNITY SAMPLE OF POSTPARTUM WOMEN

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**Introduction:** Sleep disturbance during the postpartum confers risk for postpartum depression (PPD). Less well established are the types of sleep disturbance that contribute to PPD. The present study sought to examine the degree of insomnia severity among postpartum women (PPW) and to qualify for whom (based on demographics) and when (based on time post-delivery) insomnia was most pronounced.
Methods: Data for the present analyses were extracted from a larger study on sleep disturbance, physical activity, and PPD. Using online data capture from a community sample of women (n = 108; 6 weeks to 6 months postpartum), demographic information (SES and financial status, age, race), insomnia severity (insomnia severity index; ISI), and time since delivery (less than or greater than 12 weeks postpartum) were examined in association with PPD (Edinburgh Postnatal Depression Scale).

Results: 19% of PPW had moderate to severe insomnia; 35% had subthreshold insomnia. Insomnia severity was higher in early PPW (M = 9.9, SD = 5.6) compared to later PPW (M = 7.7, SD = 5.3), p = 0.04. Racial differences emerged with ISI scores higher among Asian and/or Indians compared to Caucasians (M = 10.7, SD = 5.2 vs. M = 7.6, SD = 5.5). While age and SES were not associated with insomnia severity, endorsement of financial difficulties was associated with insomnia severity. ISI scores accounted for PPD, even when controlling for demographics and time since delivery, r2 change = 0.33, p < 0.001, β = 0.61.

Conclusion: Our findings are consistent with other studies that show an association between sleep disturbance and PPD, and further qualify that insomnia symptoms, in specific, warrant attention during this transition, particularly among early PPW. While the cross-sectional data preclude causal interpretation, prospective data that carefully assess insomnia throughout the postpartum in relation to depression are needed.

0618
PSYCHOMETRIC EVALUATION OF THE FORD INSOMNIA RESPONSE TO STRESS TEST (FIRST) IN EARLY PREGNANCY
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Introduction: The Ford Insomnia Response to Stress Test (FIRST) questionnaire is a widely used instrument that assesses an individual’s vulnerability to experience situational insomnia under stressful condition. The present study aimed to evaluate the construct validity and factor structure of the Spanish language version of FIRST questionnaire (FIRST-S) in early pregnancy.

Methods: A cohort of 647 women were interviewed at ≤16 weeks of gestation. The factorial structure of the FIRST-S was tested through exploratory and confirmatory factor analyses (EFA and CFA). Internal consistency and construct validity were also assessed by evaluating the association between the FIRST-S with symptoms of depression, anxiety and sleep quality (using the Pittsburgh Sleep Quality Index). To complement classical test theory (CTT) approaches item response theory (IRT) analyses were conducted.

Results: The mean score of the FIRST-S was 13.8 (range: 9–33). The results of the EFA showed that the FIRST-S contained a one factor solution which accounted for 69.8% of the variance. The FIRST-S items showed good internal consistency (Cronbach’s α = 0.81). The CFA results corroborated the EFA with good comparative fit index (0.902) and acceptable root mean square error value (0.057), indicators of goodness of fit and reasonable error of approximation. Sleep disturbance after getting bad news during the day (r = 0.62) and after an argument (r = 0.62) were the two items with the largest item-total correlation while the smallest component-total correlation were noted for sleep disturbance after watching a frightening movie or TV show (r = 0.33) and before having to speak in public (r = 0.35). The FIRST-S had good construct validity as demonstrated by its statistically significant associations with sleep quality, antepartum depression and anxiety symptoms. Finally the IRT methods suggested excellent item infit and outfit measures.

Conclusion: The FIRST-S was found to have good construct validity and internal consistency for assessing vulnerability to insomnia during pregnancy

Support (If Any): National Institutes of Health (R01-HD-059835)

0619
DEMOGRAPHIC DIFFERENCES IN INSOMNIA IMPACT SEVERITY ACROSS DOMAINS OF DAYTIME FUNCTIONING
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Introduction: The Insomnia Impact Scale (IIS) is a self-report questionnaire assessing the impact of poor sleep on several discrete domains of daytime functioning. Little research is available on whether demographic factors are differentially relevant to specific types of daytime impairment elicited by insomnia. The present study seeks to determine whether the association of gender, age, and race to insomnia impact severity varies across physical, cognitive, occupational, social, emotional, and general functioning.

Methods: In a randomized survey, 772 individuals completed the IIS and a demographic questionnaire on which they specified their gender, age, and race. Final analysis included 762 individuals (390 females; M age = 53.98, SD age = 19.78), who self-identified as either White or African American (223 African Americans). Six multiple regression models, each comprising the three demographic variables, predicted daytime insomnia impairment severity across six domains of functioning.

Results: Female gender and younger age were associated with greater physical (β = 0.13, p < 0.001; β = −0.21, p < 0.001) and cognitive (β = 0.17, p < 0.001; β = −0.15, p < 0.001) insomnia impairment. Younger age (β = −0.10, p < 0.01) and African American race (β = −0.11, p < 0.01) were associated with greater social impairment. Only African American race was associated with greater occupational (β = −0.12, p < 0.01) and emotional (β = −0.17, p < 0.001) impairment. Finally, female gender (β = 0.13, p < 0.001), younger age (β = −0.12, p < 0.01) and African American race (β = −0.09, p < 0.05) were all associated with general daytime impairments not otherwise specified.

Conclusion: Women, younger adults, and African Americans exhibit increased vulnerability to specific domains of daytime impairment from insomnia. Demographic differences may also influence whether individuals attribute impaired functioning to sleep difficulties or other factors.

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0620
REGISTERED NURSES WORKING 12 HOURS SHIFTS: STUDY OF SLEEP, MOOD AND PHYSICAL STATUS
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Introduction: Purpose of the Study: The purpose of the study is to increase understanding of the impact of 12 hour work shifts of registered nurses on objective and subjective sleep, physical and psychological patterns. Disturbances in sleep are derived from multi-dimensional bio-behavioral processes. Sleep is affected by circadian rhythms, hours awake, and ability to control the desire to sleep or change our day and night patterns.

Methods: We are using a descriptive study design. Registered nurses wore wrist-like instrument (Actiwatch, Respironics, Inc) and com-
completed sleep diaries for seven days and nights to record sleep patterns and complete Pittsburgh Sleep Quality Index, Insomnia Severity Index, Epworth Sleepiness Scale, Multidimensional Assessment of Fatigue Scale, Beck Anxiety Inventory, Health and Well Being Scale and a demographic questionnaire. Using flyers, acute care nurses were recruited from medical centers. After obtaining consent, participants received a packet of materials and the watch.

**Results:** In a sample of 42 registered nurses, 39 women and 3 males completed the study; mean age was 41 years with 20 on the day shift and 22 on the night shift. There was a significant difference between work and night off sleep scores. The off night scores for Time in Bed, and Total Time in Bed were all significantly higher than the corresponding work night scores. The Epworth Sleepiness score was a significant predictor of Beck Anxiety Score \( (p = 0.06) \); Insomnia Severity Index score was a significant predictor of the Health and Well Being Scale \( (p = 0.02) \); Insomnia Severity Index score was a significant predictor of CES Depression Score. The Insomnia Severity Index and the Epworth scores were significant predictors of the Multidimensional Assessment of Fatigue Scale.

**Conclusion:** Poor sleep quality was reported in both day and night shift registered nurses with mean scores on Pittsburgh Sleep Quality Index of 14; night shift had higher Insomnia Severity Index scores than the day shift \( (6.7 \text{ versus } 9.45) \); higher Multidimensional Assessment of Fatigue Scale scores \( (42.55 \text{ versus } 55.64) \); Sleep efficiency has similar means for work night and night off \( (84.6\% \text{ versus } 82.4\% \text{ respectively}) \). Total sleep time for the day shift versus the night shift was 6.27 and 7.22, respectively; total sleep time on work nights was 7.57 and 7.33 respectively. Overall the sleep quality of nurses who work both shifts have poorer quality sleep and it was associated with depressed mood and fatigue.

**0621 USING ACTIGRAPHY TO DIFFERENTIATE PATIENTS WITH INSOMNIA FROM GOOD SLEEPER CONTROLS: CAN MACHINE LEARNING TOOLS HELP?**

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**Introduction:** Although actigraphy holds potential as an objective tool for the diagnosis and clinical management of insomnia, evidence for its clinical utility remains lacking. Existing studies have focused on a limited selection of static, whole-night summary measures, none of which take into account the dynamic and multidimensional nature of sleep and insomnia. The present study capitalized on powerful discovery-based computational tools to identify features of the actigraphy time series that differentiate patients from controls.

**Methods:** Participants were from two studies of older adults, both of which included patients with insomnia \( (n = 165, 69.7 \pm 7.2 \text{ y}, 70\% \text{ F}) \) and age-matched good sleeper controls \( (n = 93, 69.5 \pm 6.6 \text{ y}, 59\% \text{ F}) \). Actigraphy was assessed for 14 days in Study 1 (S1) and 7 days in Study 2 (S2). Each night was split into four segments to account for possible differences across the night and during the hour before sleep onset. For each segment, raw actigraphy counts were used to calculate variables that we anticipated might differentiate insomnia patients from controls (e.g., segment lengths, counts and percentages of activity counts below pre-specified thresholds, counts and lengths of consecutive epochs below pre-specified threshold, percentages of activity counts across ranges, etc.). Per subject means and standard deviations of the variables were computed across all nights. After standardization, we applied random forest, J48 tree, support vector machine, naïve Bayes, and other machine learning algorithms to these attributes along with age and sex. Classifiers were tested with 10-fold cross-validation.

**Results:** Random forest with adaptive boosting best differentiated patients from controls in the S1 sample \( (\text{ROC area} = 0.749) \), with more modest results for S2 \( (\text{ROC area} = 0.669) \). When combining both data sets, the ROC area was 0.631. When using only the first 7 nights of data in S1, the ROC area dropped from 0.749 to 0.602. Among the 9 most informative variables, 7 were within-subject night-to-night standard deviations, and 2 were within-subject means.

**Conclusion:** Preliminary data suggest machine learning approaches may be used to discover novel features of the actigraphy time series that differentiate patients with insomnia from controls. These data also suggest that night-to-night variability is critical for differentiating patients from controls and that accuracy is improved with more nights of data.

**Support (If Any):** This work was supported by grants from the American Sleep Medicine Foundation #101-SR-13 (PI: Hall) and the National Institutes of Health R01 GM13243 (PI: Krafty).

**0622 INSOMNIA IS ASSOCIATED WITH INCREASED HIGH-FREQUENCY EEG DYNAMICS AS EARLY AS ADOLESCENCE**

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**Introduction:** In adults, insomnia has been associated with cortical hyperarousal as measured by spectral EEG dynamics in the high-frequency range during sleep onset and NREM sleep. Despite the association of insomnia with behavioral and neurocognitive functioning in adolescents, little is known about its pathophysiology. This is the first study to examine the association of insomnia with spectral EEG high-frequency dynamics in an adolescent sample from the general population.

**Methods:** We studied a case-control subsample of adolescents who participated in the Penn State Child Cohort, a population-based random sample of 421 adolescents \( (17.0 \pm 2.3 \text{ y}) \). All subjects underwent a 9-h polysomnography (PSG), clinical history and physical examination. We defined high-frequency bands at C3 and C4 during sleep onset latency \( (\text{SOL}) \) and NREM sleep as low-beta \( (15–25 \text{ Hz}) \) and high-beta \( (25–35 \text{ Hz}) \). Insomnia was defined as a self-report of difficulty falling (DFA) and/or staying (DSA) asleep. Insomniacs \( (n = 23) \) and controls \( (n = 21) \) were absent of sleep disordered breathing or overweight and were matched in terms of sex, race, age, Tanner stage, and evenness.

**Results:** Insomniacs reported longer SOL and showed longer PSG SOL and wake after sleep onset, shorter sleep time, and lower sleep efficiency as compared to controls, while no differences in sleep architecture were found. Insomniacs showed significantly greater relative power in high-beta during SOL \( (C4 \text{ p} = 0.047; \text{C3 p} = 0.071; \text{C3-C4 p} = 0.027) \) and NREM sleep \( (C4 \text{ p} = 0.055) \) as compared to controls. Marginally significant differences were found in low-beta during NREM sleep \( (C3 = 0.091; C4 = 0.084) \) between insomniacs and controls.

**Conclusion:** Insomnia in adolescence is associated with increased beta power when attempting to fall asleep and during NREM sleep. These data suggest that cortical hyperarousal is present in insomnia patients as early as adolescence.

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0623

DSM-IV VERSUS DSM-5: ARE WE GOING IN THE RIGHT DIRECTION WITH OUR INSOMNIA CLASSIFICATION EFFORTS?

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Introduction: DSM-5 includes an insomnia nosology designed to improve upon short-comings noted in DSM-IV. Specifically DSM-5: (1) replaces “primary” and “secondary” insomnia diagnoses with one insomnia disorder diagnosis; (2) combines alcohol and other substance-related insomnias into one category; and (3) adds a restless legs syndrome (RLS) diagnosis. This study used a novel analytic approach to compare the reliabilities of the DSM-IV and DSM-5 insomnia nosologies.

Methods: Data were obtained from a dual-site study testing the DSM-IV and ICSD-2 insomnia nosologies. The sample comprised 292 adults (69.2% women; M_age = 45.6 ± 13.7 yrs.) who met insomnia RDC. At each site, six clinicians interviewed each patient with 2 clinicians using a structured sleep interview, another 2 using a standard clinical interview (CI) and review of patients’ sleep history questionnaires (SHQ) and sleep diaries (SD) and the third pair relying on CI, SHQ, SD and polysomnographic data. All then rated how well (0 = “not at all”; 100 = “extremely well”) each DSM-IV and ICSD-2 insomnia diagnoses “fit” the patient. Using the 9 most commonly rated DSM-IV diagnoses, we constructed a diagnostic profile conveying the composite judgment of each diagnostician for each patient. A simulated DSM-5 profile also was constructed for each diagnostician for each patient by: (1) using the highest rating for the primary and secondary insomnias to form one insomnia disorder category; (2) similarly forming a combined substance-induced insomnia category (alcohol+other substance induced); and (3) forming a separate RLS category (from ICSD-2 ratings). We then conducted a multivariate profile analysis allowing us to compute a composite reliability coefficient for each DSM-IV and DSM-5 set of diagnoses simultaneously, thus providing a test of the diagnostic dependability for each system as a whole rather than for separate diagnoses.

Results: The system reliability index for the simulated DSM-5 system using one assessment method and one rater was 0.68; the comparable index for DSM-IV was 0.53. Using generalizability theory, we estimate that the average ratings of 3 raters would be required to obtain a profile reliability of 0.80 using the DSM-5 system while the average ratings of 9 raters would be required for the DSM-IV system to achieve 0.80 reliability.

Conclusion: DSM-5 provides a more dependable insomnia classification scheme than does DSM-IV. Yet, both systems require multiple diagnosticians to obtain optimal diagnostic dependability.

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0624

ITALIAN VALIDATION OF THE SLEEP CONDITION INDICATOR A CLINICAL SCREENING TOOL TO EVALUATE INSOMNIA DISORDER ACCORDING TO DSM-5 CRITERIA

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Introduction: Sleep Condition Indicator (SCI) is a eight-item questionnaire validated as a clinical tool for appraising insomnia according to DSM-5 criteria. The aim was to evaluate the validity and reliability of the Italian version in subjects with insomnia and healthy controls.

Methods: Outpatients attending the Sleep Center, University of Pisa, Italy, and the Sleep Medicine Unit, Pavia, Italy, who met diagnostic criteria for Insomnia Disorder (ID) according to DSM-5 and a healthy controls (H) were recruited. At the first evaluation (T0), SCI and Insomnia Severity Index (ISI) were administered. ID subjects completed the SCI a second time two months later (Time Retest: TR). The SCI was translated with the forward-backward procedure in collaboration with the authors. Statistical analyzes included descriptive statistics, differences in means between ID and H groups using t-test or Mann-Whitney U/Wilcoxon. Internal consistency was studied calculating Cronbach’s alpha co-efficient, and stability (test/retest) using the Spearman’s correlation. Pearson correlation was performed to study convergent validity with ISI.

Results: Eighty-eight-ID (37 M, mean age 50.1 ± 15.8) and 35 H (17 M, mean age 50 ± 2) were recruited at T0. SCI and ISI mean scores were significantly higher in ID vs H (respectively 11.2 ± 5.7 vs 30 ± 3.1 p < 0.001; 10.92 ± 6.1 vs 2.3 ± 1.5 p < 0.001). Sixty-five-ID completed the re-test part (26 male, mean age 49.6 ± 16.8, SCI: 10.92 ± 6.1). Cronbach’s alpha-co-efficient was 0.718 at T0 and 0.785 at TR (excellent internal consistency). Each SCI item resulted significantly related at T0 vs TR (significance for each SCI item p < 0.001). No significantly differences were found among SCI items at T0 vs TR (significance for each SCI item p = ns) confirming the SCI stability. At T0 Pearson correlation analysis showed a convergent negative correlation with ISI score (r_s = -0.6808 p < 0.01) confirming current validity of SCI.

Conclusion: The Italian version of the Sleep Condition Indicator show good internal consistency, stability, current and discriminant validity.

0625

ADDED VALUE OF ACTIGRAPHY FOR PEDIATRIC INSOMNIA EVALUATIONS IN CLINICAL PRACTICE

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Introduction: Actigraphy is used for research in pediatric insomnia; however, its value in clinical practice has not been established. We hypothesized that actigraphy would improve diagnostic accuracy and objectively better inform treatment decisions compared to parent report of sleep/wake patterns.

Methods: From our sleep center database, we retrospectively identified all children, ages 5 to 18 yrs, who had 2 weeks of actigraphy as part of their evaluation for chronic insomnia over the past year. Insufficient
**III. Insomnia**

T32 HL082610, T32 MH019986, AG020677, -

**0626**

POLYSOMNOGRAPHIC FEATURES IN INSOMNIACS WITH SNORING OR UPPER AIRWAY RESISTANCE SYNDROME


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**Introduction:** Insomnia is a prevalent condition worldwide. In recent years, clinicians and researchers have become increasingly aware of the frequent comorbidity of insomnia disorder and sleep-related breathing disorder but polysomnography (PSG) features still remain unclear.

**Methods:** The study included 100 insomniacs. Subjects underwent a PSG study night. Our objective was to explore different sleep parameters in insomniac patients with snoring (IS) or insomniacs with upper airway resistance syndrome (I-UARS). Patients didn’t have sleep apnea.

**Results:** TST h: IS (6.3 ±0.05) vs. I-UARS (6.3 ±0.04). SEI%: IS (78.4 ±0.65) vs. I-UARS (79.8 ±0.72). SOL min*: IS (16.2 ±1.1) vs. I-UARS (29.4 ±1.7); SOREM min*: IS (118.5 ±3.2) vs. I-UARS (102.8 ±3.1). WASO%*: IS (21.7 ±0.6) vs. I-UARS (19.7 ±0.6). S1%: IS (13.81 ±0.5) vs. I-UARS (13.4 ±0.3). S2%*: IS (60.9 ±0.83) vs. I-UARS (57.1 ±0.4). S3%*: IS (4.8 ±0.3) vs. I-UARS (6.9 ±0.2). S4%*: IS (2.9 ±0.3) and I-UARS n (6.2 ±0.2). REM%*: IS (17 ±0.4) vs. I-UARS (16 ±0.4). Arousal n*: IS (61.8 ±2.9) vs. I-UARS (47.4 ±2.3). Awakenings n*: I-S (297.1 ±3) vs. I-UARS (14.7 ±0.8). *p < 0.05

**Conclusion:** Our data indicate that there are several significant changes in PSG parameters in insomniac patients with snoring or upper airway resistance syndrome.

**0627**

IS CHRONIC INSOMNIA ASSOCIATED WITH REDUCED EEG DELTA POWER?

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**Introduction:** Patients with primary insomnia (PI) may have compromised sleep homeostatic systems, but evidence regarding sleep drive has been mixed. Homeostatic sleep drive is reflected in the rate of decline of delta power across NREM intervals. The purpose of this study was to determine whether delta power is reduced in PI compared to good sleepers (GS), and whether delta power changes with behavioral treatment. Additionally, we examined whether homeostatic sleep drive was associated with clinical characteristics. We hypothesized that the decline in delta power across NREM intervals would be diminished in Ps compared with GS, and that this effect would be greatest in individuals with greater insomnia symptoms.

**Methods:** Participants included 160 Ps (mean age 45, 60%F) and 113 GS (mean age 45, 45%F). 74 Ps were assessed before and after Cognitive Behavioral Treatment for Insomnia. Average delta power for each NREM period was measured using power spectral analysis from the C4-A1/A2 derivation. Mixed model analysis was used to test for group differences and pre-post treatment differences in delta power, using NREM interval as a fixed factor.

**Results:** Delta power during NREM sleep showed a main effect of NREM interval across participants. However, there was no main effect of group (PI vs. GS) (p = 0.68) and no interaction between group and NREM interval (p = 0.87), suggesting a similar delta power time course between groups. Time course of delta power across NREM intervals did not significantly correlate with clinical symptom ratings. There was no main effect of treatment on delta power and no interaction with NREM interval, again suggesting no difference in time course.

**Conclusion:** Homeostatic sleep drive may not be impaired in patients with insomnia. Interventions such as CBTI may engage intact homeostatic sleep mechanisms, rather than correct deficient sleep drive. Other factors, such as hyperarousal, may be important treatment targets.

**Support (If Any):** T32 HL082610, T32 MH019986, AG020677, MH124652
III. Insomnia

75.3 ± 29 vs 5.3 ± 2.3 p < 0.01; FIRS 24.5 ± 5.2 vs 9.1 ± 2.3 p < 0.01; APS 40.9 ± 8 vs 18 ± 4 p < 0.01. In ID, elevated DISRS scores were correlated with ISI (r = 0.487, p < 0.05), PSQI (r = 0.345, p < 0.05), DBAS (r = 0.473, p < 0.01), and APS (r = 0.373, p < 0.05). Multiple linear regression demonstrated DISRSs, to be best predicted by Dysfunctional Beliefs about Sleep score (DBAS B = 0.266, p < 0.05).

Conclusion: Findings suggest potential implications: insomnia-specific ruminations may be a construct more related to dysfunctional beliefs about sleep than to other factors such as sleep reactivity or arousability.

0629

PHENOTYPES OF RESTING-STATE COGNITION IN INSOMNIA DISORDERS: MIND WANDERING ACTIVITY MAY BE RELATED TO INSOMNIA SEVERITY. A PILOT STUDY

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Introduction: The state of wakeful rest—or “resting state”—from a cognitive point of view serves as a special model to study stimulus independent thought, linked to the default mode network. Investigating the mind-wandering experiences in insomnia may be particularly useful. Previous research showed cognitive processes such as a tendency toward rumination, dysfunctional beliefs about sleep, and a selective attention to sleep to play an important role in perpetuating insomnia. The aim was to explore mind wandering in insomnia using the Amsterdam Resting-State Questionnaire (ARSQ), a validated tool to quantify thoughts and feelings during rest.

Methods: The study consisted of 35 subjects who met diagnostic criteria for Insomnia disorder (ID) according to the DSM-5 and 33 healthy controls (H). In addition to the ARSQ, Insomnia Severity Index (ISI), Pittsburgh Sleep Quality Index (PSQI), and Dysfunctional Beliefs about Sleep scale (DBAS) were administered. Differences in means between ID and H groups were assessed using t-test or Mann-Whitney U/Wilcoxon test. Pearson or Spearman Correlation Coefficients to examine association between variables and ARSQ phenotypes were then performed.

Results: Subjects with ID (F 20, mean age 47 ± 1.6) presented higher ISI, PSQI, and DBAS scores than H subjects (F 18, mean age 48 ± 1) (respectively ISI: 16.3 ± 5 vs 3.5 ± 1 p < 0.01; PSQI: 14.5 ± 2.1 vs 3.5 ± 0.5 p < 0.01; DBAS 75.3 ± 29.5 vs 5.3 ± 2.3 p < 0.05). They also show higher scores in ARSQ phenotypes: Discontinuity of Mind (DoM 6.5 ± 2.1 vs 1.8 ± 0.8, p < 0.05), Health Concern (HC: 3.1 ± 0.3 vs 2.5 ± 0.5, p < 0.05) and Self (S: 8.8 ± 3.2 vs 2.5 ± 0.5, p < 0.05). DoM was correlated with ISI (r = 0.258 p < 0.001) and DBAS scores (r = 0.147 p < 0.001), S with ISI (r = 0.374 p < 0.05) and PSQI (r = 0.456 p < 0.001) scores, HC with ISI (r = 0.140 p < 0.001).

Conclusions: Mind-wandering activity in insomnia resulted to be focused on thoughts and feelings about self, or worries about their own thoughts, feelings and health. These kind of experiences resulted to be related especially to insomnia severity and dysfunctional beliefs about sleep. The studying of thoughts and feelings during resting state may provides additional informations on both cognitive and emotional processing related to sleep onset in insomnia disorder.

0630

DOES OBJECTIVE SHORT SLEEP DURATION PREDICT A POOR RESPONSE TO COGNITIVE-BEHAVIORAL INSOMNIA THERAPY?

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Introduction: Insomnia sufferers with objective short sleep duration < 6 hours per night seemingly represent a severe insomnia phenotype with increased risk for cardio-metabolic morbidity. It has been speculated that these patients may respond relatively poorly to cognitive-behavioral insomnia therapy (CBT). This study was conducted to test this assumption.

Methods: Data were obtained from a prior study that examined dose-response effects of CBT. The sample comprised 60 (53% female; MAGE = 56.1 ± 10.0 yrs.) patients who completed 1 to 8 therapist-guided, individual CBT sessions and nightly actigraphic and sleep diary monitoring before, during and 6 months after treatment. The average sleep time during the pre-treatment actigraphic monitoring was used to divide the sample into groups with average sleep durations of < 6 hours (n = 35) and ≥ 6 hours (n = 25) per night. After pre-treatment assessments, participants were randomized (without regard to their average sleep durations) to 1, 2, 4, or 8 CBT sessions delivered over an 8-week period. Analyses of variance controlling for treatment dose were used to compare the short (SSD) and normal (NSD) duration groups’ responses to CBT intervention as reflected by diary and actigraphic sleep measures. In addition, logistic regression analyses were used to ascertain the groups’ relative odds of meeting study criteria for clinically significant improvement.

Results: The SSD and NSD groups differed significantly (p = 0.0001) in their pre-therapy, actigraphic average sleep times (317.7 ± 29.9 min. vs. 409.4 ± 79.3 min.) but not in their mean ages or gender compositions. The SSD group had significantly (p’s all < 0.0006) lower actigraphic sleep times and sleep efficiencies (SEs) and greater amounts of total wake time (TWT) at all pre and post intervention assessments than did the NSD group. Significant group x time interactions showed that the NSD group achieved significantly greater pre-to-post therapy decreases in diary TWT (p = 0.0005) and increases in diary SE (p = 0.0005) than did the SSD group. NSD participants also were significantly more likely to meet clinical improvement criteria including a post-treatment actigraphy SE of > 85% (OR = 7.165, 95% CI = 1.279–40.135; p = 0.0251) and a ≥ 50% reduction in diary TWT (OR = 6.017, 95% CI = 1.680–21.556; p = 0.0058) than were the SSD patients.

Conclusion: SSD insomnia patients have a more blunted response to CBT than do those with NSD. Studies to determine how to optimize the treatment response of SSD insomnia sufferers are warranted.

Support (If Any): National Institute of Mental Health, Grant # RO1 MH48187

0631

APPLICATION OF A LOCATION-SCALE MIXED MODEL TO EXAMINE THE STABILITY OF SLEEP DURING TREATMENT FOR CHRONIC INSOMNIA

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Introduction: Insomnia treatments improve mean values of sleep but the impact of treatment on the stability of sleep remains unclear. A novel statistical approach known as a location-scale mixed model (LSMM) has been developed to examine within-subject and between-subject variances. We conducted secondary analyses using LSMM
to examine the stability of sleep in a randomized controlled trial for chronic insomnia.

**Methods:** Fifty-four adults (74% female, mean age = 43 years) with chronic insomnia were randomized to 1 of 3 arms: 1) 8-week Mindfulness-Based Stress Reduction (MBSR; n = 19), 2) 8-week Mindfulness-Based Therapy for Insomnia (MBTI; n = 19), or 3) 8-weeks of self-monitoring without treatment (SM; n = 16). Participants completed daily sleep diaries at baseline (7 days), during treatment/monitoring (63 days), and at post-week (7 days). The LSMM was conducted on sleep efficiency derived from sleep diaries with three time (within-subject) variables compared to baseline: early treatment (days 1 to 14), late treatment (days 15–63), and post-week. The two treatment arms (MBSR, MBTI) were compared to SM as between-subject variables.

**Results:** The LSMM revealed that after adjusting for mean levels, patients receiving MBSR had significantly less variance (i.e., more stability) in sleep efficiency compared to SM during early treatment (SD ratio = 0.70, p < 0.01) and late treatment (SD ratio = 0.70, p < 0.01), but not at post-week (SD ratio = 0.83, p = 0.20). MBTI was not significantly different from SM at early treatment (SD ratio = 0.96, p = 0.72), approached significance at late treatment (SD ratio = 0.81, p = 0.067), and was not significant at post-week (SD ratio = 0.84, p = 0.23).

**Conclusion:** LSMM appears to be a viable statistical model for examining within-subject and between-subject variance of sleep parameters in randomized controlled trials. These findings indicate that insomnia patients report more stable sleep efficiency during MBSR treatment compared to SM without treatment.

**Support (If Any):** National Institutes of Health, Grant number: K23AT003678

### 0632 EXPLORING OUTCOMES OF A SINGLE SESSION GROUP COGNITIVE BEHAVIORAL THERAPY FOR INSOMNIA INTERVENTION LED BY REGISTERED NURSES IN AN ACCREDITED SLEEP CENTER

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**Introduction:** This study explores the impact of a single session, group-based CBT-I program provided by registered nurses in an accredited tertiary sleep center.

**Methods:** Prospective study of patients with insomnia (N = 60, 29 returned follow up measures). Sleep diaries, Pittsburg Insomnia Rating Scale (PIRS), and Dysfunctional Beliefs about Sleep (DBAS) questionnaires were completed at baseline and 2 months after group CBT-I participation. Surveys reflecting patient satisfaction and self-efficacy outcomes were obtained. Pre and post program outcome scores were compared. Associations of intervention use (≥ 3 vs < 3 times/week) with outcome differences (pre vs post) were assessed.

**Results:** Statistically significant (p ≤ 0.05) improvements in outcomes were: wake after sleep onset (median decrease 0.6 hours/day); sleep efficiency (median increase 6.5%); total sleep time (median increase 0.4 hours); PIRS (median decrease 8); DBAS (median decrease 0.9); and subjective responses to questions regarding quality of sleep. Neither sleep latency nor total time in bed changed significantly. The significant associations (p ≤ 0.05) of intervention use (≥ 3 vs < 3 times/week) with outcome differences (pre vs post) were: restoration/refreshment by sleep with relaxation technique use (median decrease 0 vs 0.4); total sleep time with worry time use (median increase 0.9 hours vs median decrease 0.6 hours); subjective sleep quality with self-talk use (median decrease 0.1 vs median increase 0.4); sleep latency (median decrease 10.7 minutes vs median increase 11.8 minutes); time in bed (median decrease 0.3 hours vs median increase 1.2 hours), and DBAS scores (median decrease 1.3 vs median decrease 0.7), with stimulus control use. 90% felt satisfied or very satisfied with the program. 67–73% indicated the program at least moderately impacted attitude, behavior, and ability to manage insomnia.

**Conclusion:** Participants reported improvements in sleep and high satisfaction with the program, noting positive impact on self-management of insomnia.

**Support (If Any):** Division of Pulmonary/Critical Care, Mayo Clinic

### 0633 PHARMACOKINETICS OF THE DUAL OREXIN RECEPTOR ANTAGONIST E2006: RELATIONSHIP TO EFFICACY AND SAFETY

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**Introduction:** E2006 is a novel dual orexin receptor antagonist under development for the treatment of insomnia disorder. This report presents results from an analysis assessing the impact of the PK profile on measures of efficacy and safety.

**Methods:** Two Phase 1 randomized, double-blind, placebo-controlled studies determined the PK, PD and safety profile of E2006. E2006-A001-001 evaluated a single oral dose (1–200 mg) in healthy adult subjects (am dosing) and at 2.5, 10, and 25 mg in otherwise healthy subjects with primary insomnia (pm dosing). Multiple dose study E2006-A001-002 included healthy adult and elderly subjects (2.5–75 mg). E2006-G000-201 was a US-based Phase 2, randomized, Bayesian adaptive, double-blind, placebo-controlled, parallel group study of E2006 efficacy and safety in subjects with insomnia disorder (1–25 mg). A population PK/PD model was constructed pooling data from these studies. Study 201 included objective and self-report measures of morning residual sleepiness.

**Results:** E2006 exhibited linear PK following single dose administration. Plasma concentrations were measurable 15 min after dosing, peaked by 2 h and decreased to <13% of Cmax by 9 h postdose at ≤ 10 mg. The terminal t1/2 following multiple dosing was ~50 h, but accumulation was ~2-fold and consistent with a much shorter effective half-life (17–24 h). Efficacy by polysomnography and subjective reports was demonstrated by significant decreases in sleep onset latency and wake after sleep onset, and increases in sleep efficiency. The population exposure-response analysis documented no impact on measures of morning residual sleepiness including the Digit Symbol Substitution Test, Simple or Choice Reaction Time tests. A higher incidence of somnolence and higher positive change on the Karolinska Sleepiness Scale were predicted at C9h > 20 ng/mL, but plasma concentrations in most of the population fell below this level at doses ≤ 10 mg.

**Conclusion:** These results demonstrated that the PK of E2006 is compatible with a drug for insomnia that improves both sleep onset and maintenance without clinically meaningful next-morning residual sleepiness.

**Support (If Any):** These studies and analyses were supported by Eisai Inc.
III. Insomnia

Introduction: Psychologists typically conduct cognitive behavioral therapy for insomnia (CBTI). Few sleep physicians are formally trained and actively practice CBTI. The effectiveness and merits of CBTI as administered by a sleep physician in a community-based clinic is unknown.

Methods: A retrospective chart review was performed of 110 patients presenting with chronic insomnia from October 2013 to October 2014 who enrolled in CBTI with a formally trained sleep physician at a community-based clinic. The modified program consisted of 4 to 6 sessions lasting 30 to 60 minutes and emphasized sleep education, sleep consolidation, and relaxation training. Subjects were excluded if they did not attend at least 4 sessions, inadequately completed sleep logs, or if untreated sleep apnea interfered with compliance. The outcomes assessed included changes in sleep-onset latency, wakefulness after sleep onset, total sleep time, and sleep efficiency from baseline to conclusion of the program.

Results: Of the 110 subjects enrolled, 21 subjects were excluded (13 didn’t attend at least 4 sessions, 4 inadequately completed sleep logs, and 4 had untreated known sleep apnea reducing compliance). The remaining 89 subjects were 65% women and 35% men. The average age was 60.69 years (ranging from 12 to 90 years). Sleeping pills were used at baseline in 74.2% (66 subjects) and obstructive sleep apnea (AHI > 5 on testing) was identified in 65.2% (58 subjects). Improvements were seen in all averaged measures from baseline to program conclusion: sleep-onset latency (55.5 to 22.5 minutes), wakefulness after sleep onset (45.17 to 25.21 minutes), total sleep time (6.22 to 6.25 hours), and sleep efficiency (74.0% to 85.5%).

Conclusion: CBTI is highly effective when administered by a trained sleep physician and can be successfully integrated into standard clinical practice. Physicians may be better equipped to taper sleeping pills and to identify and treat comorbid sleep conditions.

B. Clinical Sleep Science

0634
TRAINED SLEEP PHYSICIANS CAN EFFECTIVELY ADMINISTER COGNITIVE BEHAVIORAL THERAPY FOR INSOMNIA (CBTI) IN THE CLINICAL SETTING

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Introduction: While insomnia is at least twice more prevalent in PLWHA than in the general population, we demonstrated that it can be effectively treated with a non-pharmacological therapy (CBTI), moreover when administered by allied-health personnel and over 4 weekly sessions.

Support (If Any): The Duke University Center for AIDS Research (CFAR), an NIH funded program (5P30AI064518)

0635
INSOMNIA IN PEOPLE LIVING WITH HIV/AIDS SUCCESSFULLY TREATED BY COGNITIVE BEHAVIORAL TREATMENT

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Introduction: The triad insomnia-fatigue-depression affects 50 to 100% of people living with HIV/AIDS (PLWHA), with 1.2 million in the US. This study intends to establish the feasibility of allied-health personnel administered cognitive behavioral therapy for insomnia (CBTI) in PLWHA.

Methods: 27 HIV-seropositive subjects, 11.2% Caucasians and 85.2% African-Americans, including 8 females (29.6%), aged 43–59 years, with insomnia for at least 3 months and all currently taking HAART were enrolled. Screening process included the Duke Structured Interview for Sleep Disorders, to ascertain sleep disorder diagnoses. Last observation carried forward (LOCF) and T-test were utilized.

Results: There was no statistical difference between the treatment group (n = 15) and the placebo group (n = 12) for age, height, weight, gender and race/ethnicity distribution, therapist allocation. There was no statistically significant difference across both groups for sleep-diary derived sleep efficiency—SE (CBTI: 68.5% ± 12.0; Placebo: 62.7% ± 14.8; p = 0.29), and for the insomnia severity index—IIS (CBTI: 16.9 ± 4.6; Placebo: 16.3 ± 7.1; p = 0.8). Blinding was effective as perceived treatment by subjects was similar regardless of actual treatment allocation (Chi-squared = 0.675 with 1 df, two-tailed p = 0.41). Treatment was effective with a final SE of 85.0% ± 11.2 for the CBTI versus 71.8% ± 15.0 for the placebo group (p = 0.02) yielding a number needed to treat (NNT) of 8 and a Cohen’s d effect size of 0.91; as well as a final IIS of 11.3 ± 6.9 for the CBTI versus 16.6 ± 5.6 for the placebo group (p = 0.036) yielding a NNT of 19 and an effect size of 0.78.

Conclusion: Few sleep physicians are formally trained to administer CBTI to PLWHA. The triad insomnia-fatigue-depression affects 50 to 80% of people living with HIV/AIDS (PLWHA). CBTI is highly effective when administered by a trained sleep physician in a community-based clinic. Physicians may be better equipped to taper sleeping pills and to identify and treat comorbid sleep conditions. Increasing attention has been paid to dual orexin receptor antagonists (DORA) to treat insomnia. This report presents Phase 2 sleep diary results with E2006, a novel DORA.

Methods: The study was a multicenter (US), randomized, double-blind, placebo-controlled, parallel group design, enrolling subjects with insomnia disorder per DSM-5. A Bayesian adaptive design tested 6 strengths of E2006 (1, 2.5, 5, 10, 15, 25 mg) or placebo administered for 15 nights (30 m before bedtime). Diaries were completed each morning. Safety was monitored via treatment-emergent adverse events (TEAEs), ECGs, vital signs, chemistries and morning assessments of residual sleepiness (in-clinic only). Sleep efficiency (SE), subjective Sleep Onset Latency (sSOL) and subjective Wake After Sleep Onset (sWASO) from sleep diaries were averaged for Baseline (BL) and during treatment (Days 1–7, 8–15).

Results: 616 screened, with 291 randomized (63.5% F, mean age 48 y). Mean (SD) BL Insomnia Severity Index was 20 ± 3 (moderate-severe). Demographics were similar between treatment groups. Overall mean (SD) BL values were: SE: 65 ± 11%; sSOL: 59 ± 33 min; sWASO: 110 ± 48 min. 94.5% of E2006 and 91.1% of placebo subjects completed. During Days 1–7, the LS mean difference (E2006 vs placebo) for change from BL in SE was statistically significant for 5–25 mg, increasing 6–9.4% with overlapping confidence intervals. Except with 1 mg, sSOL decreased significantly, with median change from BL from −23 min (2.5 mg) to −26 min (25 mg); placebo −10 min. sWASO decreased in all treatment groups (significantly for 10 mg: LS mean difference: −29 min). Benefits seen for Days 1–7 were maintained for Days 8–15. TEAEs were more common with E2006. Somnolence was dose-related. There were 2 SAEs (one placebo; one 25 mg [discontinued study]). All TEAEs except the SAE at 25 mg were mild or moderate.

Conclusion: These data highlight the potential of E2006 to treat insomnia disorder. E2006 was well-tolerated in this study, with mild-moderate adverse events. Subject-reported efficacy was demonstrated for both sleep onset and sleep maintenance.
Support (If Any): This study was funded by Eisai Inc.

0637
COMPARING OUTCOME AND ADHERENCE DATA FOR AN INTERNET-DELIVERED CBT FOR INSOMNIA PROGRAM ACROSS 5 DIFFERENT SETTINGS: WHAT IMPLICATIONS ARE THERE FOR DISSEMINATION? Thordike FP1, Morin C2, Lord H2, Gonder-Frederick L3, Ingersoll K3, Quigg MS3, Ritterband LM1
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Introduction: Little is known about how outcome and adherence data from efficacy trials translate into real-world outcomes when technology-delivered interventions are disseminated more broadly. This is also true for self-help interventions that have been developed to increase access to cognitive-behavioral therapy for insomnia (CBT-I).

Methods: To better understand the translation from clinical trials to real-world use, outcome and usage data will be shared from a self-guided (no clinical support) insomnia intervention used in five settings. These settings include two pilot RCTs with a single face-to-face assessment; one national RCT with a single phone assessment; program evaluation conducted by an Employee Assistance Plan; and a commercial entity providing access for a fee. In all cases, the intervention is identical—a 6-week Internet-delivered CBT-I intervention (SHUTi: Sleep Healthy Using the Internet). Although the time periods for measurement are not identical across settings [e.g., RCTs collected Post data 63 days after Pre data collection and non-research settings collected data as it was available from start to end of intervention use (possible to be as few as 35 days), data nonetheless provides useful information about how RCT data compares to real-world use.

Results: Pre-Post effect sizes (ES) on the primary sleep variables of insomnia severity and the diary-derived variables of sleep onset latency (SOL) and wake after sleep onset (WASO) will be compared. For insomnia severity, all ES were large, ranging from d = 1.38 (when intervention was delivered for a fee) to d = 2.34 (when intervention was delivered in pilot RCT). ES in WASO ranged from d = 0.55 to d = 1.13, and ES in SOL ranged from d = 0.47 to d = 0.83. With respect to adherence (defined as completing all assigned intervention Cores), completion rates ranged from 51% to 91%. Usage data will also be compared across the settings.

Conclusion: Findings are considered in the context of the RE-AIM framework, where issues of reach, effectiveness, adoption, implementation, and maintenance guide translation of research into practice.

Support (If Any): NIMH R34MH70805 and R01MH086758

0638
EVALUATING THE EFFICACY OF INTERNET-BASED CBT-I FOR ADULTS WITH INSOMNIA: A RANDOMIZED CONTROLLED TRIAL Hagatun S1, Vedaa Ø2, Nordgreen T3, Havik O4, Bjorvatn B4, Pallesen S5, Thorndike F3, Ritterband L1, Sivertsen B1
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Introduction: Insomnia is a public health problem in Western countries; having negative consequences for the individual, as well as leading to considerable economic costs for the society. CBT-I is an effective treatment for insomnia, but due to high economic costs and expertise being mainly centered to the largest cities, there is a lack of availability. To reduce the gap between high prevalence of insomnia and lack of available treatments, the Internet is suggested as a tool for providing CBT-I. The aim of the current study was to evaluate the efficacy of an Internet-based CBT-I treatment (SHUTi) for adults with insomnia.

Methods: A sample of 203 Norwegian adults with insomnia was randomly assigned into interactive CBT-I treatment (SHUTi) (n = 105) or to passive education/sleep hygiene (n = 98) for a six-week period. Both groups were assessed at baseline and after the intervention (questionnaires and sleep diary). There was also a six-month follow-up of the CBT-I-group.

Results: The Insomnia Severity Index was significantly improved for the CBT-I group, from 17.22 to 8.77. The between group effect size was d = 1.25. There was also a significant between group effect size on Bergen Insomnia Scale (d = 0.87), and Dysfunctional Beliefs and Attitudes about Sleep (d = 1.14). The amount of SHUTi-participants that met the DSM-IV criteria for insomnia was reduced from 94.8% at baseline to 41.0% after treatment. Secondary outcome measures, such as Chalder Fatigue Scale and HADS, had between effect sizes from d = 0.59 to 0.97. (Results from sleep diary data will be presented at the conference).

Conclusion: The results showed that online CBT-I led to significant improvements in people’s sleep and daily functioning; hence, the current study can contribute to make effective treatment for insomnia more widely accessible.

0639
TESTING PARTNER-ASSISTED COGNITIVE BEHAVIORAL THERAPY FOR INSOMNIA Jenkins MM1,2, Nappi CM1,2, Cassidy J1, Khosa V2, Drummond SP4
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Introduction: Insomnia affects 10–15% of adults worldwide. Although Cognitive Behavioral Therapy for Insomnia (CBTI) is an established treatment for insomnia, not all patients respond optimally. CBTI attrition appears higher in clinical effectiveness studies versus RCTs, suggesting greater difficulty for less homogenous patient groups receiving less intensive support to complete CBTI. Also, treatment adherence is important yet often difficult as CBTI strategies require
significant behavioral changes (e.g., sleep restriction). Given inclusion of partners in other behavioral interventions has effectively promoted individual change in patients, we examine adherence and outcomes of a new treatment protocol that includes bed partners (Partner-Assisted CBT-I; PA-CBTI).

**Methods:** Ten participants with a diagnosis of insomnia were enrolled; four have completed treatment to date and six are still in treatment. All participants are Veterans with comorbid psychiatric, medical, and/or sleep apnea (CPAP adherent) diagnoses. Treatment consists of intake and 7 PA-CBTI sessions administered to patients and their bed partners. Analyses examine adherence in PA-CBTI compared to clinical data from traditionally administered CBT-I (n = 18). Analyses also examine pre/post PA-CBTI differences on daily diaries (SE,TST, WASO), self-reported sleep (ISI), and relationship functioning (DAS).

**Results:** Compared to traditional CBT-I, PA-CBTI showed greater adherence and similar efficacy. Using deviations in minutes from the prescribed sleep/wake times per week as a measure of adherence, PA-CBTI (M = 45 ± 51.9) demonstrated higher adherence than traditional CBT-I (M = 190.2 ± 207.6) post-treatment, d = 0.96. Within subjects, PA-CBTI improved SE (Pre:M = 76.7 ± 11.7 vs. Post:M = 88.9 ± 7.6, d = 1.3), SL (Pre:M = 23.9 ± 21.6 vs. Post:M = 16.9 ± 8.1, d = 0.73), WASO (Pre:M = 57.1 ± 48.4 vs. Post:M = 14.3 ± 23.2, d = 1.2), and ISI (Pre:M = 22.3 ± 4.4 vs. Post:M = 10.8 ± 4.9, d = 1.5). Also, PA-CBTI increased relationship functioning (Pre-DAS:M = 104.7 ± 11.4 vs. Post-DAS:M = 112.3 ± 21.5, d = 0.4).

**Conclusion:** Sleep difficulties have largely been studied and treated at the individual level. This is the first pilot test of a new CBTI protocol that includes bed partners. Preliminary findings suggest PA-CBTI results in increased adherence, decreased insomnia, and improved relationship functioning. This study supports continued testing of PA-CBTI.

**Support (If Any):** NIH, grant #: 5T32MH018399-27.

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**0640 RELATIVE EFFECT OF A SEDATIVE ANTI DEPRESSANT AND COGNITIVE BEHAVIORAL THERAPY FOR INSOMNIA ON THE HYPOTHALAMIC-PITUITARY-ADRENAL AXIS: A PILOT STUDY**

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**Introduction:** Insomnia has been associated with hyperactivity of the hypothalamic-pituitary-adrenal (HPA) axis, particularly in the evening. However, no study to date has examined the relative effect of a sedative antidepressant and cognitive-behavioral therapy for insomnia (CBT-I) in down-regulating the HPA axis.

**Methods:** We addressed this question in a sample of 10 middle-aged men and women who received either Trazodone (n = 5) or CBT-I (n = 5). Severity of insomnia complaints was assessed via the Insomnia Severity Index (ISI) both at baseline and after 3 months of treatment. Salivary cortisol levels were measured in the morning (8:00 h) and evening (18:00 h) both at baseline and after 3 months of treatment. Cohen’s d for paired samples assessed the effect size (ES) in change in ISI score and cortisol levels within each treatment group.

**Results:** The ISI score improved largely either with CBT-I (Δ = −3.2 ± 3.4 ng/mL, t = 8.6, ES = 3.8) or with Trazodone (Δ = −12.8 ± 5.0 ng/mL, t = 5.7, ES = 2.6). Both groups moderately improved in morning cortisol levels (Δ = −3.3 ± 6.9 ng/mL, t = 1.1, ES = 0.5 and Δ = −5.4 ± 9.9 ng/mL, t = 1.2, ES = 0.5 for Trazodone and CBT-I, respectively). In contrast, evening cortisol levels improved largely with Trazodone (Δ = −8.2 ± 10.8 ng/mL, t = 1.7, ES = 0.8), while they did not improve or even increase with CBT-I (Δ = 1.7 ± 3.5 ng/mL, t = 1.1, ES = 0.5). An analysis of covariance adjusting for baseline cortisol levels showed a marginally significant effect of Trazodone vs. CBT-I in decreasing evening cortisol levels (−6.1 ± 1.8 ng/mL vs. −0.4 ± 1.8 ng/mL, p = 0.06).

**Conclusion:** These pilot data indicate that Trazodone and CBT-I are efficacious in improving the subjective complaint of insomnia and that Trazodone, but not CBT-I, down-regulates the evening activation of the HPA axis. Future studies should examine this effect in larger samples and whether the effects of medication vs. CBT-I differ in insomnia phenotypes with hypercortisolism.

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**0641 LONG-TERM EFFICACY OF COGNITIVE BEHAVIOR THERAPY, BEHAVIOR THERAPY, AND COGNITIVE THERAPY FOR CHRONIC INSOMNIA**

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**Introduction:** There is strong evidence documenting the efficacy of cognitive behavior therapy (CBT) for insomnia but less information is available about the unique contribution of its therapeutic components, particularly with regard to long-term outcomes. This paper presents the 12-month follow up data from a controlled trial assessing the relative efficacy of behavior therapy (BT) and cognitive therapy (CT), compared to full CBT, on nighttime and daytime insomnia symptoms.

**Methods:** The sample consisted of 186 adults (117 women; M age = 47.4 years) with chronic insomnia (average of 14.5 years duration). They received an 8-week course of BT (n = 63), CT (n = 65), or CBT (n = 60). Main end points were insomnia severity, measured by the Insomnia Severity Index (ISI), and several measures of sleep and daytime symptoms.

**Results:** All three treatments produced significant improvements on most outcome measures at post treatment, with greater benefits for the combined CBT relative to its single BT or CT component. Post-treatment ISI scores were well maintained at 12-month follow up (9.6 for BT, 9.3 for CT, and 7.5 for CBT). Response and remission rates were also well maintained over time in all three conditions, with higher rates at follow up assessment for CBT (72% response, 63% remission) relative to BT (58% response, 40% remission) and CT (63%, 38% remission). Except for sleep efficiency, which was higher for CBT (82%) and BT (83%) at follow up relative to CT (77%), all other measures of sleep, fatigue, depression, anxiety, and quality of life remained equally improved in all three conditions at follow up.

**Conclusion:** These results provide further evidence about the long-term effect of CBT for improving nighttime and daytime symptoms of insomnia. Despite the intuitive appeal in clinical practice for using tailored interventions, these data suggest that full CBT produces the best short- and long-term outcomes.

**Support (If Any):** Research supported by the National Institute of Mental Health (MH79188).
**B. Clinical Sleep Science**

**0642**  
COGNITIVE-BEHAVIORAL THERAPY FOR INSOMNIA FOR SURVIVORS OF INTERPERSONAL VIOLENCE WHO SUBSEQUENTLY RECEIVE COGNITIVE PROCESSING THERAPY  
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**Introduction:** Insomnia frequently occurs in the context of posttraumatic stress disorder (PTSD) for which evidence-based trauma treatments like cognitive processing therapy (CPT) are efficacious, but do not treat insomnia symptoms directly. We sought to test whether delivering cognitive behavioral therapy for insomnia (CBT-I) followed by CPT, produced greater reductions in PTSD and depression severity compared to CPT alone. We conducted a planned interim analysis from an ongoing clinical trial.

**Methods:** Subjects, who had all experienced interpersonal violence (IPV) in the past year and met diagnostic criteria for PTSD, Major Depressive Disorder (MDD) and insomnia, were randomized to receive either individual CBT-I (4 sessions) followed by CPT (12 sessions) or Attention Control (4 supportive phone calls) followed by CPT. Assessments, which occurred at baseline (T1), after CBT-I/Control (T2) and after CPT (T3), included the Insomnia Severity Index (ISI), the Clinician-Administered PTSD Scale (CAPS), and the Hamilton Rating Scale for Depression (HRSD). Two sets of general linear models with repeated measures were used to test time x group interactions from T1-T2 for ISI and T1-T3 for CAPS and HRSD. Subjects were entered if they completed assessments regardless of whether they completed treatment; subjects lost to follow-up were excluded.

**Results:** The analysis includes N = 46 subjects with a mean (sd) age of 35.8 (8.9) who were primarily women and included 32% minorities; mean baseline scores were: ISI = 20.1 (4.6); CAPS = 67.6 (13.6) and HRSD = 23.4 (4.4). Groups did not differ by demographic factors or by clinical severity. CBT-I, compared to attention control, was associated with a significant reduction in ISI at T2 (F(44) = 46.3; p < 0.001). Timexgroup interactions for both CAPS (F(44) = 11.5; p = 0.001) and HRSD (F(44) = 24.5; p < 0.001) scores were significantly lower in the CBT-I condition at T2. At T3, 27 subjects had completed assessments. The time (T1-T3) x group (CBT-I-CPT vs. attention control-CPT) interactions for subjects completing the study at T2 (n = 27) were trending towards significance for CAPS (F(25) = 3.7; p = 0.066) and HRSD (F(25) = 3.3; p < 0.087) total scores. Notably the mean reduction in CAPS score was 35.0 (20.9) at T3 for the CBT-I+CPT condition compared to 20.2 (17.7) in the CPT only condition.

**Conclusion:** The findings suggest that CBT-I is an efficacious in treating insomnia in patients with IPV who have concurrent PTSD and MDD. Though not significant at this interim analysis stage, the findings more tentatively suggest that CBT-I may also augment the effects of subsequent CPT on PTSD and depression symptoms.

**Support (If Any):** This work is supported by R01NR013909.

**0643**  
SEQUENCED THERAPIES FOR COMORBID AND PRIMARY INSOMNIA: PRELIMINARY FINDINGS OF A RANDOMIZED CONTROLLED TRIAL  
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**Introduction:** There is little information about how best to combine or sequence psychological and pharmacological therapies for optimal insomnia management. This paper reports preliminary findings from a two-site randomized clinical trial that is testing different treatment sequences for 224 patients with an insomnia disorder.

**Methods:** This paper reports on the first 82 participants (46 women; M age = 49.7 years old) who have completed treatment. Participants are randomly assigned to first-stage 6-week therapy involving either behavioral therapy (BT) or zolpidem. After initial therapy, individuals in remission are followed for the next 12 months on maintenance therapy. Those not achieving remission are randomized to a second, 6-week treatment involving either pharmacotherapy (zolpidem or trazodone) or psychological therapy (BT or cognitive therapy-CT). Participants are re-evaluated after this second treatment and periodically through 12-month follow-ups. Primary end points include treatment response and remission (Insomnia Severity Index < 8) and several secondary end points (sleep, mood, QoL) are also monitored but not reported in this paper.

**Results:** After initial treatment with BT or zolpidem, there were equivalent proportions of treatment responders (53% vs. 57%) and remitters (32% vs. 35%). For those who did not remit following BT, the addition of zolpidem or cognitive therapy as a second treatment yielded equivalent overall response rate of 72%. Following zolpidem treatment, the addition of BT or trazodone yielded similar response rates (69% vs. 71%, respectively). Remission rates were slightly different after second therapy. Following BT, the addition of zolpidem led to an overall remission rate of 47% relative to 36% when CT followed BT. In contrast, the addition of BT or trazodone after zolpidem therapy led to similar remission rates (43% and 45%, respectively).

**Conclusion:** These preliminary findings suggest that sequential therapies may be an effective strategy to optimize insomnia management. This clinical trial is likely to provide new information about optimal treatment sequencing and to have implication for the development of clinical guidelines for managing chronic insomnia.

**Support (If Any):** Research supported by the National Institute of Mental Health (MH091053)

**0644**  
ACUTE COGNITIVE EFFECTS OF THE HYPOCRETIN RECEPTOR ANTAGONIST ALMOREXANT RELATIVE TO ZOLPIDEM AND PLACEBO  
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**Introduction:** Hypnotic medications can adversely affect behavior during peak concentration after dosing. Animals treated with the hypocretin receptor antagonist almorexant (ALM) have less acute cognitive impairment compared to animals treated with the GABA-A receptor modulator zolpidem (ZOL). This study aimed to confirm if the same effect would be found in human subjects.

**Methods:** Healthy male and female subjects were tested with a neurocognitive battery, the psychomotor vigilance task (PVT), and the
III. Insomnia

Support (If Any): Supported by USA MRMC grant W81XWH-09-2-0080. Blinded study medications were provided by Actelion Pharmaceuticals.

0645 DOES PRETREATMENT SCHEDULE VARIABILITY PREDICT CBTI ADHERENCE?
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Introduction: Adherence is a putative predictor of treatment outcome (Kraemer et al., 2002) and likely important in Cognitive-Behavioral Therapy for Insomnia (CBTI; Edinger & Carney, 2008). It is not known what factors predict CBTI adherence. This study examined predictors of adherence after the first session of CBTI, during which a sleep schedule is prescribed.

Methods: Participants (N = 44, M = 47.9 years) met Research Diagnostic Criteria for Insomnia (Edinger et al., 2004) and were enrolled in a CBTI open trial. The Core Consensus Sleep Diary (CSD; Carney et al., 2011) was completed daily between treatment sessions. Variability in bedtime (BT) and rise time (RT) were calculated from CSD data. BT and RT adherence involved not going to bed before a prescribed earliest BT or getting out of bed after a prescribed latest RT.

Results: A multiple linear regression analysis assessed whether RT and BT variability predicted early adherence to prescribed BT. The model was significant, R2 = 0.234, F(2, 42) = 6.416, p = 0.004. Beta coefficients indicated that BT variability at baseline was a strong predictor of BT adherence (β = −0.449, p = 0.004), while RT variability was not (β = −0.023, n.s.). A second multiple linear regression predicting RT adherence was significant, R2 = 0.307, F(2, 42) = 9.308, p < 0.001. Baseline RT variability (β = −0.37, p = 0.038) and BT variability (β = −0.296 p = 0.011) both significantly contributed to the model.

Conclusion: Pretreatment sleep schedule variability is important to early treatment adherence. Greater BT variability was associated with greater BT adherence. In contrast, greater RT variability was related to increased difficulty adhering to both the earliest BT and latest RT recommendations. For those with high pretreatment BT and RT variability, clinical attention to potential barriers to adherence may be useful during the first CBTI session.

0646 PREDICTING SLEEP SCHEDULE ADHERENCE BASED ON PRETREATMENT INSOMNIA SEVERITY
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Introduction: There is a great deal of support for the efficacy of Cognitive-Behavioral Therapy for Insomnia (CBTI; Edinger & Carney, 2008). Some have argued that nonadherence may be the “single greatest impediment” to CBTI outcome (Bouchard et al., 2003). The current study investigated whether one index of insomnia severity, total wake time (TWT), predicted early treatment adherence (i.e., at the second of four treatment sessions) in a CBTI open trial.

Methods: Participants (N = 45, mean age = 49.2 years) met Research Diagnostic Criteria for Insomnia (Edinger et al., 2004) and completed the daily Core Consensus Sleep Diary (CSD; Carney et al., 2011). Pretreatment TWT was calculated from the CSD by summing the CSD indices of wakefulness in bed prior to the first treatment session. Adherence variables were derived by comparing deviations of actual reported bedtime (BT) and rise time (RT) on the CSD to therapist-prescribed BT and RT.

Results: A linear regression analysis was conducted to examine the relationship between pretreatment TWT and RT adherence. Results indicated that pretreatment TWT was a significant predictor of adherence to a prescribed earliest RT at the second treatment session, R2 = 0.12, F(1, 44) = 6.09, p = 0.018. A second linear regression analysis revealed that pretreatment TWT was not a significant predictor of BT adherence, R2 = 0.006, F(1, 44) = 0.25, n.s.

Conclusion: These findings suggest that pretreatment wakefulness in bed may be a key factor in predicting patient adherence to earliest prescribed RT in CBTI. Interestingly, TWT was not related to BT adherence. For those with greater TWT prior to treatment, it may be that a certain degree of desperation influences their adherence to treatment recommendations. Clinical implications include targeting RT in those with greater pretreatment TWT, and focusing on other putative factors (e.g., health anxiety) in those with lower pretreatment TWT.

0647 IMPROVING THE SLEEP OF HOSPITAL-BASED HEALTHCARE WORKERS THROUGH AN EMAIL-DELIVERED SLEEP WELLNESS PROGRAM
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Introduction: Healthcare worker sleepiness and fatigue increases the risk of adverse events, compromises patient safety, and increases risk to personal safety and well-being. Addressing sleep problems in large healthcare institutions, though, can be challenging and expensive. This study examined the effectiveness of an email-based wellness program as an inexpensive, easy-to-implement initiative to address health care workers’ sleep problems.

Methods: The Sleep Smart Wellness Program was created by a clinical psychologist who is board certified in Sleep Behavior Medicine with consultation and review by an experienced employee wellness coordinator. It consisted of 8 weekly emailed modules highlighting different aspects of sleep, paired with online surveys. Participants completed measures including the Pittsburgh Sleep Quality Index (PSQI), a well-validated measure of sleep problems. Demographic data (gender, age, and education level) was collected. Participants included 1,267 em-
III. Insomnia

ASSOCIATIONS BETWEEN HYPNOTICS CRAVING AND OTHER CLINICAL VARIABLES AMONG LONG-TERM HYPNOTICS USERS

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Introduction: Long-term hypnotics use is often reported among patients with chronic insomnia. Craving is regarded to play a role in chronic hypnotics use. The aim of the study is to investigate the associations between hypnotics craving and other clinical variables in a population of long-term hypnotic users in Taiwan.

Methods: The Hypnotic Craving Questionnaire (HCQ) and other self-report questionnaires, which included Dysfunctional Beliefs and Attitudes about Sleep (DBAS), Beck Anxiety Inventory (BAI), Beck Depression Inventory-II (BDI-II), Insomnia Severity Index (ISI), Tri-dimensional Personality Questionnaire (TPQ) and Pre-Sleep Arousal Scale (PSAS) were administered to 161 long-term hypnotics users. Stepwise multiple regression analysis was applied to explore which variables can predict the craving score.

Results: Four variables significantly predict the first HCQ factor ‘expectation of hypnotics effect’ (R2 = 0.39, F(4,116) = 18.25, p < 0.001), including ‘Medication’ factor of DBAS (β = 3.20, t = 5.26, p < 0.001), hypnotics use frequency (β = −5.23, t = −3.31, p = 0.001), ‘Consequences’ factor of DBAS (β = 1.53, t = 2.71, p = 0.008), and duration of hypnotics use (β = 0.04, t = 2.43, p = 0.02). Two variables significantly predict the second HCQ factor ‘loss of control’ (R2 = 0.60, F(3,121) = 61.55, p < 0.001), which are hypnotics use frequency (β = −10.03, t = −10.07, p < 0.001), ‘Medication’ factor of DBAS (β = 2.42, t = 5.86, p < 0.001), and duration of hypnotics use (β = 0.05, t = 4.31, p < 0.001). Three variables significantly predict the third HCQ factor ‘desire for hypnotics’ (R2 = 0.27, F(3,122) = 15.24, p < 0.001), which are ‘Medication’ factor of DBAS (β = 1.31, t = 4.13, p < 0.001), hypnotics use frequency (β = −3.24, t = −3.93, p < 0.001), and duration of hypnotics use (β = 0.02, t = 2.15, p = 0.03).

Conclusion: Duration of hypnotics use and sleep related cognition are positively associated with hypnotics craving scores. However, hypnotics use frequency was found to have negative associations with HCQ scores. The meanings of the associations deserve further discussion.

GUIDED IMAGERY CONTRIBUTION TO INSOMNIA TREATMENT

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Introduction: Additional data are needed to determine whether guided imagery is effective when added to other specific approaches in insomnia treatment. Our aim is to verify the effect of guided imagery added to insomnia treatment.

Methods: Insomniacs (n = 26, 18 female, mean age 50.8 years) received two phase group insomnia treatment after 2 baseline weeks. Phase 1 (P1) consisted of 3 weeks educational lectures on worries as perpetuating insomnia factor, sleep hygiene, dysfunctional beliefs, stress management, insomnia microanalytic and cognitive models and 15 minutes reading before sleep. Phase 2 (P2) started 60 days after phase 1 end and included educational lectures on guided imagery technique and 15 minutes listening a CD with instructions to imagine how to get rid of emotions that interfere with getting to sleep. Follow up was measured after 4 weeks in both phases during 1 week. Sleep parameters were measured at baseline (B), post treatment (PT-P1) and follow-up (FU-P1) on phase 1 and on week 1 of treatment (T-P2), post treatment (PT-P2) and follow-up (FU-P2) on phase 2.

Results: Participants showed statistically significant increased total sleep time (TST) at PT-P2 (p = 0.007), with 66 minutes increase and at FU-P2, (p = 0.001) with 1 hour increase compared to baseline. Compared to baseline, there was a significant increase in sleep efficiency (SE) at T-P2 (p = 0.001), at PT-P2 (p = 0.001) and at FU-P2 (p < 0.001). Sleep latency (SL) was significantly reduced at FU-P2 (p = 0.007) in 30 minutes. Comparing PT-P2 (p = 0.001) and FU-P2 (p = 0.001) with PT-P1 there was significant increase in TST. In FU-P2 data showed statistical increase in SE compared to PT-P1 (p < 0.001) and compared to PT-P2 (p = 0.008).

Conclusion: Total treatment improved TST, SE and SL. Enhanced improvement obtained in phase 2 compared to phase 1 may show the benefit of adding guided imagery to insomnia treatment.

GUIDED IMAGERY AND READING ADDED TO INSOMNIA TREATMENT HELP TO COPE WITH WORRIES

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Introduction: One of the most important insomnia maintenance factor is cognitive pre-sleep arousal or worry. Reading is a popular method of getting to sleep. Guided imagery is an important tool in dealing with cognitive arousal. We compare the effect from reading and guided imagery added to insomnia treatment on coping with worry.

Methods: A reading group (n = 42; 30 females; mean age = 52.1 years) and an imagery group (n = 38; 27 females; mean age = 53.3 years) participated in lectures on sleep hygiene, dysfunctional beliefs and attitudes about sleep, microanalytic and cognitive models of insomnia and the role of worries in maintaining insomnia. Before sleeping, the reading group read during 15 minutes and the imagery group listened a 14 minutes CD with instructions related to get rid of emotions that disturbed sleep. After two baseline weeks and 3 treatment weeks there was a break of 4 weeks and follow-up was made during one week. Somatic and cognitive arousal during pre-sleep time was measured by the Pre-Sleep Arousal Scale (PSAS) at baseline, post treatment and follow-up.

Results: Cognitive component at baseline had higher scores for both groups: 112 ± 44 for reading and 118 ± 50 for imagery, while somatic...
component scores were 83 ± 41 for reading and 78 ± 33 for imagery. There was no difference related to the cognitive and somatic components between reading (p = 0.977) and imagery (p = 0.877) groups at baseline (B), post treatment (PT) and follow-up (FU). Cognitive component at post treatment and follow-up decreased significantly (p < 0.001) compared to baseline. Cognitive component remained the same from post treatment to follow-up. Compared to baseline, there was no difference in post treatment (p = 0.233) for the somatic component and it decreased at follow-up (p = 0.001). Somatic component showed significant decrease at follow-up (p = 0.003) compared also to post treatment.

**Conclusion:** Cognitive factors in insomnia are more highly involved in pre sleep arousal than somatic factors. Reading and guided imagery added to insomnia treatment have a quicker reducing pre-sleep arousal effect on cognitive components than on somatic components. Guided imagery and reading before sleeping included in insomnia treatment may help coping with worries and cognitive arousal.

### 0651

**THE MODERATING ROLE OF CRAVING ON THE ASSOCIATION BETWEEN DEPRESSIVE MOOD AND HYPNOTIC USE**

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**Introduction:** Previous research shows that depression patients were more likely to develop dependence on sedative-hypnotic. However, the association between depressive mood and hypnotics in primary insomnia patients is still not clear. This study is aim to examine the role of depressive mood on hypnotic use frequency and the moderating effect of craving on the association.

**Methods:** The study recruited 168 primary insomnia patients from hospitals and communities. Participants were given questionnaires including Chinese Version of the Beck Depression Inventory-II (BDI-II) and Hypnotic Craving Scales (HCS) to measure the level of depression and craving toward hypnotic use respectively, as well as questions regarding their hypnotic use. HCS included three factors: (1) Anticipated effects of hypnotic use, (2) Lack of cognitive and behavioral control over hypnotic use, and (3) Desire and anticipated pleasurable effects from hypnotic use.

**Results:** Pearson’s correlations showed that BDI-II (r = 0.130, p = 0.046) and all three factors of the HCS correlated significantly with hypnotic use frequency (F1: r = 0.175; F2: r = 0.190; F3: r = 0.108; ps < 0.05). Hierarchical regression showed depressive mood alone could not predict frequency of hypnotic use (β = 0.195, p = 0.092). However, after entering the moderating effect of Factor 2 of the HCS (lack of control of hypnotic use), the model could significantly predict hypnotic use frequency (β = −0.134, R² = 0.673, F change (1,164) = 5.219, p = 0.024).

**Conclusion:** The study showed that lack of control over hypnotic use could moderate the association between depressive mood and hypnotic use in primary insomnia patients. Depression can lead to more hypnotic use in those with lower degree of lack of control over hypnotic use. The result suggests that depressive mood may play more important role in those with less craving over hypnotic use.

**Support (If Any):** The study is supported by the Ministry of Science and Technology, Taiwan

### 0652

**THE USE OF BRIEF DAYTIME NAPS IN THE BEHAVIORAL TREATMENT OF CHRONIC PRIMARY INSOMNIA**

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**Introduction:** Sleep Restriction Therapy (SRT) has consistently shown therapeutic benefits to insomnia sufferers, however results are considered sub-optimal due to low adherence rates. SRT works by restricting the insomniacs time in bed which is thought to strengthen the homeostatic drive for sleep. Bedtime restrictions can initially cause increased daytime sleepiness which in turn may reduce patient adherence. Modafinil has been used to offset this sleepiness with increased therapeutic benefits for insomnia treatment. An alternative proposal may be the use of brief daytime naps that can alleviate daytime sleepiness without interfering with nocturnal sleep and which may increase adherence to SRT and maximize treatment outcomes.

**Methods:** Twenty primary chronic insomnia patients were recruited and randomly allocated to receive SRT with or without brief daytime naps recommended. Those in the napping group were instructed to nap for no longer than 20 minutes and not nap after 5 pm. All participants completed two weeks of baseline and post treatment measures bracketing three weeks of SRT.

**Results:** Improvements were shown in all sleep and daytime functioning measures post treatment, providing further support of SRT as an effective treatment of insomnia. Despite recommendations for brief naps very few participants in the napping group reported daytime napping. The average reported daytime sleepiness was not excessive at baseline and increased less than two points on the Epworth Sleepiness Scale in the first week of SRT. Thereafter it decreased. Retrospective reports suggested that the participants were usually too busy and not sufficiently sleepy to be motivated to take naps during the day. They also identified that the period of maximum sleepiness was during the late evening just before allowed bedtime when napping was not permitted.

**Conclusion:** Further research should focus on the effects of brief evening napping within SRT or alternate strategies to alleviate evening sleepiness and increase compliance.

**Support (If Any):** Flinders University Research Grant

### 0653

**META-ANALYSIS OF CBT-I FOR THE TREATMENT OF COMORBid INSOMNIA**

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**Introduction:** Cognitive behavioral therapy for insomnia (CBT-I) is increasingly applied to treatment of insomnia comorbid with medical and psychiatric conditions. This meta-analysis aimed to determine the effectiveness of CBT-I for treatment of comorbid insomnia.

**Methods:** Multiple databases were searched for randomized controlled trials of CBT-I published between 1985 and 2014. Inclusion criteria were at least one medical or psychiatric diagnosis; and insomnia defined by DSM, ICSD or research diagnostic criteria, or an Insomnia Severity Index (ISI) > 7. CBT-I components included at minimum sleep restriction and stimulus control, lasted at least four sessions, and were delivered face-to-face individually or in groups.

**Results:** After screening 1,690 titles and abstracts, 23 studies including 1379 patients met criteria. Disorders included chronic pain syndromes, cancers, hearing impairment, COPD, major depressive disorder, alcohol dependence, posttraumatic stress disorder and mixed medical and psychiatric diagnoses. There were large pre- to post-treatment effects for the ISI (6 points) and Pittsburgh Sleep Quality Index.
III. Insomnia

0654  
TREATMENT PROTOCOL FOR A RANDOMIZED CONTROLLED NONINFERIORITY TRIAL TO TEST IF ONLINE CBT-I IS NONINFERIOR TO FACE-TO-FACE CBT-I  
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Introduction: Insomnia is a highly prevalent and disabling disorder where Cognitive Behavior Therapy for Insomnia (CBT-I) is established as the best available treatment. Still, only a negligible number of patients with insomnia receive this treatment. One potential way of improving the dissemination of CBT-I is by using online adaptations of CBT-I. This is a new method for delivering CBT-I and we do not know how effective online treatment is compared to face-to-face CBT-I. We have therefore designed a trial to compare face-to-face CBT-I to online CBT-I. Because of the great advantage of online treatment in both availability and cost, the trial is designed as a noninferiority trial. To test if online CBT-I is noninferior in reducing insomnia complaints compared to CBT-I as delivered face-to-face by a therapist.

Methods: 100 patients diagnosed with insomnia disorder will be randomized to face-to-face CBT-I or online CBT-I. Treatment will last 6–8 weeks. The online treatment is to be the Sleep Healthy Using The internet (SHUTi) program. Results: Main outcomes will be assessed using self-report questionnaires about sleep and sleep diaries at treatment termination and 6 months follow-up. The non-inferiority margin is defined as a difference of 2 points on the primary outcome (Insomnia Severity Index) with an assumed SD of 4.0. A difference within this margin is likely to be of limited clinical importance.

Conclusion: The findings from this research project could open up for improved low-threshold implementation of established and evidence-based treatments.

ClinTrials identifier: NCT02044263

0655  
ACUPRESSURE FOR INSOMNIA IN BREAST CANCER SURVIVORS: A PRELIMINARY REPORT  
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Introduction: Insomnia occurs in 30–60% of breast cancer survivors (BCS) and adversely affects quality of life. Research into non-medication treatments for insomnia in BCS other than CBT is lacking. In a randomized controlled trial of acupressure for persistent cancer-related fatigue in BCS, we compared self-administered acupressure to usual care on self-reported measures of insomnia and sleep quality.

Methods: Women 18+ years of age with breast cancer and persistent fatigue (≥ 4 on the Brief Fatigue Inventory [BFI]) were recruited. Participants had completed cancer treatments a minimum one year prior; were otherwise healthy; and had not participated in acupuncture or acupressure in the past six months. Participants with insomnia symptoms (sleep efficiency < 80% on baseline sleep diary) and no evidence of other sleep disorders were evaluated (n = 29). Women were randomized to six weeks of self-administered acupressure (stimulating or relaxing, n = 21) or usual care (UC, n = 8). The acupressure groups were combined for analysis. The Pittsburgh Sleep Quality Index (PSQI) was administered at baseline, post-acupressure (Week 6), and at 4-week follow-up. Two-week daily sleep diaries were recorded at baseline and follow-up.

Results: Global PSQI scores improved by Week 6 in the combined acupressure groups (‒1.7 ± 3.2, p = 0.008), but not in the UC group (+0.1 ± 3.5, p = 0.92). Week 10 Global PSQI scores were significantly lower in the combined acupressure than the UC group (8.0 ± 2.3 vs. 10.2 ± 2.2, p = 0.03) with improvements sustained at 4-week follow-up. Sleep diary data indicated improvements over the 10-week trial in sleep latency (p < 0.01), wake after sleep onset (p < 0.01), sleep efficiency (p < 0.01), and total sleep time (p < 0.01) for the combined acupressure groups only.

Conclusion: Acupressure improves sleep quality and insomnia symptoms in BCS with persistent cancer-related fatigue and insomnia. Randomized controlled trials of acupressure for insomnia are needed.

Support (If Any): NIH R01 CA151445 (co-PIs: S Zick and R Harris)

0656  
ANXIOLYTIC EFFECTS OF COGNITIVE BEHAVIOR THERAPY FOR INSOMNIA: PRELIMINARY RESULTS FROM AN INTERNET-BASED PROTOCOL  
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Introduction: Though it is now well-recognized that insomnia can exacerbate comorbid anxiety, it remains unclear whether improving sleep can improve co-occurring anxiety symptoms. Therefore, we assessed the impact of a web-delivered cognitive behavior therapy for insomnia (CBTI) intervention on symptoms of insomnia and anxiety.

Methods: A sample of 22 adults (49.8 ± 13.5 yo; 62.5% female) with DSM-IV based insomnia were randomized to either an active CBTI treatment group (n = 13) or an information-control group (n = 9). Specifically, participants in the active treatment group underwent a standard 6-week CBTI program delivered by a virtual therapist through an empirically validated computer program, whereas the information-control group received weekly ‘sleep tips’ and general sleep hygiene education via email. All participants self-reported sleep parameters,
such as sleep onset latency (SOL), insomnia symptoms per the Insomnia Severity Index (ISI), as well as anxiety symptoms per the Beck Anxiety Inventory-Second Edition (BAI-II) at both baseline and follow-up assessment.

**Results:** There were no significant differences between the CBTI and information control groups on SOL, ISI scores, or BAI scores at baseline. The CBTI group showed a significantly larger decrease (t = 2.3; p < 0.05) in SOL from baseline (62.3 ± 44.0 minutes) to follow-up (22.3 ± 14.4 minutes) than did the information control group (baseline: 55.0 ± 44.2 minutes; follow-up: 50.6 ± 60.2 minutes). Further, reductions in ISI scores (t = 2.1; p < 0.05) and BAI scores (t = 2.6; p < 0.05) were also significantly greater for the CBTI group than for the information-control group.

**Conclusion:** This study offers preliminary evidence that treating insomnia can lead to improvements in comorbid anxiety. Replication in future studies with larger samples that allow for mediational analyses can further elucidate these anxiolytic effects of CBTI.

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**0657**

**EFFICACY OF COGNITIVE BEHAVIORAL THERAPY FOR POST-MENOPAUSAL INSOMNIA AND COMORBID VASOMOTOR SYMPTOMS**

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**Introduction:** Insomnia is a common sleep disorder in post-menopausal women. We examined the efficacy of Cognitive Behavioral Therapy for Insomnia (CBT-I) and Sleep Restriction Therapy (SRT) as treatments for post-menopausal insomnia and their effects on other menopausal symptoms.

**Methods:** Post-menopausal females (n = 32, mean age 55.5 ± 4.75) suffering from insomnia concurrent with menopause were recruited. Participants were screened for contraindicative psychopathology and sleep disorders via Structured Clinical Interview for DSM-IV Disorders and polysomnography (PSG). All participants showed an average wake time after sleep onset ≥45 minutes as evidenced by two nights of PSG. Subjects were randomly assigned to receive 6-week CBT-I (n = 12), 2-week SRT (n = 13), or a 6-week information control (n = 7). The Insomnia Severity Index (ISI) and Menopause Quality of Life Intervention (MENQOL-I) were administered before and after treatment.

**Results:** One-Way ANOVA showed no significant between-group differences in baseline ISI score (CBT-I: X = 13.92 ± 3.8; SRT: X = 14.69 ± 2.53; Control: X = 16.29 ± 3.77) or vasomotor symptoms as indexed by the MENQOL-I (CBT-I: X = 5.03 ± 1.62; SRT: X = 5.10 ± 1.87; Control: X = 4.67 ± 2.52). For ISI, the difference between groups post-treatment was significant (F = 6.66, p = 0.054). Independent subjects t-tests revealed a significant difference in ISI change score between CBT-I (X = −7.92 ± 4.83) and controls (X = −3.00 ± 3; t = −2.74, p = 0.014), and a significant difference in change score between SRT (X = −6.77 ± 3.91) and controls (t = 2.40, p = 0.029). A paired t-test revealed a significant decrease in vasomotor menopause symptoms in the SRT group (X = 4.15 ± 2.02; t = 3.80, p = 0.012), and an independent samples t-test showed a significant difference in vasomotor symptom change scores between the SRT (X = −0.95 ± 0.90) and control groups (X = 0.00 ± 0.47; t = 2.58, p = 0.019).

**Conclusions:** These results suggest that CBT-I and SRT both result in a reduction in insomnia symptoms in women with menopausal-related insomnia, with both treatments displaying similar efficacy. In addition to improved sleep, SRT leads to a reduction in self-reported vasomotor menopause symptoms post-treatment.

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**0658**

**TREATING INSOMNIA IN OLDER ADULTS WITH MILD COGNITIVE IMPAIRMENT IN RESIDENTIAL CARE SETTINGS**

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**Introduction:** More than half of adults over the age of 65 report serious problems with sleep. Rates of sleep disturbance increase with age, particularly among women and those with concurrent medical or psychiatric conditions. In addition, sleep disturbance is one of the most frequent symptoms observed in older patients with mild cognitive impairment (MCI). Independent Living Facilities (ILF) and Assisted Living Facilities (ALF) occupy the middle of the care continuum and represent the fastest growing segment of long-term care, making it possible to reach a large number of individuals. Sleep problems, insomnia specifically, are an ideal intervention target given the evidence that treatments are very successful for a broad range of individuals; improvements have the potential to broadly impact public health; and further, sleep represents a modifiable risk factor for a range of other disorders, such as declining cognition, depression and functional impairment.

**Methods:** A six-session, adapted version of a cognitive behavioral intervention for insomnia was administered to older adults (N = 28) across two residential facilities. Participants were randomly assigned to either the sleep intervention or an active control group. Participants were evaluated at baseline (T1), post-intervention (T2) and at a 2 month follow-up (T3). Participants’ ratings of their sleep quality via the Insomnia Severity Index, and actigraphy ratings of sleep latency, wake after sleep onset and total sleep time were recorded via actigraphy, were included in the battery of assessment measures.

**Results:** Preliminary analyses support the hypothesis that this intervention was effective at improving sleep in this population. The percent decrease in time awake after falling asleep was greater for the sleep group than for the control group both from T1 to T2 (47% vs. 15%) and for T1 to T3 (52% vs. 17%). Finally, the sleep efficiency improvements from T1 to T3 were higher for the sleep group than for the control group (10 vs. 3%).

**Conclusion:** It is not yet understood how MCI may moderate the effects of treatment and what therapeutic adaptations are needed to maximize treatment effects. Adaptations found to aid implementation and outcome will be detailed. Findings will be detailed and future studies, focused on transferability and scalability across residential care settings will be included.

**Support (If Any):** This study is supported by Grant #2012-199 from the Retirement Research Foundation.

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**0659**

**THE ASSOCIATION BETWEEN HYPNOTIC CRAVING AND HYPNOTIC USE: A SIX-MONTH FOLLOW-UP STUDY**

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**Introduction:** Although hypnotic medications are suggested for short-term use, prolonged use is very common in clinical settings. Craving has been demonstrated to be one of the core elements of substance dependence. It is not clear if it also plays a role in long-term hypnotic use. The present study aims to investigate the association between hypnotic craving and the frequency of hypnotic use, as well as the predictability of craving on hypnotic use 6 months later.
III. Insomnia

Methods: 94 current hypnotic users were recruited from hospitals and communities. Subjects with severe medical and psychiatric disorders were excluded through a screening interview. Participants were given questionnaires including the Hypnotic Craving Scale (HCS), the Insomnia Severity Index (ISI), and a questionnaire for demographic data and hypnotic use. Their frequency of hypnotic use and ISI were followed after six months by phone.

Results: Pearson’s correlations showed that the HCS total score and subscale scores all correlated significantly with the frequency of hypnotic use at baseline (Total: r = 0.59, p < 0.01; F1-anticipated effects of hypnotic use: r = 0.43; F2-lack of cognitive and behavioral control over hypnnotics use: r = 0.68; F3-desire and anticipated pleasurable effects from hypnotic use: r = 0.042; ps < 0.01) and at 6-month follow-up (Total: r = 0.59, p < 0.01; F1: r = 0.46; F2: r = 0.63; F3: r = 0.044; ps < 0.01). Hierarchical regression identified that only the Factor 2 of the HCS was a significant predictor (ΔR² = 0.052, p < 0.01) for the hypnotic use frequency at follow-up after controlling for age and hypnotic use at baseline.

Conclusion: The results indicate that craving is not only related to current medication use but also a predictor for future hypnotic use. Among the components of craving, the inability to control over hypnotic use is the most critical factor to predict future use of hypnotic drugs in insomnia patients.

Support (If Any): This study is supported by the Ministry of Science and Technology, Taiwan

0660
DUAL OREXIN RECEPTOR ANTAGONISTS DEMONSTRATE EFFICACY WITH REPEATED TREATMENT AND RESTORE REM SLEEP FOLLOWING INDUCED INSOMNIA IN HEALTHY ANIMALS


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Introduction: Clinical cases of abuse and dependence of GABA-A modulators have been documented in humans, and tachyphylaxis following chronic administration of GABA-A modulators may contribute to abuse and dependence. GABA-A modulators have been shown to exhibit tolerance and dependence such that sleep promoting efficacy diminishes with chronic exposure in rodents. The current work compares effectiveness of chronic GABA-A modulator or DORA treatment in rodents

Methods: Locomotor activity was assessed in wildtype C57/BL6 mice treated with Zolpidem (30 mg/kg, p.o., Q.D., n = 16) or DORA-12 (100 mg/kg, p.o., Q.D., n = 16) by infrared beam break. Core temperature of wildtype C57/BL6 and Ox1/2R double knock-outs were monitored continuously over 6 days of baseline home cage conditions using implanted telemetry devices. Sleep efficacy and architecture in rats was evaluated by polysonomography in radiotelemetry-implanted animals. REM deprivation evaluated in mice utilizing the pedestal method for 28 hours.

Results: Even in the presence of increased sleep drive in REM deprived animals, treatment with eszopiclone (60 mg/kg, po, QD) has no immediate impact on REM sleep in comparison to control animals, and even suppressed REM at later time points. On the other hand, sleep deprived animals treated with DORA-22 (100 mg/kg, po, QD) exhibit a significant increase in both non-REM and REM sleep. Animals treated with Zolpidem (30 mg/kg, po, QD) exhibited desensitization over a 9 day period, with reduced or total loss of efficacy on the last day of treatment. Treatment with DORA-12 (30 mg/kg, po, QD) was fully efficacious throughout the same 9 day treatment window, and also had equal effectiveness in animals previously desensitized to Zolpidem (10 mg/kg, p.o., QD).

Conclusion: Together, these results in animal models suggest that DORAs promote sleep that is similar to natural sleep, maintain effectiveness with chronic treatment, and have efficacy that is resistant to prior desensitization to GABA-A modulators.

0661
LONG-TERM OUTCOMES OF GROUP CBT-I IN TERTIARY SETTING

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Introduction: Group CBT-I has been found to be an effective intervention; among patients with insomnia disorder. Continued improvements have been observed at 6, 12, and 24 months post-treatment in randomized controlled trials. Less is known about maintenance of treatment gains in a clinical setting, where comorbidities are common. In this longitudinal study, we examined the outcomes of group CBT-I at 24-months post-treatment in a tertiary setting.

Methods: Participants were 27 adults, age ranged from 34 to 90 y (M = 58.3, SD = 14.6) who presented for a 6-session CBT-I group at a university based sleep disorders clinic. Pre-treatment, post-treatment, and 24-month follow-up questionnaires included the Insomnia Severity Index (ISI), Dysfunctional Beliefs about Sleep (DBAS), and Glasgow Sleep Effort Scale (GSES).

Results: Repeated measure ANOVAs and paired-samples t-tests were conducted, comparing baseline to each subsequent time point. ISI score significantly decreased over time (F = 7.2, p = 0.012) from baseline (ISI = 17.6) to post-treatment (ISI = 10.1) t = 3.6, p = 0.003) and from baseline to 24-month follow-up (ISI = 9.1; t = 4.5, p < 0.001). DBAS and GSES scores also significantly decreased from baseline to post-treatment (p-values < 0.001) and from baseline to follow-up (p-values < 0.002). Whereas DBAS and ISI scores were not significantly correlated at baseline and post treatment (p-values > 0.1), there was a strong positive relationship between ISI and DBAS scores at the 24-month follow-up (r = 0.76, p < 0.001).

Conclusion: This replicated previous reports of durable benefits of group CBT-I and extends these findings to a tertiary setting. At the 24-month follow-up only, insomnia severity was associated with DBAS, suggesting that dysfunctional beliefs about sleep might be a risk for insomnia relapse; this possibility will need to be directly tested in a randomized controlled trial with a long-term follow-up.

0662
EFFECT OF INCOMPLETE COGNITIVE BEHAVIOR THERAPY FOR INSOMNIA ON PATIENTS WITH PRIMARY INSOMNIA

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Introduction: Although there is little debate of the usefulness of cognitive-behavioral therapy for insomnia (CBTI) in patients with primary insomnia (PI), following factors such paucity of specialty-trained experts or the duration, intensity, and cost of 4 individual treatment sessions limit the widespread application in Korea. The aim of this study is to compare the clinical efficacy of complete (4 sessions) and incomplete (< 4 sessions) CBTI.

Methods: We investigated 115 adults with chronic PI (82 female, mean 53.6 y) who were prescribed to have individual, 4-session CBTI (sleep education, stimulus control, sleep restriction, sleep hygiene, and cognitive therapy) from Feb. 2010 to Oct. 2014. All patients completed self-reported 1 to 2 week sleep diary before and during CBTI. Clinical
efficacy was evaluated by estimated of total sleep time (TST), sleep latency (SL), waking after sleep onset (WASO), and sleep efficiency (SE) based on the sleep diaries.

**Results:** 36 (31.3%) completed 4-session CBTI (24 female). 31 (30.0%) were withdrawn after 1st session, 31 (30.0%) after 2nd session, and 17 (14.8%) were dropped after 3rd session. Eighty patients excluded due to incomplete sleep diary. Clinical efficacy was measured in patients who completed at least 2 sessions (n = 76, 66.1%). Mean SE was improved from 69.1 to 78.1% (p = 0.005). In 55 of 76 patients (72.4%), their SE was increased to normal range (≥ 85%). Other measures such as TST (318.5 – > 350.8 min, p < 0.001), SL (61.9 – > 27.1 min, p = 0.002), and WASO (84.2 – > 23.4 min, p = 0.001) were all improved after CBTI in 76 patients.

**Conclusion:** About third of patients stopped voluntarily after just 1st session of CBTI. Nevertheless, incomplete CBTI improved sleep induction and maintenance as well as sleep quality in patients with PI. It suggests the necessity of development of brief CBTI to increase the adherence of patients in Korea.

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**0663**

**A RANDOMIZED PLACEBO CONTROLLED TRIAL OF MELATONIN ENRICHED MILK - CAN IT IMPROVE SYMPTOMS OF INSOMNIA?**

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**Introduction:** A naturally derived product that assisted with insomnia symptoms would have broad appeal. The aim of the study was to determine whether a milk product (iNdream3TM) with naturally enhanced levels of melatonin and other bioactive components improved sleep in a cohort of insomnia patients when compared with day milk (low melatonin and no bioactive ingredients).

**Methods:** A 9 week double blind randomized placebo controlled cross-over trial of 19 adults with primary insomnia (mean age 40 ± 14 years, 14/19 female, Insomnia severity index (ISI) > 15, 14/19) were randomized to 3 weeks of iNdream3TM and 3 weeks of day milk separated by a one week washout. Total sleep time (TST), sleep efficiency (SE), sleep onset latency (SOL) and sleep quality were measured both subjectively (sleep diary and questionnaires) and objectively (actigraphy), over one week for baseline and active treatment arms. At baseline and at the end of each arm subjects underwent home polysomnography (PSG).

**Results:** Consuming iNdream3TM compared with day milk improved insomnia symptoms: PSQI (Pittsburg Sleep Quality Index) efficiency (+5.2 vs −0.4, p = 0.039), PSQI daytime dysfunction (−0.58 vs no change, p = 0.019) and sleep related disturbance (−3.3 vs −1.5, p = 0.011) and SOL by sleep diary, (−8 min vs +5 min, p = 0.045). The % stage N3 sleep-PSP (+8 min vs −9 min, p = 0.004), SE-actigraphy (+2.3% vs −0.5%, p = 0.004), number of awakenings-actigraphy (+1.8/night vs +1.5/night, p = 0.003) also improved. TST was not significantly different between treatments.

**Conclusion:** In subjects with primary insomnia, consuming a milk product with enhanced melatonin and other bioactive ingredients, produced small but significant improvements in insomnia symptoms; sleep efficiency and depth of sleep but did not change objectively measured total sleep time. The size of the effects seen is similar to other non-pharmacological insomnia treatment options but smaller than those reported for commonly prescribed pharmaceutical hypnotic products.

**Support (If Any):** The study was funded by an unrestricted research grant from Synlait Milk Ltd

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**0664**

**CLINICAL PROFILE OF SUvorexANT FOR THE TREATMENT OF INSOMNIA OVER 3 MONTHS IN MEN AND WOMEN: GENDER SUBGROUP ANALYSIS OF POOLED PHASE-3 DATA**

Herring W, Connor KM, Snavely D, Zhang Y, Snyder E, Lines C, Michelson D

Merck & Co., Inc., Kenilworth, NJ

**Introduction:** Suvorexant is an orexin receptor antagonist approved for treating insomnia at a maximum dose of 20 mg. Previously-reported Phase-3 trial results showed that suvorexant was effective and generally well-tolerated. Here we report on its clinical profile in gender subgroups.

**Methods:** Gender subgroup efficacy analyses were pre-specified and included pooled data from two similar randomized, double-blind, placebo-controlled, parallel-group, 3-month trials in elderly (≥ 65 y) and non-elderly (18–64 y) insomnia patients. Two age-adjusted (non-elderly/elderly) dose-regimes of 40/30 mg and 20/15 mg were evaluated. Fewer patients were assigned to 20/15 mg than 40/30 mg or placebo. Efficacy was assessed by patient-reported outcomes (PRO), and by objective polysomnography (PSG) endpoints in ~75% of patients. The pooled safety analyses by gender included data from the 3-month trials plus 3-month data from a safety trial for 40/30 mg.

**Results:** 1264 women and 707 men were included in the efficacy analysis of PRO endpoints. The gender subgroup analyses mirrored the improvements seen for suvorexant 40/30 mg and 20/15 mg over placebo on PRO and PSG sleep maintenance and onset endpoints in the primary analyses; 95% CIs excluded zero in favor of suvorexant for the majority of endpoints in both subgroups and similar efficacy was observed across genders (95% CIs overlapped). 1744 women and 1065 men were included in the safety analyses. Suvorexant was generally well-tolerated in women and men. The most frequent adverse event was somnolence for both 40/30 mg (women: 11.1% vs. 2.3% for placebo; men: 10.1% vs. 4.2% for placebo) and 20/15 mg (women: 8.5% vs. 3.0% for placebo; men: 3.4% vs. 3.6% for placebo). Somnolence was generally transient and mild-to-moderate in intensity.

**Conclusion:** Suvorexant 20/15 mg and 40/30 mg were generally effective and well-tolerated by women and men with insomnia. Given that the maximum approved dose is 20 mg, the 20/15 mg data are the most clinically relevant.

**Support (If Any):** Merck

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**0665**

**EFFECTS OF SUvorexANT ON SLEEP ARCHITECTURE IN PATIENTS WITH INSOMNIA: ANALYSIS OF POOLED PHASE-3 DATA**

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**Introduction:** Suvorexant is an orexin receptor antagonist approved for treating insomnia at a maximum dose of 20 mg. Suvorexant increases total sleep time (TST) and reduces time to sleep onset. We report here on its effects on sleep architecture.

**Methods:** The analyses included pooled polysomnography data from two similar randomized, double-blind, placebo-controlled, parallel-group, 3-month trials evaluating two age-adjusted (non-elderly/elderly) dose-regimes of 40/30 mg and 20/15 mg in patients with insomnia. Polysomnography was recorded at baseline and on three nights during treatment: Night-1, Month-1, and Month-3. Effects on non-REM sleep (Stage-1, Stage-2, SWS) and REM sleep were evaluated. A power spectral analysis of non-REM sleep was also performed.
Results: 1482 patients were included in the sleep architecture analysis. Suvorexant increased the time spent in all sleep stages compared with placebo. When comparing suvorexant to placebo in terms of changes in % of TST spent in each sleep stage, small differences were noted with decreases of ≤ 2.2%, ≤ 0.8%, and ≤ 0.8% for Stage-1, Stage-2, and SWS, respectively, and an increase of ≤ 3.9% in REM. The largest differences from placebo were observed at Night-1 and generally diminished over time. Suvorexant reduced REM latency (number of non-REM sleep 30-sec epochs from lights-off to the first REM epoch) compared to placebo; the reduction was greater at Night-1 (approximately 40–50 epochs) than at later timepoints (approximately 12–25 epochs at Month-3). The spectral analysis of non-REM sleep showed a small decrease in power of 3–6% in the gamma and beta bands at Night-1 for suvorexant relative to placebo; these effects were not significant at the later Month-1 and Month-3 timepoints.

Conclusion: Overall sleep architecture appears to be preserved in insomnia patients taking suvorexant. The power spectral profile of suvorexant is generally similar to placebo.

Support (If Any): Merck

0667
A POLYSOMNOGRAPHIC STUDY OF SLEEP EFFECTS OF MK-1064, A SELECTIVE OREXIN-2 RECEPTOR ANTAGONIST, IN HEALTHY INDIVIDUALS
Merck & Co., Inc., Kenilworth, NJ

Introduction: Dual orexin receptor-1 and –2 (OX1R/OX2R) antagonists promote sleep, both in healthy volunteers and insomnia patients. Pharmacodynamic investigation of the effects of selective OX2R antagonists in non-clinical species has suggested that this class of drugs can exert sleep-promoting effects similar to dual antagonists. MK-1064 is a selective OX2R antagonist (~100 fold) that has a Phase I pharmacokinetic, pharmacodynamic and safety profile supportive of assessment of clinical sleep effects.

Methods: 20 healthy male subjects without insomnia were randomized in a double blind 4-period balanced-sequence crossover design study. Subjects were assigned to receive either MK-1064 (50 mg, 120 mg, or 250 mg) or matching placebo in each treatment period. Drug administration occurred approximately 1 hour before individuals' habitual bedtimes followed by overnight PSG. In addition to PSG, subjective sleep evaluations and next-day psychomotor assessments including Simple Reaction Time testing (SRT), Choice Reaction Time testing (CRT), and the Digit Symbol Substitution Test (DSST), were performed.

Results: MK-1064 was generally well tolerated. All three doses of MK-1064 decreased Latency to Persistent Sleep, the primary PSG endpoint for the study, compared to placebo. MK-1064 at doses of 120 mg and 250 mg also significantly decreased Wake after Sleep Onset. In secondary analyses, MK-1064 increased Total Sleep Time, and increased percent of NREM sleep 30-sec epochs from lights-off to the first REM epoch compared to placebo, but there was no significant SRT treatment effect after 120 and 50 mg doses. Next-day CRT and DSST performance was not significantly different from placebo at any dose tested.

Conclusion: Selective antagonism of OX2R by MK-1064 exerts significant sleep-promoting effects when administered at bedtime. These sleep effects are qualitatively similar to those attributed to dual OX1R/ OX2R receptor antagonists.

Support (If Any): Merck

0668
OPEN-LOOP NEUROFEEDBACK AUDIO-VISUAL STIMULATION FOR INSOMNIA IN PEOPLE WITH CHRONIC PAIN
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Introduction: Insomnia and chronic pain are common comorbid conditions and their relationship has been viewed as bidirectional. Recent studies suggest a relatively dominant role of sleep in this dyad. The purpose of this pilot study was to test the efficacy of an audio-visual stimulation program for sleep promotion in people with chronic pain, and to explore if an intervention that promotes sleep can reduce pain.

Methods: This was an intervention study testing an open-loop neurofeedback Audio-visual intervention (AVS) that provided stimulus designed to enhance slow brainwaves (delta-theta). The stimulus (from 10 to 1 Hz) was delivered through goggles (flashing light) and earphones (audio strobe). Participants self-administered a 35-minutes AVS program nightly at bedtime for one month. We used a pre-post measure design. Participants were 18 years of age or older, had non-cancer re-
lated pain most days over the past 6 months (Brief Pain Inventory-BPI: Worst pain ≥ 4 and < 10) and difficulty sleeping for 3 months, confirmed with the Insomnia Severity Index (ISI, score 8 or higher). Sleep (ISI and sleep diary) and pain (BPI) were assessed at baseline and again at the conclusion of the 4 week intervention phase.

**Results:** Nine adults (mean age 33 ± 15.8 years, range 19–63; female, 89%) completed the study. After using the AVS device for 4 weeks, significant improvement was seen in reported insomnia (ISI, p = 0.003), worst pain (BPI, p = 0.004), and ability to sleep through pain (BPI, p = 0.015), although total sleep time did not change. Large effect sizes (Partial Eta2: 0.54–0.68) were evident in the treatment effect.

**Conclusion:** This pilot study is the first to examine the effect of AVS for sleep induction. Although the sample size was small, the significant improvement and large effect on sleep and pain suggested favorable potential of AVS as a non-pharmacological self-care intervention to promote sleep in adults with chronic pain. These pilot results warrant a future large scale randomized controlled study that further explores the use of AVS in insomnia and comorbid pain.

**Support (If Any):** This project was conducted with the support of 1) John A. Hartford Foundation Claire M. Fagin Fellowship, 2) National Institute of Nursing Research T-32 Post-doctoral fellowship (NINR 5-T32-NR009356) from the NewCourtland Center for Transitions and Health, School of Nursing University of Pennsylvania, 3) Biobehavioral Research Center, School of Nursing University of Pennsylvania, and 4) Center for Research on the Management of Sleep Disturbances (P30 NR011400), University of Washington.

**0669 DUAL OREXIN RECEPTOR ANTAGONIST E2006 SHOWS EQUIVALENT EFFICACY IN MEN AND WOMEN IN PHASE 2 STUDY**

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**Introduction:** E2006 is a dual orexin receptor antagonist under development for insomnia disorder. This report presents polysomnographic results from a Phase 2 study, with comparisons by sex.

**Methods:** Subjects with insomnia disorder received 1 of 6 doses of E2006 (1 mg–25 mg) or placebo (PBO) double-blind for 15 nights followed by PBO single-blind for 2 nights. Pairs of 8-hr PSGs were recorded at baseline (BL), first and last 2 treatment nights, and PBO run-out nights.

**Results:** 291 subjects were randomized (64% F, mean 48 yrs). BL PSG characteristics (all groups combined) were (mean ± SD; female/male): SE (%) 65 ± 12 (66 ± 11/62 ± 12); median LPS (min) 67 ± 42 (57 ± 36/67 ± 49); WASO (min) 109 ± 43 (107 ± 42/113 ± 44). 91% of PBO and 95% of E2006 subjects completed. LS Mean differences vs PBO in change from BL (CFB) at Days 1/2 for SE% were 1 mg: 4.6; 2.5 mg: 4.4; 5 mg: 5.7; 10 mg: 8.1; 15 mg: 10.1; 25 mg: 10.1. The largest difference in SE response between females and males was 9.2% (2.5 mg); with other doses, the magnitude of sex difference was 0.7–4%. Median LPS decreased substantially from baseline in all groups (p < 0.05 vs PBO at ≥ 2.5 mg), as did WASO (p < 0.05 vs PBO at ≥ 10 mg). Effects at Days 1/2 were maintained at Days 14/15. SE was higher, LPS shorter, and WASO less compared to BL during the PBO run-out, indicating no rebound insomnia. ANCOVA showed no significant effect of sex on PSG endpoints. AEs of somnolence (83% mild; 17% moderate; 0% severe) were dose-related but were not reported at different rates in females vs males.

**Conclusion:** E2006 led to an approximately 50% decrease in both LPS and WASO, and SE increased to 86% on average. Baseline PSG indices were worse in males, but equivalent efficacy and no significant sex differences in safety measures were observed. These results support the potential clinical utility of E2006 for insomnia disorder.

**Support (If Any):** This study was funded by Eisai, Inc.

**0670 INTENTION-TO-TREAT OF SUBLINGUAL AND ORAL ZOLPIDEM FOR TREATING INSOMNIA: A RANDOMIZED CONTROLLED TRIAL**

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**Introduction:** Zolpidem is a standard in insomnia treatment. However, the incidence of treatment failure in different dosing-regimens, or therapeutic-schemes remains unknown. Our objective was to evaluate a 5 mg sublingual formulation of Zolpidem administered at bedtime, and ‘as needed’, following middle-of-the-night-awakenings, in a 3-month, randomized, and double-dummy study, controlled by Oral_10 mg Zolpidem.

**Methods:** Participants were 67 adults (mean age 48 y; 79% women) with insomnia, reporting difficulty initiating/resuming sleep. Therapeutic-schemes included one sublingual and one oral tablet nightly at bedtime, and one elective sublingual tablet. Groups received either active sublingual 5 mg (n = 34) or oral 10 mg (n = 33), with matching placebos. Medical evaluation, sleep diaries and scales were applied at all five visits, and blood testing, the Psychomotor Vigilance Test, and Polysomnography performed twice, at randomization and week-13.

**Results:** Of 67 randomized patients, 21 (31%) withdrawn. One lost-to-follow, one failed to comply, and 19 due to adverse events (AE). In total, 152 events were registered by clinicians, 58 (38%) rated as not-related to study medication. Headache, sleepiness, and dizziness were the most likely associated, followed by gastrointestinal symptoms, and agitation/irritability. No abuse-related or AE was observed to the point of discouraging the use of either drug. Of all patients, 55% (n = 37) achieved sustained global-clinical-improvement at week-13. Patients in the Oral_10 mg group had a higher incidence of symptom recurrence after week-6, and an increased relative-risk (1.7) for treatment failure. Men, divorced/widowed, lower sleep quality baseline-scores, and history of musculoskeletal symptoms also associated with treatment failure.

**Conclusion:** Our study found that for about one third of patients treatment fails. There might be predisposing factors preventing patients of benefiting from a relatively high-cost therapy that could be possibly easily addressed, for example by tailoring or alternating therapeutic-schemes or routes of drug administration. To what extent such strategies would influence treatment outcome remains unknown.

**Support (If Any):** Supported by EMS (Brazilian Pharmaceutical Company).

**0671 FACTORS ASSOCIATED WITH LONG-TERM USE OF HYPNOTICS AMONG PATIENTS WITH CHRONIC INSOMNIA**

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**Introduction:** This study investigated factors associated with long-term use of hypnotics (benzodiazepines (BZDs) or benzodiazepine receptor agonists (BzRAs)) in patients with chronic insomnia.
III. Insomnia

Methods: Consecutive patients (n = 140) with chronic insomnia were enrolled in this study (68 men and 72 women; mean age, 53.8 ± 10.8 years). All patients filled out a self-assessment questionnaire asking clinical descriptive variables at the baseline of the treatment period; patients received the usual dose of a single type of BZD or BzRA. The Pittsburgh Sleep Quality Index (PSQI) and the Zung Self-Rating Depression Scale were self-assessed at the baseline, and the former was re-evaluated at the time of cessation of medication or at the end of the 6-month treatment period. The PSQI included the following sub-items: evaluating sleep quality (C1), sleep latency (C2), sleep duration (C3), habitual sleep efficiency (C4), frequency of sleep disturbance (C5), use of sleeping medication (C6), and daytime dysfunction (C7).

Results: Among the patients, 54.6% needed to continue hypnotics for a 6-month treatment period. Logistic regression analysis revealed that, among descriptive variables, only the PSQI score appeared as a significant factor associated with long-term use (odds ratio (OR) = 2.8, 95% confidence interval (CI) = 2.0–4.0). The receiver operating curve (ROC) analysis identified that the cut-off PSQI total score at the baseline for predicting long-term use was estimated at 13.5 points (area under the curve = 0.86, 95% CI = 0.8–0.92). Among the sub-items of PSQI, the increases in C1: (OR = 8.4, 95% CI = 2.4–30.0), C3: (OR = 3.6, 95% CI = 1.1–11.5), C4: (OR = 11.1, 95% CI = 3.6–33.9), and C6: (OR = 3.4, 95% CI = 1.9–6.2) scores were associated with long-term use.

Conclusion: This study revealed that a high PSQI score at the baseline, particularly in the sub-items relating to sleep maintenance disturbance, is predictive of long-term hypnotic treatment. Our results imply the limitation of the effectiveness of hypnotic treatment alone for chronic insomnia.

0672
THE THERAPEUTIC EFFECT OF COGNITIVE-BEHAVIOUR THERAPY FOR INSOMNIACS WITH SHORT OBJECTIVE SLEEP DURATION: A RANDOMIZED CONTROLLED TRIAL
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Introduction: Recent literature suggests individuals suffering chronic insomnia who have short objective sleep duration have underlying pathophysiological and clinical characteristics distinct from those with normal objective sleep duration. However, it remains unclear whether the therapeutic effects of CBTi differ between these proposed groups of insomnia sufferers. The present study evaluated the efficacy of a brief group-based program of cognitive-behaviour therapy (CBTi) for older insomniacs with short objective sleep relative to those with normal sleep duration.

Methods: Ninety-four adults (male = 46, mean age = 63.34, SD = 6.41) with sleep maintenance and/or early morning awakening insomnia were selected from a community-based sample. The participants were classified as short sleepers (SS; < 6 hrs total sleep time) or normal sleepers (NS; ≥ 6 hrs total sleep time) based on one night of home-based polysomnography. Participants were randomly allocated to a four-week, group-based treatment program of CBTi (N = 30 SS, N = 33 NS) or to a wait-list control condition (N = 9 SS, N = 19 NS). One-week sleep diaries, actigraphy, and comprehensive battery of questionnaire were used to evaluate the efficacy of CBTi for those with short objective sleep relative to those with normal sleep duration. Outcome measures were taken at pre-treatment, post-treatment, and 3-month follow-up.

Results: CBTi produced robust and durable improvements in the timing and quality of sleep including later bedtimes, earlier out-of-bed times, reduced wake after sleep onset, and improved sleep efficiency. Participants also reported a reduction of scores on the Insomnia Severity Index, Flinders Fatigue Scale, Epworth Sleepiness Scale, Daytime Feeling and Functioning Scale, Sleep Anticipatory Anxiety Questionnaire, the Dysfunctional Beliefs and Attitudes Scale, and increased Sleep Self-Efficacy Scale. All improvements were significant relative to the waitlist group. The benefits of CBTi were comparable for those with short and normal objective sleep prior to treatment.

Conclusion: Older insomniacs with short objective sleep receive comparable therapeutic benefits following CBTi relative to those with normal objective sleep.

0673
THE EXPLORATORY POWER OF SLEEP EFFORT, DYSFUNCTIONAL BELIEFS, AND AROUSAL FOR INSOMNIA SEVERITY AND PSG DETERMINED SLEEP
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Introduction: Differences between subjective sleep perception and sleep determined by polysomnography (PSG) are prevalent, particularly in patients with primary insomnia, indicating that the two measures are partially independent. To identify individualized treatment strategies, it is important to understand the potentially different mechanisms influencing subjective and PSG determined sleep. The aim of this study was to investigate to which extent three major components of insomnia models, i.e. sleep effort, dysfunctional beliefs and attitudes about sleep, and pre-sleep arousal, are associated with subjective insomnia severity and PSG-determined sleep.

Methods: A sample of 47 patients with primary insomnia according to DSM-IV criteria and 52 good sleeper controls underwent two nights of PSG and filled in the Glasgow Sleep Effort Scale, the Dysfunctional Beliefs and Attitudes about Sleep Scale, the Pre-Sleep Arousal Scale, and the Insomnia Severity Index. Regression analyses were conducted to investigate the impact of the three predictors on subjective insomnia severity and PSG-determined total sleep time. All analyses were adjusted for age, gender, depressive symptoms, and group status.

Results: Subjective insomnia severity was positively associated with sleep effort. PSG determined total sleep time was negatively associated with somatic pre-sleep arousal and dysfunctional beliefs and attitudes about sleep.

Conclusion: Suggesting that subjective insomnia severity and PSG determined total sleep time are associated with different cognitive and somatic variables, our results might contribute to the formation of new hypotheses for future research. The reduction of sleep effort appears to be a particularly important therapeutic target. Based on the results of this study, we suggest that future treatment studies investigate the efficacy of treatments designed to reduce sleep effort, such as mindfulness based treatment or acceptance and commitment therapy.
trials in elderly (≥ 65 y) and non-elderly (18–64 y) insomnia patients. Age-adjusted (non-elderly/elderly) dose-regimes of 40/30 mg and 20/15 mg were evaluated. Fewer patients were assigned to 20/15 mg than 40/30 mg or placebo. The ISI, a 7-item patient questionnaire, was administered as an exploratory assessment at Months 1 and 3.

**Results:** 1824 patients were included in the analysis. Compared to placebo, suvorexant improved change-from-baseline in total score at both timepoints (Month 3: 20/15 mg = -6.2, 40/30 mg = -6.7, placebo = -4.9, p-values < 0.001) and the percentage of responders (≥ 6-point improvement from baseline) at both timepoints (Month 3: 20/15 mg = 55.5%, 40/30 mg = 54.9%, placebo = 42.2%, p-values < 0.001). Scores for individual items of the ISI showed numerical improvement for both suvorexant dose regimes versus placebo at both timepoints; for 40/30 mg p-values were < 0.01 for all items at both timepoints, for 20/15 mg p-values were < 0.01 at ≥ 1 timepoint for all items except “sleep problem interferes with daily functioning”. The “impact of insomnia” component (last 3 items) which assesses the impact of insomnia on daytime function/quality-of-life was improved by both dose regimes versus placebo at both timepoints (p-values < 0.01).

**Conclusion:** Suvorexant 20/15 mg and 40/30 mg improve sleep as assessed by the ISI in patients with insomnia. Improvement in sleep onset/maintenance as well as a reduction of the impact of sleep problems on daytime function contribute to the overall improvement observed in ISI total score. Given that the maximum approved dose is 20 mg, the 20/15 mg data are the most clinically relevant.

**Support (If Any):** Merck

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**0675**

**CASE SERIES REVIEW OF CBT-I OUTCOMES: THE RELEVANCE OF MEDICATION USE AND MORBIDITY**


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**Introduction:** The efficacy of CBT-I in randomized trials is well-established. Last year data were presented on the “real world” efficacy of CBT-I and it was shown that, overall, the in-clinic outcomes were comparable to meta-analytic norms. The present study examined whether the in-clinic outcomes vary with medication use or comorbidity.

**Methods:** Seventy-Nine patients (47% female; mean age = 52 ± 15.8 years) were evaluated and treated at the Penn Center for Sleep. The sample was sorted into several subgroups including: 1) patients who did not use hypnotics during treatment (Nonmed, n = 39) and patients who used hypnotics throughout treatment or who were tapered off during treatment (Med, n = 40); 2) patients with one or more medical comorbidities (n = 37), one or more psychiatric comorbidities (n = 5), both medical and psychiatric comorbidities (n = 29), or no comorbid conditions (n = 8). Outcome data were coded to reflect either treatment response (SL and/or WASO reduced by 50%) or remission (both SL and WASO < 30 min). Changes were calculated based on data from the first and final sessions. All subjects had at least 4 sessions but the absolute number of sessions was free to vary. Outcomes were evaluated using chi-squared tests.

**Results:** There were no significant group differences in rates of response and remission for patients using and not using hypnotics, or for between group contrasts with respect to comorbidity.

**Conclusion:** The analysis based on concurrent use and non-use of medication was adequately powered. The absence of group differences may reflect the lack of relevance of this factor. Alternatively, the potential confounding effects of medication may have yielded similar outcomes but required more sessions and/or were only comparable for subjects that were weaned from medication or for subjects that reduced their medication use. The analysis of outcomes by comorbidity was not adequately powered for the Psych and No Comorbid Illness groups. Alternative analyses are on-going.

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**0676**

A PILOT TEST OF AN ONLINE COGNITIVE-BEHAVIORAL INSOMNIA THERAPY FOR PATIENTS WITH COMORBID INSOMNIA AND SLEEP APNEA

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**Introduction:** Cognitive behavioral insomnia therapy (CBT) combined with standard therapy (e.g., CPAP) for obstructive sleep apnea (OSA) seems to provide optimal outcomes for those with comorbid OSA and insomnia. Whereas many such patients have difficulty accessing a CBT provider, emerging online CBT (OCBT) interventions may provide a remedy for this problem. This pilot study tested the efficacy of an OCBT for such patients.

**Methods:** Participants were 10 adults with OSA and comorbid insomnia being treated with CPAP. All had unresolved insomnia despite using CPAP and indicated willingness to try OCBT. Patients completed the Insomnia Severity Index (ISI) and Epworth Sleepiness Scale (ESS), and then were randomized to a waitlist (WL: n = 5) or OCBT (n = 5). The OCBT group was given free access to the commercially available online Sleepio® program and allowed 8 weeks to complete its 6 sessions. OCBT recipients provided nightly sleep estimates using the online sleep diary while using the Sleepio® program. Eight weeks after completing their initial ISI and ESS, both groups again completed these measures. ANOVAs and effect size calculations were used to compare ISI and ESS changes observed for the OCBT and WL groups. Mean changes in sleep diary total sleep time (TST) and sleep efficiency (SE) for OCBT recipients were also examined.

**Results:** Nine of 10 patients enrolled (4 OCBT; 5 WL) continued in the study once randomized and completed study measures. OCBT recipients showed an 8-point mean ISI score decline whereas WL assignees showed only a 3-point average ISI score decline across the two assessment time points (p = 0.24; ES = 0.82). OCBT recipients also showed a 5-point mean ESS score decline, whereas the mean change shown by the WL group was a 1.8-point increase (p = 0.02; ES = 1.42). At post-intervention assessment, 3 of 4 OCBT patients had normal ISI scores (< 8) whereas only 1 of 5 WL achieved a normal ISI score. All four OCBT assignees had normal ESS scores (≤ 10) at the post-intervention assessment whereas only 2 of 5 WL had normal ESS scores at that time. The OCBT group reported mean (± SE) increases of 1.36 (± 2.7) hours in TST and 24% (± 27.2%) in their SE during treatment.

**Conclusion:** CPAP-treated comorbid OSA/insomnia patients can achieve additional benefits from OCBT. Trials to compare OCBT, therapist-directed CBT and usual care for comorbid OSA/insomnia patients are warranted.

**Support (If Any):** Support provided by Sleepio® UK

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**0677**

PRE-SLEEP AROUSAL IN PATIENTS WITH INSOMNIA DISORDER WITH AND WITHOUT OBSTRUCTIVE SLEEP APNEA

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**Introduction:** Between 20–40% of individuals with insomnia have co-morbid obstructive sleep apnea (OSA). The psychological characteristics of this comorbid population are not well identified. The aim of this study was to explore the role of pre-sleep arousal in patients with
Insomnia disorder (ID), compared to insomnia and co-morbid OSA (ID+OSA).

**Methods:** One-hundred and forty-six participants with insomnia disorder underwent an overnight polysomnogram (PSG) to confirm OSA (Apnea Hypopnea Index, AHI ≥ 5). Each participant completed the Pre-Sleep Arousal Scale (PSAS), Epworth Sleepiness Scale (ESS) and Fatigue Severity Scale (FSS). Scores on these scales were compared between the two groups (ID and ID+OSA) using an independent-samples t-test or Mann-Whitney test. The ID+OSA group was further divided into three groups by insomnia phenotype (onset, maintenance, mixed) using median splits on each of the first three items of the Insomnia Severity Index (ISI). Differences in PSAS scores across phenotypes were explored using a Kruskal-Wallis test.

**Results:** Of the 146 participants (females = 92, mean age = 48 yrs, mean ISI = 17.3), 55.5% participants had confirmed comorbid OSA. Pre-sleep arousal was higher in those with ID (mean = 35.9, SD = 9.0) compared to the ID+OSA group (m = 30.4, SD = 10.2, t(142) = 3.4, p < 0.01). The two groups differed significantly on the cognitive (p < 0.001), but not the somatic arousal subscale (p = 0.1). There were no differences in daytime sleepiness and fatigue. Of the 81 individuals with comorbid OSA, 5 had sleep onset, 31 had sleep maintenance and 40 mixed insomnia (both onset and maintenance). There were differences in PSAS across phenotypes ($\chi^2 (2) = 12.94, p < 0.01$). Posthoc analysis revealed that onset [median = 35] and mixed [median = 33] phenotypes had higher pre-sleep arousal than the maintenance group [median = 24].

**Conclusion:** This study indicates that cognitive arousal is more prominent in ID compared to ID+OSA. Furthermore, arousal was different across OSA participants depending on phenotype and it is thus unlikely that sleep disordered breathing per se is associated with higher arousal.

**Support (If Any):** This research is supported by two grants (K23AT003678, R01HL114529) from the National Center for Complementary and Alternative Medicine (NCCAM), the National Heart, Lung, and Blood Institute (NHLBI) and the National Institutes of Health (NIH).

**0678 IMPACT OF INTERNET-DELIVERED CBT FOR INSOMNIA ON DEPRESSION SYMPTOMS IN ADULTS AT-RISK FOR MAJOR DEPRESSION: RESULTS OF AN RCT COMPARING ONLINE CBT-I VERSUS A HEALTH WEBSITE**

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**Introduction:** Cognitive Behaviour Therapy for Insomnia (CBT-I) delivered through the Internet has been shown to be effective as an intervention to improve sleep in individuals seeking help for insomnia. CBT-I has also been shown to lower levels of depression. However, it is not known if targeting insomnia using online CBT-I can lower depressive symptoms in those at risk for development of major depression. The current study was, in part, designed to evaluate whether Internet delivery of a fully automated self-help CBT-I program could lower depression symptoms in an at-risk real-world sample.

**Methods:** A sample of 1,148 community-dwelling adults (aged 18–64) in Australia, who screened positive for both insomnia and subclinical levels of depressive symptoms, were randomised to either a 9-week Internet-delivered CBT-I program (SHUTi: Sleep Healthy Using the Internet) or an attention-matched control website (HealthiWatch). Although longer-term follow-up data are still being collected, Pre-Post data collection is complete and includes self-reported symptoms of depression (Patient Health Questionnaire-9, PHQ-9) and anxiety (Generalized Anxiety Disorder-7, GAD-7).

**Results:** Analysis of the Pre-Post data shows that, after controlling for baseline levels of depression, adults in the online CBT-I group experienced greater Pre-Post reductions in depression symptoms (PHQ mean change from 8.02 to 3.65) than adults in the control group (PHQ change from 7.84 to 6.24), estimate = −2.77, p < 0.001. Adults in the online CBT-I group also experienced greater Pre-Post reductions in anxiety (GAD-7 change from 5.83 to 2.98) than adults in the control group (GAD-7 change from 5.77 to 5.02), estimate = −2.11, p < 0.001.

**Conclusion:** This is the largest known research dataset evaluating CBT-I as a means of reducing depressive symptoms, potentially providing a scalable, low-cost method to impact depression by focusing on a condition that may be less stigmatising. Data from the Pre-Post dataset support the notion that online, fully automated CBT-I can reduce depressive symptoms.

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0680
COGNITIVE FUNCTIONING IN OLDER ADULTS WITH COMORBID INSomnia AND SLEEP APNEA
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Introduction: Research has examined the independent relationships between insomnia and cognitive functioning, and between sleep apnea and cognitive functioning. However, insomnia and sleep apnea are often comorbid, and the cognitive profile of older adults with both disorders is unknown. We examined the cognitive profiles of older Veterans with comorbid insomnia and sleep apnea.

Methods: Subjects included 40 older Veterans (mean age = 64.8 ± 8 years) recruited from a VA Sleep Clinic. All subjects underwent either an in-laboratory sleep study or a portable home sleep test, and were screened for insomnia using the International Classification of Sleep Disorders, 3rd edition (ICSD3). Subjects meeting both ICSD-3 criteria for insomnia and having an apnea-hypopnea index (AHI) ≥ 15 were included in the present analysis. Subjects completed a cognitive battery assessing: (1) long-term memory, (2) working and short-term memory, (3) processing speed, and (4) executive functioning (i.e., language/verbal fluency and sequencing/switching). One-sample t-tests were used to determine whether the obtained cognitive scores significantly differed from demographically-adjusted normative values.

Results: Average AHI of the sample was 35 (± 17.3). Older adults with comorbid insomnia and sleep apnea displayed significant cognitive deficits in (1) all measures of long-term memory, t(39)'s = 3.59–6.26, p's < 0.001, (2) one out of two measures of working memory, t(39) = 2.54, p < 0.05, and the single indicator of short-term memory, t(39) = 2.24, p < 0.05, (3) all measures of processing speed, t(39)'s = 5.23–9.30, p's < 0.001, and (4) one out of two measures of language/verbal fluency, t(39) = 4.43, p < 0.001, and the single indicator of sequencing/switching, t(39) = 4.91, p < 0.001.

Conclusion: The cognitive profiles of older adults with comorbid insomnia and sleep apnea are evident of deficits across multiple cognitive domains. These deficits may directly impact treatment adherence, quality-of-life, and functional independence. Studies are needed to examine the cognitive response of combined treatments for comorbid insomnia and sleep apnea.

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0681
TIME TO INITIAL INSomnia DIAGNOSIS AND SEDATIVE HYPONOTIC PRESCRIPTION IN A VETERAN COHORT
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Introduction: Insomnia is commonly comorbid with psychiatric disorders and treated with prescription sedative hypnotics. However, less is known about the temporal relationships between insomnia, psychiatric comorbidities, and sleep medications.

Methods: Data was obtained from electronic medical records of a VA Pittsburgh Healthcare System (VAPHS) cohort (n = 35,479). ICD codes, grouped by disorder, were used to determine diagnosis of insomnia and psychiatric disorders. Sedative hypnotics included benzodiazepine receptor agonists (BzRA), trazodone, and temazepam in doses indicated for treating insomnia. Survival analysis, using Kaplan-Meier estimates, was used to compare the mean and median duration from entry into VAPHS to the initial insomnia diagnosis and prescription of a sedative hypnotic for Veterans with and without psychiatric disorders.

Results: Time to insomnia took longer for Veterans with depressive, adjustment, or substance disorders. Time to insomnia was also prolonged if prescribed BzRA or trazodone; however, time to insomnia was shorter if prescribed temazepam. Insomnia was the only diagnosis with shorter time to temazepam and PTSD the only diagnosis with shorter time to BzRA. PTSD, depression, anxiety, and substance abuse resulted in shorter time to trazodone. For Veterans with adjustment disorder, subsequent diagnosis of insomnia significantly prolonged time to BzRA, trazodone, and temazepam. The same was true for PTSD and time to trazodone.

Conclusion: Contrary to expectations, time to insomnia was prolonged in Veterans with a psychiatric disorder. Time to first sedative hypnotic, however, was accelerated in Veterans without insomnia. This supports previous research that insomnia remains treated primarily as a symptom, at least initially, rather than a comorbid disorder. Temazepam appears to be an important indicator for accelerated insomnia diagnosis. Temazepam, over trazodone or BzRA, may indicate more severe insomnia symptoms and therefore a more rapid diagnosis. Further investigation of temporal relationships between insomnia, psychiatric comorbidities, and sedative hypnotics may help improve assessment, diagnosis, and treatment of insomnia.

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0682
INTER-RELATIONSHIPS OF SLEEP DURATION AND RESISTANT HYPERTENSION IN A CLINIC-BASED COHORT WITH BASELINE HYPERTENSION AND OBSTRUCTIVE SLEEP APNEA
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Introduction: Hypertension (HTN) has been identified as a consequence of obstructive sleep apnea (OSA) and also as a factor in short or long self-reported total sleep time (TST), however, these inter-relationships in resistant HTN (RHTN) remain under-studied. We hypothesize that extremes of sleep duration are associated RHTN in patients with HTN and OSA.

Methods: Multivariable logistic regression models were used to examine the cross-sectional relationship of self-reported TST and RHTN in patients with HTN and OSA (Apnea Hypopnea Index > 5) from July 2008 to July 2013 in the Cleveland Clinic. A five-level predictor for TST (sleep in hours; [ ≤ 5, (5–7), [7–8] (reference), (8–9], > 9) was included in the models with the following covariates considered: age, sex, race, body mass index (BMI), diabetes mellitus (DM), education, marital status, alcohol and caffeine consumption, sleepiness (Epworth Sleepiness Scale; ESS) and depression (Patient Health Questionnaire-9; PHQ-9).

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Results: Final models included 878 patients. Demographics (mean age 58 ± 12 years, 52%/male, 72% Caucasian, BMI 36 ± 9 kg/m², 14.8% RHTN, 29% using alcohol, median AHI 29 (25th-75th percentile, 15–54), mean ISI 16 ± 6 (among 18% of patients who answer “yes” to an insomnia qualifier question) and self-reported TST distribution (29% ≤ 5, 35% between 5–7, 28% between 7–8, 7% > 8 hours) provided sufficient modeling data. No significant cross-sectional association was observed between TST and RHTN after covariate adjustment. As anticipated, non-Caucasian race (odds ratio [OR] = 2.06, 95% CI [1.34–3.17]), alcohol use (OR = 2.14 [1.42–3.23]), previous history of DM (OR = 1.58 [1.05, 2.37]) and increased BMI (OR = 1.04 [1.02–1.06]) were associated with increased odds of RHTN in the fully adjusted model.

Conclusion: No significant cross-sectional relationships between RHTN and TST were observed. High BMI, history of DM, alcohol use and non-Caucasian race were associated with increased odds of RHTN. We recommend enhanced screening strategies for RHTN in these patients.

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0683
RESISTANT HYPERTENSION AND FUNCTIONAL STATUS MEASURES AS PREDICTORS OF INSOMNIA SYMPTOM RESPONSE TO CONTINUOUS POSITIVE AIRWAY PRESSURE IN OBSTRUCTIVE SLEEP APNEA IN A CLINIC-BASED COHORT

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Introduction: Clinic-based predictors of insomnia improvement after continuous positive airway pressure (CPAP) initiation in obstructive sleep apnea (OSA) and hypertension (HTN) are sparse. We postulate that resistant hypertension (RHTN), due to accompanying higher sympathetic activation, and secondarily sleepiness and depression, will predict insomnia improvement after OSA treatment.

Methods: This clinic-based retrospective study involved data from patients with insomnia (Insomnia Severity Index (ISI) > 10), OSA (Apnea Hypopnea Index, AHI > 5) and HTN from July 2008 to July 2013. Among those with baseline insomnia, multivariable logistic regression models were used to examine insomnia remission (ISI < 10) in response to CPAP therapy relative to baseline RHTN status (primary predictor). Sleepiness (Epworth Sleepiness Scale; ESS) and depression (Patient Health Questionnaire-9; PHQ-9) (secondary predictors) were also examined. Age, sex and body mass index (BMI) were included in the fully adjusted model. Odds ratios and 95% confidence intervals are presented.

Results: 149 patients comprised the final analytic sample: age 58 ± 12 years, 42% male, 71% Caucasian, BMI 36 ± 9 kg/m², 15% with RHTN and median AHI of 31 (25th-75th percentile, 17–52). 66 of these patients (44%) remitted at the first visit after CPAP initiation (mean duration of 81 ± 50 days) (indicated “no” to insomnia qualifier question or ISI < 10). No significant association was observed between RHTN and insomnia remission with CPAP after covariate adjustment. Although no significant association was observed with ESS, a 37% decreased odds of insomnia remission per 5-point increase in PHQ-9 (OR = 0.63; 95% CI: 0.44–0.91) was noted.

Conclusion: In this pragmatic clinic-based study, RHTN status did not predict insomnia remission in response to CPAP therapy in co-morbid insomnia; this is possibly explained by irreversibility of the RHTN-related hyperarousal state in response to CPAP. Alternatively, higher depression scores predicted decreased insomnia remission after CPAP suggesting the potential need for enhanced/supplementary strategies to combat insomnia in this subgroup.

Support (If Any): Research was made possible by the Cleveland Clinic Neurological Institute Research Project Pilot Funding. We acknowledge the Knowledge Program Data Registry of Cleveland Clinic, Cleveland, OH for providing the data used in these analyses. We acknowledge the Neurological Institute Center for Outcomes Research and Evaluation (NI-CORE) Cleveland Clinic, Cleveland, OH for providing bio-statistical resources.

0684
GHRELIN AND LEPTIN LEVELS IN PATIENTS WITH INSOMNIA
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Introduction: The objective of this study is to evaluate differences in metabolic parameters in adults with and without insomnia complaints.

Methods: We analyzed data from Episono including 1024 individuals, 468 males, 574 females 20–80 years old. Individuals were classified in three groups: no insomnia, insomnia complaints and insomnia syndrome. These groups were compared for levels of glucose, insulin, cholesterol, HDL, LDL, VLDL, triglycerides, homocysteine, ghrelin, leptin, TGO, TGP, creatinine, and cortisol. Statistical comparisons were made by one-way ANOVA.

Results: Significant differences (p < 0.05) among groups were found for the following metabolic parameters: glucose, cholesterol, HDL, homocysteine, leptin and creatinine.

Conclusion: Insomnia is related to alterations in multiple metabolic parameters corroborating previous research. The significance of these findings remains to be clarified.

Support (If Any): FAPESP and AFIP

0685
COGNITIVE-BEHAVIORAL THERAPY FOR INSOMNIA COMORBID WITH PSYCHIATRIC AND MEDICAL CONDITIONS: A META-ANALYSIS
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Introduction: Cognitive-behavioral therapy for insomnia (CBT-I) is the current gold standard non-pharmacological treatment for insomnia disorders. Although meta-analyses have examined primary insomnia, less is known about the comparative efficacy of CBT-I on comorbid insomnia. The objective of the study is to examine the efficacy of CBT-I for insomnia comorbid with psychiatric and/or medical conditions for: 1) remission from insomnia; 2) self-reported sleep efficiency (SE), sleep onset latency (SOL), wake after sleep onset (WASO), total sleep time (TST), and subjective sleep quality; and 3) comorbid symptoms.

Methods: A systematic search was conducted in June, 2014 through PubMed, PsychINFO, the Cochrane Library, and manual searches. Trials were included if they were randomized clinical trials with at least one CBT-I arm, and had an adult sample meeting diagnostic criteria for insomnia and a co-occurring condition. Thirty-eight trials were included in the final analyses; main outcomes derived from sleep diary
and other self-report measures were meta-analyzed using a random-effects model. Study quality was evaluated using the Cochrane Risk of Bias Assessment Tool.

**Results:** At post-treatment, 36% of patients who received CBT-I were in remission from insomnia, compared to 17% in control conditions (pooled OR: 3.14, p < 0.0001). Pre-post controlled effect sizes (ESs) were medium to large for most sleep parameters (SE: Hedges’ g = 0.88; SOL: Hedges’ g = 0.79; WASO: Hedges’ g = 0.68; sleep quality: Hedges’ g = 0.83; p’s < 0.0001), except TST. Comorbid outcomes yielded a small ES (Hedges’ g = 0.39, p < 0.0001); improvements were greater in psychiatric than in medical populations (X²Interaction = 12.24, p < 0.0001).

**Conclusion:** CBT-I is efficacious for improving insomnia symptoms and sleep parameters in patients with comorbid insomnia. A small effect was found across comorbid outcomes, with larger effects on psychiatric relative to medical conditions. Large-scale studies with more rigorous designs to reduce detection and performance bias are needed to improve the quality of the evidence.

**Support (If Any):** Dr. Ong serves as a consultant for Sleepio, Inc. This activity is not related to the current study. Other authors have no conflicts to disclose.

### 0686

**PERFECTIONISM AND INSOMNIA: THE MEDIATING ROLE OF ANXIETY AND DEPRESSION**

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**Introduction:** Perfectionism can be considered a predisposing factor in the onset of insomnia. Prior research has demonstrated that individuals with insomnia often exhibit aspects of perfectionism. Further, symptoms of anxiety and depression often appear to be prominent amongst those with insomnia. Despite this, examination of these factors together has been limited. The present study aimed to determine whether individuals with insomnia, compared to normal-sleepers, report increased aspects of perfectionism. In addition, the meditational role of anxiety and depression was examined.

**Methods:** Seventy-eight participants, 39 of whom met the DSM-5 criteria for insomnia disorder (92% female, mean age 22.18 years ± 5.37 years) and 39 normal-sleepers (69% female, mean ages 24 years ± 6.25 years), completed two Multidimensional Perfectionism Scales (F-MPS; HF-MPS) and the Hospital Anxiety and Depression Scale (HADS).

**Results:** Individuals with insomnia reported significantly higher scores of concern over mistakes (t(76) = −2.50, p = 0.02), doubts about action (t(76) = −2.64, p = 0.01) and parental criticism (t(76) = −2.74, p = 0.01) compared to normal-sleepers. In addition, individuals with insomnia also reported greater symptoms of anxiety (t(76) = −4.49, p = 0.01) and depression (t(76) = −2.80, p = 0.01). However, a series of ANCOVA analyses demonstrated that when anxiety and depression were controlled for, none of the previous differences concerning perfectionism remained significant, p > 0.05.

**Conclusion:** The present study indicated that although individuals with insomnia exhibit a greater degree of concern over mistakes (e.g., “people will think less of me if I make a mistake”), doubts about action (e.g., “I have doubts about everyday things I do”) and parental criticism (e.g., “My parents never tried to understand my mistakes”) relative to normal-sleepers, these differences appear to be mediated by anxiety and depression. These results highlight the significance of treating symptoms of anxiety and depression with the prospect of alleviating negative thoughts concerning ones mistakes, doubts about actions, and perception of parental criticism, which may contribute to disturbed sleep.
binary logistic regression was conducted to identify significant predictors from this list of demographic factors and sleep disordered breathing symptoms.

**Results:** Of the sample, 81 had OSA and 65 did not. The final regression model correctly identified 80.7% of OSA cases (R^2 = 0.54, χ^2 (1) = 74.73, p < 0.001). The regression analysis identified that endorsement of witnessed apneas (β = 2.3, p < 0.001), snoring (β = 0.97, p < 0.05) and increased age (β = 0.8, p < 0.01) were significant predictors of OSA on the PSG. BMI as a predictor approached significance (β = 0.07, p = 0.052). Choking and gender were not significant predictors.

**Conclusion:** The purpose of this study was to determine risk factors that are the greatest predictors for OSA in an insomnia disorder sample. The findings indicate that age, snoring, and witnessed apneas are all significant predictors of OSA among patients with insomnia. The results may be informative in assessing risk of OSA when conducting clinical trials on patients with insomnia or in BSM clinics.

**Support (If Any):** This research is supported by two grants (K23AT003678, R01HL114529) from the National Center for Complementary and Alternative Medicine (NCCAM), the National Heart, Lung, and Blood Institute (NHLBI) and the National Institutes of Health (NIH).

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**0689 INSOMNIA AFFECTS EMPATHY IN HEALTH CARE WORKERS**

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**Introduction:** Physician's empathy and the patient's awareness of it can lead to a positive clinical outcome reducing stress and anxiety. Health care workers have high rates of insomnia as they have irregular work hours, fragmented sleep, and circadian misalignment. The effect of insomnia on empathy has never been explored before. In this study, we hypothesize that insomnia is associated with decreased empathy in health care workers.

**Methods:** Ninety seven Subjects including but not limited to physicians, residents, nurses, nurse assistants, pharmacists, radiology technicians, lab technicians were recruited from Henry Ford health system. Empathy was measured by the Interpersonal Reactivity Index (IRI) across four subscales: fantasy, perspective-taking, empathic concern, and personal distress. The IRI has good psychometric properties. Each subscale has seven questions scored on a five point Likert scale ranging from “Does not describe me well” to “Describes me very well” with higher scoring denoting decreased empathy. Insomnia was measured using the Insomnia Severity Index (ISI). Subjects were classified into two groups based on a ISI score of 8 (67 with ISI > 8).

**Results:** The two groups were comparable for sociodemographic data including age (age ISI > 8 = 40.3 and ISI < 8 = 46, SD = 12), gender (females with ISI > 8 = 54, chi-square = 0.8), and marital status (ISI > 8 = 32, chi square = 0.42). The mean ISI score with ISI > 8 is 20.49 (SD-4.37) and with ISI < 8 is 10.5 (SD-2.86) Subjects with ISI > 8 (67) scored significantly higher across all four subscales of empathy (P < 0.05).

**Conclusion:** Insomnia decreases empathy in health care workers. There is an urgent need to address this issue as it can lead to adverse clinical outcomes and medical errors.

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**0690 PERSONALITY DISORDERS IN INSOMNIA PATIENTS**

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**Introduction:** Comorbidity between insomnia and personality disorders (PD) is poorly studied. The aim of this research was to investigate the presence of PD in consecutive patients with a diagnosis of primary insomnia.

**Methods:** We evaluated 100 insomnia patients (55% women; meanage: 41 ± 11 years) with the Structured Clinical Interview for DSM-IV-TR (SCID-II,V.2.0) and with the Multidimensional Battery for Assessment of Personality (Adaptive/Maladaptive)-BMVP(A/D).

**Results:** PD were present in 57 patients (4 patients with a co-diagnosis). Within this group cluster B was the most diagnosed (28), with a wide presence of narcissistic- (17), and less frequent histrionic- (6) and borderline- (5) PD. In cluster C the most diagnosed PD was obsessive-compulsive (4). In Temperament Character Inventory Revised (TCI-R) insomniacs with PD showed lower scores in the subscales eagerness of effort, responsibility, purposeful, resourcefulness, enlightened second nature and higher scores in anticipatory worry subscale and in self-transcendence in comparison to no-PD. In the Aggression Questionnaire (AQ), physical aggression and total score also showed higher rates. In the Attachment Style Questionnaire (ASQ), PD insomnia patients obtained higher scores in the “secondariness of relationships” and “need of approval” subscales and lower scores in “confidence” subscale than no-PD patients. In the Barratt Impulsiveness Scale (BIS-11), attention impulsivity subscale showed higher scores in PD patients.

**Conclusions:** Our data show a high occurrence of PD in insomnia patients. We found cluster B as the most frequent in patients with insomnia. In contrast with previous studies that highlighted the relationship between insomnia and borderline-PD, we found a higher prevalence of narcissistic-PD in our sample. In conclusion, our study suggests a relevant association between insomnia and PD. Future studies are necessary to clarify this relationship in order to improve the efficacy of (non pharmacological) treatments and the therapy compliance in these patients.

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**0691 EMOTIONAL AND SLEEP-SPECIFIC VULNERABILITIES AS PREDICTORS OF INSOMNIA SYMPTOM SEVERITY IN A NON-CLINICAL POPULATION**

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**Introduction:** Sleep-specific vulnerability factors have traditionally been emphasized in understanding insomnia. A stress-reactive sleep system and beliefs about one’s ability to control their own sleep have been implicated as vulnerability factors for insomnia (Drake et al., 2004; Espie et al., 2006). Recently, temperamental vulnerabilities (such as a predisposition to experience heightened negative and diminished positive affect) and deficits in emotional functioning (heightened emotional reactivity and perseverative cognition) have been implicated in insomnia (Baglioni et al., 2010; Brosschot et al., 2006; Fairholme & Manber, in press). It is not yet known how these general and sleep-specific vulnerability factors collectively relate to insomnia symptom severity.

**Methods:** Participants were 380 healthy adults (58% female; mean age = 19.08, range = 18–40) recruited from a large west coast university. Participants completed self-report measures of sleep specific vulnerabilities (Ford Insomnia Response to Stress Test, Glasgow Sleep...
Effort Scale), emotional vulnerabilities (Emotional Reactivity Scale, Perseverative Thinking Questionnaire), temperamental vulnerabilities (Behavioral Activation Scale, Behavioral Inhibition Scale), as well as insomnia symptom severity (Insomnia Severity Index).

**Results:** Multiple regression was conducted to evaluate whether sleep-specific, emotional, and temperamental vulnerabilities were independently related to insomnia symptom severity. Sleep effort ($\beta = -0.37$, $p < 0.001$), emotional reactivity ($\beta = 0.14$, $p < 0.01$), and perseverative thinking ($\beta = 0.23$, $p < 0.001$) were all significantly associated with insomnia symptoms severity, but stress reactive sleep system ($\beta = 0.08$), behavioral activation ($\beta = 0.07$), and behavioral inhibition ($\beta = 0.07$, all $ps > 0.05$) were not.

**Conclusion:** Sleep-specific and emotional vulnerabilities were independently associated with insomnia symptom severity. Results highlight the potential importance of emotional functioning in understanding insomnia. Potential clinical implications for insomnia are discussed.

### 0692
**DRINKING HABIT AFFECTS ANXIETY AND SLEEP QUALITY IN POOR SLEEPERS**
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**Introduction:** Although most poor sleepers tend to relieve their anxiety for better sleep quality, whether drinking habit is a factor that truly modulates poor sleepers’ sleep quality is still unknown. The aim of the study was to explore the association between a drinking habit and anxiety among poor sleepers in northern Taiwan.

**Methods:** A total of 84 poor sleepers (Pittsburgh Sleep Quality Index, PSQI > 5) aged 20 to 80 years old were recruited into this cross-sectional study. A structured questionnaire on demographics and drinking habits, level of anxiety, level of depression and perceived sleep quality was used to collect data.

**Results:** The poor sleepers were mostly women (72.6%) with a mean age of 41.81 ($\pm$ 12.62) years old. Fifty-six percent of poor sleepers currently used sleep therapy. 7.1% of poor sleepers had a drinking habit, with 19.0%, 13.1% and 14.3% of those having mild, moderate and severe anxiety, respectively. The poor sleepers with a drinking habit had prolonged sleep duration and often used sleeping medication. Besides, those with severe anxiety have the worst subjective sleep quality, sleep latency, use of sleeping medication, and daytime dysfunction. After adjusting factors related to the sleep quality using multiple regression analysis, both a drinking habit and anxiety are predictors of poor sleep quality. Moreover, the drinking habit had a moderating effect on the relationship between anxiety and sleep quality among poor sleepers.

**Conclusion:** The results revealed a drinking habit had a moderating effect on the association between their anxiety and sleep quality.

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### 0693
**BURNOUT SYNDROME AND INSOMNIA IN ELEMENTARY SCHOOL TEACHERS**
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**Introduction:** Models of burnout often suggest that it is a work-related, multidimensional condition consisting of several symptom clusters, such as exhaustion, cynicism, professional efficacy, physical fatigue, and mental weariness. A few studies have explored the relationship between insomnia and burnout in small, selected samples. The aim of this study was to investigate whether there is a relationship between burnout and insomnia in elementary school teachers.

**Methods:** The study included 44 subjects. They answered 2 questionnaires: Maslach Inventory Burnout for Educators (MIB-ES) and The Pittsburg Sleep Quality Index (PSQI). In this abstract it is only showed sleep latency (SL) values. Conditions were divided for analysis as follows: No Burn Out (NBO)+Sleep Latency (SL) and Burn Out (BO)+SL, NBO+Insomnia (NBO+I) and BO+Insomnia (BO+I); Emotional Exhaustion (EE) Depersonalization (D), Personal Accomplishment (PA). The cut-off point of SL for insomnia was 25 min.

**Results:** Mean age: (34.9+7.8), SL min (20.68+8.9), BO (54.68+12.7), NBO+SL (19.12+1.5) vs. BO+SL (26.0+2.7)*. NBO+I (31.8%), BO+I (18.2%), NEE+SL (18.7+1.5) vs. EE+SL (25.8+7.6)*, ND+SL (20.7+1.6) vs D+SL (20.63+2.45), PAL (22.33+1.5) vs PA (17.4+2.4)** (*p < 0.05, **p < 0.58), NEE+I (27.3%), EE+I (22.7%), ND+I (31.8%), D (18.2%). PAL (40.9%) and PA (9.1%).

**Conclusion:** Our data indicate that there are significant changes in BO+SL and between NEE+SL, There is also a relationship among BO and insomnia.

### 0694
**NEUROBIOLOGICAL BASIS FOR INSOMNIA DISORDER: SMALLER WAKE-NREM SLEEP REDUCTIONS IN REGIONAL BRAIN GLUCOSE METABOLISM COMPARED TO GOOD SLEEPERS**
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**Introduction:** Early studies in small samples indicate that, compared to good sleepers, adults with insomnia have smaller differences in relative regional brain metabolism between wakefulness and NREM sleep. Smaller differences were observed in the brainstem, hypothalamus, thalamus, insular cortex, medial temporal lobe, and medial frontal cortex. This study aimed to replicate and extend these findings in a larger sample. In line with the hyperarousal model of insomnia, we predicted that patients with insomnia would have smaller wake-NREM differences in glucose metabolism within wake-promoting brain centers than good sleepers.

**Methods:** The study sample ($M = 38$ years old, range $21–60$) included 37 patients with insomnia and 31 good sleepers who underwent [18F] fluoro-2-deoxy-D-glucose positron emission tomography scans during morning wakefulness and NREM sleep. Groups were well-matched for age, sex, and racial identity. A flexible factorial design in SPM8 was conducted to investigate whether groups differed in relative decrease in metabolism during NREM sleep compared to wake. Seven a-priori
III. Insomnia

Regions of interest (ROIs) hypothesized to be associated with hypopausal arousal were selected. Cluster-wise extent thresholds for ROIs were computed using AlphaSim (voxel-wise, \( p < 0.05 \) uncorrected; cluster-wise, \( p < 0.05 \)). Exploratory whole-brain analyses were also conducted (voxel-wise, \( p < 0.05 \) uncorrected; cluster-wise, FWE-corrected).

**Results:** No significant group differences in wake-NREM change were detected in ROI analyses. Exploratory whole-brain analyses showed that patients with insomnia had smaller wake-NREM difference in relative glucose metabolism in a large cluster including the left frontoparietal cortex, left posterior thalamus, occipital regions, posterior cingulate, and precuneus (\( k = 27936, p < 0.001 \) corrected). Good sleepers did not have greater wake-NREM differences than patients with insomnia in any brain region.

**Conclusion:** Smaller wake-NREM differences in the posterior cingulate cortex and precuneus in patients with insomnia may be related to dysregulation of the default mode network. Insomnia may involve alterations in neural circuits underlying self-perception and awareness rather than alterations in primary sleep-wake centers.

**Support (If Any):** Supported by MH24652, MH61566, PSE00001, PMBC-HL65112, and T32 HL082610

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B. Clinical Sleep Science

**0695 REGIONAL GLUCOSE METABOLISM IN THE ANTENAL CINGULATE CORTEX AND INSULA CORRELATES WITH SUBJECTIVE-OBJECTIVE SLEEP DISCREPANCY IN PATIENTS WITH INSOMNIA**

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**Introduction:** Sleep discrepancy, the difference between objectively measured and self-reported sleep, is common in insomnia. We hypothesize that sleep discrepancy results from persistent activation of brain centers associated with conscious awareness during NREM sleep including the insula, anterior cingulate cortex (ACC), and precuneus, whose activation is not reflected in traditional polysomnographic (PSG) sleep measures. This study tested whether sleep discrepancy correlates with greater glucose metabolism in these regions during NREM sleep.

**Methods:** The study sample (\( M = 36 \) years old, range 27–50) included 20 patients with insomnia who underwent NREM sleep \(^{18}F\)fluorodeoxyglucose positron emission tomography scans. Sleep onset latency discrepancy (SOLd) on the night of the scan was calculated by subtracting PSG values from sleep diary self-reports the following morning. Three a priori regions of interest (ROIs) hypothesized to be associated with conscious awareness were examined: insula, ACC, and precuneus. SPM8 software was used to investigate whether relative glucose metabolism in these ROIs correlated with SOLd on the night of the scan (voxel-wise, \( p < 0.001 \) uncorrected). Cluster-wise extent thresholds for ROIs were computed using AlphaSim (\( p < 0.05 \)).

**Results:** Patients with greater sleep discrepancy (self-report SOLd > PSG SOL) had significantly greater relative glucose metabolism in the right insula (peak voxel xyz = 36−6 8, \( Z = 3.95, p = 0.018; k = 54, r^2 = 0.56 \)), left insula (peak voxel xyz = −28, 16, −10, \( Z = 3.71, p = 0.040; k = 46, r^2 = 0.47 \)), and left ACC (peak voxel xyz = −6, 28, 28, \( Z = 4.02, p = 0.010; k = 90, r^2 = 0.59 \)) during NREM sleep (all clusters \( p < 0.05 \) corrected). Sleep discrepancy was not associated with lower relative glucose metabolism in any ROI.

**Conclusion:** Heightened activation of the insula and ACC during NREM sleep may contribute to continued conscious awareness. Although traditionally disregarded as misperception or measurement error, sleep discrepancy may represent a regionally-specific dysregulation of brain activity that is not captured by PSG. Future studies should address the consequences of this regionalized sleep disturbance on cognitive and affective functioning.

**Support (If Any):** Supported by MH24652, MH61566, PSE00001, PMBC-HL65112, and T32 HL082610

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**0696 SLEEP IN MILITARY COUPLES DURING AND AFTER DEPLOYMENT: A PRELIMINARY QUALITATIVE STUDY**

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**Introduction:** Sleep is a social behavior. In co-sleeping couples, the sleep disturbances of an individual can affect sleep in the bed partner and the couple’s relationship functioning. Post-9/11 military veterans are at higher risk of sleep disturbances, but the impacts on their bed partners are unknown. In this study, we created a qualitative interview to explore sleep before, during and after deployment in military couples.

**Methods:** Participants were seven heterosexual military couples. Males were deployed in support of Operation Enduring Freedom or Operation Iraqi Freedom for a segment of the relationship. All participants individually completed a semi-structured, audio-recorded interview focused on preparation, challenges, coping and sleep before, during and after deployment. Fifty-two common themes were identified and synthesized into 14 categories, including responses pertaining to the nighttime presence of the bed partner.

**Results:** Mean age was 30.2 (s.d. = 4.5) for veterans and 30.0 (s.d. = 4.7) years old for partners. The length of interviews did not differ between veterans and partners (means 1355.29 words + 1029.26 vs. 1607.86 + 424.95 words, respectively). Veterans didn’t endorse difficulty sleeping during deployment. However, partners frequently endorsed sleep difficulty during deployment as a result of the separation. Partners also identified coping strategies to mitigate these effects. Personal connection and intimacy with the bed partner played a large role in how partners readjusted to the presence of the veteran after deployment.

**Conclusion:** These preliminary findings using qualitative research methods suggest that military deployment can significantly impact sleep in military couples. Given that partners are critical to veterans’ successful readjustment, enhancing sleep health before, during, and after deployment may be important in resilience and readiness.

**Support (If Any):** HL112646 (PI: Wendy M. Troxel, Ph.D.)

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**0697 SOCIAL DEPRIVATION AND SLEEP SYMPTOMS IN TWINS**

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**Introduction:** The Singh Index (SI) is a composite, area-level measure of social deprivation. We sought to investigate the relationship between insomnia symptoms and sleepiness and the SI in a genetically informative twin sample.

**Methods:** Insomnia symptoms were ascertained by the Women’s Health Initiative Insomnia Rating Scale (WHIIRS). Sleepiness was determined by the Epworth Sleepiness Scale (ESS). The SI was constructed from 17 census-based socioeconomic measures. Higher SI, WHIIRS, and ESS scores indicate greater social deprivation, insomnia symptoms, and sleepiness respectively. Structural equation mod-
els established the genetic and environmental contributions to SI, WHIIRS and ESS. Biometric regression assessed the non-shared environmental effect of social deprivation in twins on insomnia symptoms and sleepiness—considered a “quasi-causal” effect since genetic and shared environmental effects are fully accounted for in the twin model.

**Results:** Participants were 4,349 twin pairs [2,394 monozygotic pairs, 1,955 dizygotic pairs], 65% female, with mean age 40.7 years (SD = 17.3) from the University of Washington Twin Registry. Mean WHIIRS was 11.6 (SD = 4.5), ESS 5.5 (SD = 3.6) and SI −0.002 (SD = 0.871). The heritability of WHIIRS was 35%, ESS 38%, and SI 31%. The phenotypic regression showed insomnia symptoms and sleepiness were positively associated with social deprivation as each additional unit of SI was associated with a 0.037 increase in the latent WHIIRS construct (p < 0.001) and a 0.024 unit increase in the latent ESS construct (p < 0.05). A “quasi-causal” effect was not observed for WHIIRS (βQC = 0.050, p = 0.091) or ESS (βQC = −0.025, p = 0.242).

**Conclusion:** The Singh index was associated with insomnia symptoms and sleepiness across all twins but not within twin pairs. This indicates the association is driven by familial factors such as genetics and common environment that are not shared between twin pairs.

**Support (If Any):** This work was supported by NIH grants R01AG042176, K23HL083350, P30NR011400, OD006547, and a University of Washington General Clinical Research Center Pilot Grant.

**0698**
**MAPPING ILLNESS TRAJECTORIES IN PATIENTS WITH INSOMNIA: COMPARISONS BETWEEN A CLINIC AND COMMUNITY PATIENT POPULATION**

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**Introduction:** Patients with insomnia tend to delay medical care while actively seeking alternative self-help options. These options do not necessarily resolve insomnia and persisting daytime symptoms eventually motivate individuals to seek varying levels of care from mainstream health practitioners. How patients integrate lay and professional opinions about managing insomnia are important for delivering targeted care but remain an unknown phenomenon. The aim of this study was to map the upstream patient illness trajectories between a specialist clinic and general community population in urban Australia.

**Methods:** In-depth semi-structured interviews were conducted with 51 insomnia patients from specialist sleep/psychology clinics (n = 23) and general community settings (n = 28). The interviews explored patients’ illness and help-seeking experiences and were subsequently transcribed verbatim. Analysis was informed by critical interpretative phenomenology to identify emergent themes.

**Results:** Initial periods of sleeplessness were perceived by both patient groups as an expected outcome within their biographical timeline. Ongoing sleeplessness and daytime fatigue led participants to rethink their physiological and psychosocial biography. This appeared to be an important process for medicalizing sleeplessness to insomnia. We observed deficits in similar psychosocial domains (e.g. career and social) across both patient groups. However, clinic patients held less rigid sleep beliefs and had greater acceptance of an altered sleep physiology. All participants iteratively drew on their social environment (e.g. television, radio, print media, Internet and family and friends) for treatment options and resources. This spectrum of information sources influenced subsequent help-seeking behaviors such as self-medication and consulting alternative and/or mainstream health practitioners. Clinic access was rarely initiated by primary care doctors but discovered by patients within their social environment.

**Conclusion:** This study compared the illness trajectories between a specialist clinic and general community patient population. Sleep clinic access was contingent on the resourcefulness of an individual’s social environment. Integrating abbreviated forms of psychotherapy into primary care and the patients’ social environment represents important steps for promoting timely treatment access and optimizing insomnia management.

**Support (If Any):** J Cheung is the recipient of an Australian Postgraduate Award (APA) scholarship and has received seed funding to conduct part of this research from the National Health and Medical Research Council (NHMRC) Centre for Integrated Research and Understanding of Sleep (CIRUS).

**0699**
**THE ASSOCIATION BETWEEN PERFECTIONISM AND POLYSOMNOGRAPHICALLY DETERMINED SLEEP PARAMETERS**

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**Introduction:** Increased levels of maladaptive perfectionism have been suggested to contribute to the development and maintenance of insomnia. However, the association between perfectionism and objectively determined sleep parameters has not been investigated up to now. In the present study, we used the Frost Multidimensional Perfectionism Scale (FMPS) and polysomnography (PSG) to fill this void.

**Methods:** The FMPS was used to assess perfectionism in 380 consecutive clinical patients (223 women, 157 men; 44.6 ± 15.5 years) of the sleep laboratory of the Department of Psychiatry and Psychotherapy, University of Freiburg Medical Center. All participants underwent 2 consecutive nights of PSG sleep monitoring. Sleep recordings were evaluated for the following parameters: total sleep time (TST), sleep-onset latency (SOL), wake after sleep onset (WASO), number of awakenings (NOA), arousal index per h, amounts of stage 1,2, slow wave sleep (SWS), and rapid eye movement (REM) sleep as percentage of sleep period time. Age- and gender-controlled univariate linear regression analyses were conducted to evaluate the association between FMPS scores (independent variable) and polysomnographic parameters (dependent variables).

**Results:** The total FMPS score was significantly associated with several sleep continuity parameters of the first sleep laboratory night (TST: t = −2.22, p = 0.027; WASO: t = 2.00, p = 0.046; NOA: t = 3.77, p < 0.001; REM %: t = −2.72, p = 0.007). These relationships were mainly driven by the concern over mistakes and personal standards subscales of the FMPS. With respect to the second sleep laboratory night, there were only significant associations between concern over mistakes and the arousal index (t = 2.05, p = 0.040) as well as between doubts about actions and the arousal index (t = 2.11, p = 0.036).

**Conclusion:** These findings further support the hypothesis that perfectionism is associated with sleep continuity disturbances. Future work should aim at elucidating the association between this trait and objectively determined sleep parameters using longitudinal designs.
III. Insomnia

0700
GENOME-WIDE ASSOCIATION ANALYSIS OF THE PITTSBURGH SLEEP QUALITY INDEX REVEALS NOVEL SUGGESTIVE GENOMIC REGIONS IN THE BRAZILIAN POPULATION
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Introduction: Deficient sleep quality is a highly prevalent condition associated with sleep disorders such as insomnia, and other comorbidities. The pathophysiology of sleep disturbances that might lead to poor sleep quality could be benefited by understanding its genetic basis. However, due to the heterogeneous characterization of sleep related phenotypes across different studies, the investigation of the genetic component of sleep quality becomes difficult to accomplish. The Pittsburgh Sleep Quality Index (PSQI) has been widely used as a measure of sleep quality and it offers an interesting standardized phenotype for Genome-Wide Association Studies (GWAS) of sleep related traits.

Methods: We conducted a GWAS of the total PSQI score in the population-based cohort from the Sao Paulo Episodic Sleep Study (EPISONO) by genotyping ~700,000 single nucleotide polymorphisms (SNPs) in 948 individuals. Mixed-linear model was used to verify association between SNPs and the PSQI total score while accounting for variation in allele frequencies due to population stratification.

Results: We found suggestive significant association hits (p < 10e-5) in SNPs within 2p, 2q, 6q, 9q, 16q and 21q regions, after adjustments for age, gender, depressive symptoms, body mass index and use of medications that influences sleep. Also, we found that common SNPs were able to explain a relevant proportion of variation in PSQI score when the whole sample was investigated.

Conclusion: This study potentially identified novel candidates on the genetics of subjective sleep quality and suggests that common genetic variation might explain a significant proportion of variability in sleep quality.

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0701
QUALITATIVE STUDIES ON INSOMNIA: A SYSTEMATIC REVIEW
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Introduction: Despite its high prevalence and burden, insomnia is often trivialized, under-diagnosed, and under-treated in practice. Little information is available on the subjective experience and perceived consequences of insomnia, help-seeking behaviors, and treatment preferences. The use of qualitative approaches may help gain a better understanding of this sleep disorder. This paper summarizes the current state of knowledge on the nature of insomnia and its treatment options based on studies using qualitative or mixed methods research.

Methods: A systematic review of the literature was conducted using PsycINFO and Medline databases. Selected articles were categorized according to their main focus: “Experience of insomnia”, “Insomnia assessment”, “Management of insomnia”, “Use of prescribed sleep aids”.

Results: The main findings derived from 29 insomnia studies using qualitative and mixed methods research indicate that: 1) insomnia is often experienced as a 24-hour burden and perceived to affect several domains of one’s life, 2) a sense of frustration and misunderstanding is very common among patients, which is possibly due to a mismatch between patients’ and health care professionals’ perspectives on insomnia and its treatment, 3) health care professionals pay more attention to sleep hygiene and medication therapies and less to the patient’s subjective experience of insomnia, and 4) health professionals are often unaware of non-pharmacological interventions other than sleep hygiene education (i.e., cognitive behavioral therapies).

Conclusion: The main implication is that new clinical measures and more targeted treatments taking into account the patient’s experience of insomnia are needed. Greater use of qualitative approaches in future research may produce novel and more contextualized information leading to a broader and more in-depth understanding of insomnia.

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0702
REM SLEEP DREAM IMAGERY ACTIVITY AS A POTENTIAL REFLECTION OF HYPERAROUSAL IN INSOMNIA SUFFERERS
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Introduction: Dream imagery activity has been seldom studied in insomnia, especially in laboratory settings. Therefore, the main objective was to determine if dream recall frequency (DRF), and dream content could be reflecting the hyperarousal observed in insomnia. This was achieved using in-lab dream collection to compare DRF and dream content of insomnia sufferers (INS) with those of good sleepers (GS).

Methods: Twelve INS (Mean age = 37.5, SD = 4.3) and 12 GS (Mean age = 37.3, SD = 4.7) underwent 5 consecutive PSG nights where nights 1, 3 and 5 occurred in the lab and nights 2 and 4 at home. REM sleep awakenings were triggered during nights 3 and 5 (in lab) for dream collections. Dreams were analysed for positive and negative components using the HVDC scales, and dreamer self-evaluations.

Results: Groups were similar on DRF (p = 0.23). As expected, GS’ dreams tended to include more positive emotions (p = 0.06) and INS’ dreams were characterized by a greater ratio of negative elements than positive ones (p = 0.001). Subjectively, GS characterized their dreams as being more pleasant and containing more joy, happiness and vividness (p ≤ 0.03) than INS. Finally, elevated negative dream contents were positively correlated to low objective sleep efficiencies in INS (p = 0.004).

Conclusion: The absence of difference in DRF may be due to the in lab forced REM awakening procedure. Low amounts of positive emotions, high ratios of negative elements and subjective negative evaluation of dreams of INS is consistent with previous observations of home dream collections and dream questionnaires in INS. It may reflect their heightened arousal and could be related to their sleep maintenance difficulties as the observed positive correlation between negative dream elements and low sleep efficiency suggests. Future prospective studies should further determine if this negative experience of dream in INS potentially exacerbates their negative sleep assessment and insomnia condition.

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HOW INDIVIDUALS WITH INSOMNIA VIEW THEIR OWN AND OTHERS FACES: AN EYE-TRACKING STUDY

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Introduction: Previous research has demonstrated that individuals with insomnia perceive their own facial appearance as more tired in comparison to others. Furthermore, facial perceptions of tiredness have been shown to rely on preferential attention towards the eyes. The present study aimed to objectively explore whether individuals with insomnia differentially observe their own and others faces relative to normal-sleepers and more specifically whether people with insomnia display a self-specific or general attentional bias towards the eye-region.

Methods: Twenty participants who met the DSM-V criteria for insomnia (85% female, mean age 21.30 ± 3.91) and 20 normal-sleepers (75% female, mean age 24.50 ± 7.08) viewed 48 neutral facial photographs (24 of themselves, 24 of another) each for periods of 4000 msec. Three interest-regions, examined for overall gaze duration (eyes, nose, mouth) were compared both between, and within groups.

Results: A mixed ANOVA demonstrated that Individuals with insomnia observed all three interest-regions for longer compared to normal-sleepers, F(1,38) = 4.03, p = 0.05. Further, a group x region interaction confirmed that those with insomnia spent more time looking at the eyes, and less time at the nose and mouth compared to normal-sleepers F(2,76) = 5.64, p = 0.01. Although all participants attended to their own eyes for longer than others, F(1,50) = 27.00, p = 0.01, no group x face (self vs. other) interaction was apparent, p > 0.05.

Conclusion: The present study showed that individuals with insomnia display preferential attention towards the eye-region whilst viewing faces in general compared to normal-sleepers. Additionally, such attention was evident whilst viewing both their own and others’ faces, suggesting insomnia is characterized by a general, rather than self-specific, bias of attention towards eyes. Additional research should explore whether such attention may be indicative of evaluations of tiredness. The current findings contribute to understanding face perception in insomnia, highlighting potential importance of the eye-region for the perception of tiredness in insomnia.

B. Clinical Sleep Science

III. Insomnia

0705

DOES ACCULTURATION PREDICT INSOMNIA SEVERITY IN PREGNANT WOMEN ENROLLED IN A STUDY OF CBT FOR INSOMNIA?

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Introduction: Acculturation in the U.S. is associated with poor health outcomes, yet relatively little is understood about its role in sleep, specifically among pregnant women. One previous study among pregnant Latinas found that those who chose to complete study measures in English, a proxy for acculturation, had higher insomnia severity. The current study aimed to examine if acculturation, measured using a validated scale, predicted insomnia severity among pregnant women with insomnia disorder.

Methods: Pregnant women with insomnia disorder (gestational ages 18–32 weeks) were enrolled in a treatment study of cognitive behavioral therapy for insomnia (CBTI). Eligible women who met DSM-5 criteria for insomnia disorder and had no co-morbid affective or sleep disorders were recruited from community obstetric clinics. At baseline, participants completed the Acculturation Rating Scale for Mexican Americans-II (ARSMA-II) and the Insomnia Severity Index (ISI) among other measures.

Results: Twenty one of 39 women (mean age 32.9 ± 4.9 years; mean gestational age 24 weeks ± 4.5 weeks) self-identified as having been born and raised in a non-Anglo culture. Of these women, 48% were Latina. The ISI average score was 18.2 ± 4.1. A multiple regression model that included the two ARSMA-II subscales, Anglo Orientation Scale (AOS) and Culture of Origin Orientation Scale (COS), explained a significant amount of variance in ISI scores [p < 0.05, R² Adjusted = 0.24]. AOS significantly predicted ISI scores (Beta = 0.62, p = 0.01) but COS did not (p = 0.08).

Conclusion: These preliminary findings suggest that, among pregnant women with insomnia disorder, greater cultural orientation toward the Anglo culture is associated with more severe insomnia severity, but greater cultural orientation toward the culture of origin is not. Future research is needed to better understand mechanisms underlying the observed relationship between acculturation and insomnia and the clinical relevance of acculturation in terms of response to CBTI.

Support (If Any): R01 NR013662
III. Insomnia

Howell EE

PERCEIVED SOCIAL SUPPORT BUFFERS THE NEGATIVE EFFECT OF LOW INCOME ON PERINATAL INSOMNIA
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Introduction: Research has identified low income as a risk for insomnia. Additionally, greater perceived social support is associated with better mental and physical health outcomes. We examined the possibility that social support may moderate the relationship between low income and insomnia symptoms among pregnant women with insomnia disorder (ID).

Methods: Thirty-nine women, 17 to 34 weeks pregnant (M = 25.56, SD = 5.25), who met DSM-5 criteria for ID, with no co-morbid depressive, anxiety, or sleep disorders, enrolled in a treatment study of perinatal insomnia. At baseline, participants reported total family income, and completed the Edinburgh Postnatal Depression Scale (EPDS), the Multidimensional Scale of Perceived Social Support (MSPSS), and one week of sleep diaries.

Results: Regression analyses were conducted to test the hypotheses that perceived social support moderates the association between income and mean self-reported sleep onset latency (SOL), wakefulness after sleep onset (WASO), and early morning awakening (EMA), while controlling for age, gestational week, and depressive symptoms. Lower income (β = −0.29, t = −2.83, p = 0.009) and lower perceived social support (β = −0.78, t = −2.71, p = 0.012) were both associated with longer SOL, but not with WASO or EMA. The interaction between income and perceived social support was also a significant predictor of SOL (β = 2.08, t = 2.30, p = 0.031).

Conclusion: This study is the first to document that social support may play an important role in the sleep of pregnant women with ID. Specifically, in this sample of treatment-seeking pregnant women with ID, perceived social support buffered the negative effect of low income on SOL, such that income was not associated with SOL among women with high levels of perceived social support. Our findings suggest that social support may serve as a protective factor for ID symptoms, especially among women of low SES.

0707
IMPACT OF A MULTICOMPONENT HOSPITAL SLEEP INTERVENTION ON POST-DISCHARGE INSOMNIA SYMPTOMS
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Introduction: Poor sleep is associated with poor health outcomes and is common during hospitalizations and few studies have assessed interventions for improvement. Authors designed a multicomponent sleep intervention and assessed implementation, inpatient sleep, 30-day post-discharge sleep, length of stay (LOS) and 30-day all-cause readmission rates.

Methods: A prospective two arm randomized trial design with baseline and 30-day follow-up assessment. Participants completed measures of depression (CES-D), global sleep disturbance (PSQI), daytime sleepiness (ESS), and insomnia symptoms (ISI). Throughout hospitalization, data was collected using self-report sleep diaries and actigraphy. Authors used a mixed, between-within subjects ANOVA to test intervention effects, controlling for baseline differences between control and intervention arms on sleep latency (SOL) and wake after sleep onset (WASO).

Results: Ninety-seven patients completed the study (mean age: 56.7 (± 16.3); 58% female; mean BMI: 32.3 (± 9.6)), 40% in the intervention group. At baseline, the intervention group self-reported 34 minutes longer SOL relative to controls, p-value 0.007. During hospitalization intervention patients had more fragmented sleep with 32 minutes longer WASO than control, p-value 0.04 by actigraphy. More control subjects used sleep medications prior to admission, (34% vs 10%, p-value 0.014), differences were treated as covariates. Subjects did not differ by LOS or other baseline measures. Mixed-between-within subjects ANOVA showed significant interaction effect between treatment group and time [Wilks Lambda = 0.89, F(1, 46) = 5.91, p = 0.02, partial eta squared = 0.11 demonstrating statistically significant difference in insomnia at 30 days as a function of inpatient intervention.

Conclusion: Sleep is vital for recovery. Poor sleep during hospitalization could be a modifiable risk factor. This study demonstrates feasibility in delivering a multicomponent inpatient sleep intervention with ameliorations in several clinically relevant outcomes, particularly after discharge. Greater attention to hospitalized patient sleep should be a priority.

0708
NOCTURIA AND THE EXPERIENCE OF INSOMNIA
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Introduction: Elderly individuals frequently report nocturia (waking at night one or more times to void their bladder). However, nocturia’s impact on insomnia is not well studied. Here we distinguish the different manifestations of nocturia and examine if these are linked with different sleep profiles.

Methods: Thirty-four community-dwelling applicants (69.5 ± 6.70 years, 25 = women ) for a study of Cognitive-Behavioral Treatments for Insomnia completed sleep diaries (1 week) and polysomnography (1 night). Participants were screened to have < 4 nocturnal voids, and completed the American Urological Association 8 (AUA8) and Insomnia Severity Index (ISI). Participants were divided into three groups: 1) nocturia waking because of an urge to void (Urge), 2) nocturia because they were already awake (Non-Urge), 3) < 1 nocturnal voiding per night (No-Nocturia). GLM with post hoc Tukey were used to examine group-level differences.

Results: The number of awakenings per night with an urge to void was positively correlated with the AUA8 total score (r = 0.6745), while voids without a waking urge were not. There were differences among the groups in the ISI, sleep diary wake after sleep onset and sleep efficiency (all p < 0.05), but no difference on PSG measures. Post hoc analyses indicated that the No-Nocturia group had less insomnia symptomatology than the two nocturia groups, which did not differ from one another. Total awakenings were not different among the three groups (p = 0.1327).

Conclusion: Although waking with an urge to void correlated with more urinary symptoms, the Urge group was not different from the Non-Urge group regarding sleep. However, nocturia from either cause did negatively affect an individual’s experience of sleep. These results cannot be explained by a greater number of awakenings in individuals with nocturia but may be related to the length of the awakenings. Nocturnal voiding appears to play a significant role in the experience of insomnia.
INSOMNIA IDENTITY AS A DETERMINANT OF DAYTIME IMPAIRMENT
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Introduction: The adverse effects of insomnia on daytime functioning have long been established in the literature. However, little is known about the effects of insomnia identity on daytime functioning. The current research seeks to determine whether having the complaint of insomnia affects daytime functioning, regardless of meeting quantitative criteria for insomnia.

Methods: To determine the role of insomnia identity in daytime impairment, a series of one-way ANOVAs were conducted using an epidemiological database collected by Lichstein and colleagues (2004). The database sample included 761 randomly selected adults from 20 to 98 years of age. Participants completed two weeks of sleep diaries in addition to the Beck Depression Inventory (BDI), State Trait Anxiety Inventory (STAI), and the Insomnia Impact Scale (IIS). 137 participants had insomnia and identified themselves as such, 76 participants satisfied the quantitative criteria for insomnia but did not have an insomnia complaint, and 120 participants complained of insomnia but did not satisfy the quantitative criteria for insomnia. One-way ANOVAs compared insomniacs, complaining good sleepers, and non-complaining poor sleepers on the BDI, STAI, and IIS.

Results: The BDI, STAI, and IIS scores of insomniacs were not significantly different from those of complaining good sleepers. The BDI scores of insomniacs were significantly higher than those of non-complaining poor sleepers, F(1,255) = 34.9, p < 0.001; STAI scores of insomniacs were significantly higher than those of non-complaining poor sleepers, F(1,255) = 56.2, p < 0.001; and IIS scores of insomniacs were significantly higher than those of non-complaining good sleepers, F(1,255) = 25.6, p < 0.001. Post-hoc group comparisons were conducted with Tukey set at p < 0.05.

Conclusion: Complaining good sleepers were indistinguishable from insomniacs on measures of daytime impairment, and non-complaining poor sleepers reported significantly less daytime impairment than insomniacs. As such, the complaint of insomnia, rather than meeting quantitative criteria for insomnia, seems to determine daytime impairment as measured by the BDI, STAI, and IIS.

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0710
RESTLESS LEGS SYNDROME IS ASSOCIATED WITH SUBSEQUENT DEVELOPMENT OF STROKE: A PROSPECTIVE STUDY OF THE NURSES HEALTH STUDY II COHORT

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Introduction: Restless legs syndrome (RLS) has been shown to be associated with several risk factors for stroke, such as obesity, hypertension, and autonomic dysfunction. We thus hypothesize that RLS—especially RLS of greater severity—is associated with subsequent development of stroke.

Methods: The current analysis included 72,916 female registered nurses ages 41–58 years in 2005, free of diabetes, stroke, and pregnancy at the baseline. Information on RLS was collected via a questionnaire which was based on International RLS Study Group criteria. The primary outcome was diagnosis of stroke (ischemic, hemorrhagic or unknown etiology). We calculated hazard ratio and 95% confidence intervals (CIs) for stroke incidence for each RLS group using Cox proportional hazard models, adjusting for potential confounders, such as age, BMI, smoking, diet, alcohol, menopause status, iron supplement use, family history of stroke, hypertension, hypercholesterolemia and sleep.

Results: During 6 years of follow-up, we documented 161 incident stroke cases. In the multivariate adjusted model, RLS severity is associated with increased risk of stroke compared to participants with no RLS, adjusted hazard ratio of stroke in participants with RLS 5–14 times per month was 1.37 (0.72–2.62, 95% CI) and participants with RLS over 15 times per month was 2.07 (1.13–3.77) (p-trend = 0.01). The association was particularly strong for ischemic stroke alone (adjusted HR = 3.52 comparing two extreme RLS categories; p-trend = 0.01). The similar association between RLS symptom severity and stroke was observed with exclusion of individuals with cancer, myocardial infarction, arthritis, or those with stroke onset during the first two years of follow-up.

Conclusion: We demonstrate in this prospective study that increased RLS severity is associated with subsequent increased risk of stroke. Appropriate management of cardiovascular risk factors for primary prevention of stroke is indicated for patients with RLS.

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0711
PREVALENCE OF RAPID EYE MOVEMENT SLEEP BEHAVIOR DISORDER: A POPULATION-BASED STUDY

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Introduction: Rapid eye movement sleep behavior disorder (RBD), characterized by dream enactment due to REM without atonia, is reported to predominantly affect elderly male and precede neurodegenerative diseases. Previously only a few studies reported the prevalence as 0.4–2.0% and mainly in the elderly population. Considering the long latency between the onset of pathologic process and the clinical manifestation of neurodegenerative disease, and the long interval between the onset of RBD and neurodegenerative diseases, the epidemiologic study in the middle adulthood is strongly indicated. The purpose of this study is to investigate the prevalence of RBD in middle adulthood.

Methods: This was a cross-sectional analysis from the ongoing prospective cohort study, the Korean Genome and Epidemiology Study (KoGES). We included 2,868 adults (male 49.27%, range 49–80 years, 59.3 ± 7.2) who participated in the KoGES evaluation, 2012–2013 were utilized in this study. All subjects were asked to fill out the RBD Screening Questionnaire, and probable RBD was defined when the score was ≥ 5. Sleep specialists confirmed the presence of clinical RBD by telephone interview of subjects with probable RBD.

Results: After screening, four hundred subjects (male 47.8%, 59.6 ± 7.2 years) were diagnosed as probable RBD. Among them, 396 subjects (male 44.9%, 59.5 ± 7.2 years) were interview. Forty eight subjects (male 50%, 50.1 ± 8.4 years) were diagnosed as clinical RBD. The prevalence was to be 1.67%. There was no gender difference, 1.70% in male and 1.65% in female (p < 0.001). Disease duration was 7.8 ± 5.1 years (range 1–20). Prevalence in the age group was 2.44% in 50–60 years old, 1.30% in 60–70, 5.97% in older than 70 years.

Conclusion: We presented the prevalence of clinical RBD from large-scale epidemiologic cohort in middle-to-late adulthood. There was no gender difference.

0712
PREVALENCE AND ITS TEMPORAL CHANGES OF RESTLESS LEGS SYNDROME DURING THE PREGNANCY IN CURRENT JAPAN

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Introduction: Restless legs syndrome (RLS) during pregnancy is relatively frequent but exists only few precise epidemiological report in current Japan, where treatment for anemia in pregnant women has been widely prevailed. Furthermore, the change in the prevalence of RLS symptoms according to the pregnancy term has not been clarified. Thus, we investigated prevalence and temporal changes of RLS during the pregnancy and measured some factors related to RLS.

Methods: We enrolled 71 second trimester pregnant women at local clinic and followed up 16 of them up to after their deliveries. The questionnaire to assess International Restless Legs Syndrome Rating Scale (IRLS), Epworth sleepiness Scale (ESS), and their anemia treatment were performed at the second trimester, the third trimester and one month after delivery. We also measured the levels of ferritin, vitamin B12 and folic acid at the second and the third trimesters.

Results: The prevalence of definite RLS was 7.0% and suspicious RLS was 16.9% in 71 pregnant women at the second trimester and, in 16 women whom we followed up to after delivery, the rate of definite RLS was 12.5%, 12.5% at the second and the third trimester and 0.0% at one month after delivery. At the second and the third trimester, 56.3% and 59.5% pregnant women were taking some medication or supplement for anemia. The folic acid level decreased from 8.1 ± 4.7 ng/mL to 5.5 ± 2.3 ng/mL during the second and the third trimester (p = 0.048). The ESS increased significantly toward the end of pregnancy (7.3 ± 3.4, 8.0 ± 4.6, 9.5 ± 5.2) but IRLS rather decreased during same period (6.3 ± 8.7, 3.1 ± 7.0, 1.3 ± 4.5).

Conclusion: The prevalence of RLS is high even in current Japan and decreased after delivery. The levels of ferritin, vitamin B12, and folic acid and daytime sleepiness did not relate to the change of the IRLS, meaning that sleepiness might be caused by other disease than RLS.

IV. RLS, Movement Disorders and Parasomnias
0713
RELATIONSHIP OF SLEEP DISORDERS AND BEHAVIORS TO SLEEP STARTS

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Introduction: Sleep starts, also known as hypnic jerks, hypnagogic jerks, or premonitional myoclonus, are sudden brief contractions of the legs, sometimes involving the arms and head, which may occur at sleep onset. There is little empirical evidence studying the consequences and correlates of sleep starts. The literature that does exist are mainly clinical reports.

Methods: Participants (n = 461, M = 34.3 years old, SD = 12.7; 71.7% male, 77% white) were recruited throughout the United States via the internet. Participants answered the Epworth Sleepiness Scale (ESS), Pittsburg Sleep Quality Index (PSQI), Insomnia Severity Index (ISI), Horne-Östberg Morningness-Eveningness Questionnaire (HOMEQ), Sleep Hygiene Index (SHI), and questions related to sleep starts querying behaviors that proceed, parallel, and follow sleep starts.

Results: Respondents indicated 77.7% had experienced sleep starts. 48% of those reported having sleep starts at least once a week and 4.5% reported that their sleep starts were so severe that they considered seeking help. The frequency of sleep starts were reported to be reduced if respondents slept in their own bed, drank alcohol before bed, or exercised before sleep. Those reporting sleep starts were more likely to endorse symptoms consistent with sleep movement disorders, hypnagogic hallucinations, sleep paralysis, and nightmares. Respondents reporting sleep starts were significantly more sleepy as measured by the ESS (p < 0.001), more likely to report symptoms of insomnia as measured by the ISI (p < 0.001), and exhibited poorer sleep hygiene as measured by the SHI (p < 0.001) than participants without sleep starts. There were no significant differences in PSQI (p = 0.272) or HOMEQ (p = 0.388).

Conclusion: Sleep starts are common and generally thought to be benign. However, here we found people with sleep starts were sleepier and had poorer sleep hygiene than those without sleep starts and that at least some have indicated a desire for help. Future research should explore possible relationships between sleep related movement disorders and sleep starts.

0714
THE REALITY OF SEXSOMNIA: CHARACTERISTICS AND MANIFESTATIONS OF SEXSOMNIA

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Introduction: Sexsomnia is an important albeit newly recognised parasomnia which can negatively impact on the well being of the sufferer and the bed partner and might also have medico-legal implications.

Methods: Observational case series study of individuals presenting to a tertiary referral Sleep Clinic from 2008–2014 with symptoms suggestive of sexsomnia identified by searching Electronic Patient Records for the terms Sexsomnia and Sleep Sex. Analysis medical history and a review of polysomnographic studies were carried out.

Results: 41 individuals were identified; 37 male and 4 female. The majority were married and White-British and the mode age was 32 (22–50 years). Manifestations of sexsomnia varied; females describing predominantly masturbation (n = 3), and males sexual intercourse or fondling/groping (n = 22). 11 cases reported violence or aggression and in one case there were forensic issues. Amnesia was reported by all

Conclusion: The reality of sexsomnia is no longer in doubt with an increasing number of self-referrals to the sleep centres. To our best knowledge this is the biggest case series describing the manifestations of sexsomnia.

0715
INDEPENDENT ASSOCIATIONS OF BOTH RLS AND PLMS WITH INCIDENT CARDIOVASCULAR EVENTS IN OLDER MEN: THE MROS SLEEP STUDY

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Redline S
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Introduction: Both RLS (restless legs syndrome) and PLMS (periodic leg movements in sleep) may be associated with incident cardiovascular disease (CVD). However, the individual contributions of these factors to adverse cardiovascular outcomes are unknown.

Methods: During the MrOS Sleep Study, 2,826 men (mean age 76.3 years) participated in a comprehensive sleep assessment from 2000–2002. RLS was identified by self-report of a physician diagnosis of RLS. PLMS were scored from unattended in-home polysomnography, presented as PLM per hour sleep (PLMI). Incident cardiovascular events were centrally adjudicated during 8.3 ± 2.3 years of follow-up. The primary outcome (CVD) was a composite event, which included coronary heart disease (CHD), cerebrovascular (CBV), congestive heart failure, peripheral vascular disease events, and other ‘definite’ unstable coronary artery syndromes. Secondary outcomes included incident myocardial infarction (MI), CBV, and CHD. Cox proportional hazards regression assessed the association between RLS and risk of incident CVD. Models were adjusted for age, clinic, BMI, alcohol use, smoking, depression, prevalent DM, physical activity, antidepressant and benzodiazepine use, and AHI. Models were further adjusted for PLMI to examine if there was an independent association of RLS and PLMI to the outcomes. Results are presented as hazard ratios (HR) with 95% confidence intervals (CI).

Results: Physician-diagnosed RLS was reported by 2.2% of the men, and 59.6% had PLMI ≥ 15. There were 812 CVD, 552 CHD, 250 CBV, and 197 MI events confirmed. RLS was not associated with the composite CVD outcome. RLS was significantly associated with incident MI (HR = 2.09, 95% CI, 1.08–4.06) after multivariate adjustment. Results were similar when PLMI was added to the model. PLMI was also associated with incident MI (per SD increase in PLMI, HR = 1.14, 95% CI, 1.00–1.31).

Conclusion: Both RLS and PLMS independently contribute to risk for myocardial infarction events.
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0716
CAUSES OF INSOMNIA IN CHILDREN WITH CEREBRAL PALSY
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Introduction: Sleep problems (SPs), mainly insomnia, in children with cerebral palsy (CP) are compounded by children’s complex multifaceted clinical presentations. We investigated the clinical presentation of SPs in children and adolescents with CP. Our focus was on insomnia caused by Willis-Ekbom Disease (WED).

Methods: 30 children/adolescents (age range 1y11m–16y; 18 males) were assessed clinically in two periods (2007–2011, 2012–2014); in the latter period, we integrated family sleep history and applied the concept of therapeutic emplotment (TE). TE uses narrative schema to analyze bedtime problems, night awakenings and challenging daytime behaviours. We shared reports with clients for quality control purposes. In addition, 10 patients received home-videosomnography (HVS).

Results: All patients presented with insomnia; 90% with sleep disordered breathing; 77% with possible WED symptoms; 30% with parasomnias; 56% with probable WED diagnosis in period one, and 100% with probable familial WED in period two. HVS captured total sleep period, efficiency and positions, restful/restless sleep, and individual characteristic “cascading movement patterns” (CMPs) of periodic limb movements in sleep (PLMs). The CMPs followed three specific stages: (1) brief twitches/shakes in fingers/hands/feet that initiate a bigger movement in one limb (periodic limb movements); (2) head turning, limb stretching, arm/leg lifting and/or face rubbing; and (3) generalized body movement, mainly a position change and elbow/knee flexing. Patients varied in initiation type of these CMPs; however, each patient tended to follow the same particular pattern several times in their restless period.

Conclusion: Insomnia, experienced by patients with CP, appears to be due to sleep disruptions caused by sleep disordered breathing and familial WED. Along with familial sleep history, TE allows parents to provide narratives associated with their child’s insomnia, to reveal important details. HVS supported the diagnostic approach to clinical WED experienced in children/adolescents with CP and revealed child specific CMPs caused by PLMs.

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0717
QUANTITATIVE ANALYSES OF REM SLEEP WITHOUT ATONIA IN PATIENTS WITH VOLTAGE GATED POTASSIUM CHANNEL ANTIBODY SYNDROME
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Introduction: Voltage-gated potassium channel antibody syndrome (VGKC-AS) is an autoimmune disorder with prominent neurological and sleep disturbances, including limbic encephalitis (LE) and REM sleep behavior disorder (RBD). We analyzed REM sleep without atonia (RSWA) in patients with VGKC positivity, with and without RBD.

Methods: We comparatively analyzed RSWA between VGKC-AS patients (n = 18) with (n = 7) and without (n = 11) RBD, age-matched controls, and RBD patients (n = 18) without VGKC-AS. Manual phasic, tonic, and “any” muscle activity percentages were compared in the submentalis (SM) and anterior tibialis (AT) muscles, and the automated REM atonia index (RAI) was calculated. Statistical analyses involving group comparisons and regression were then performed. Additional laboratory analyses for Lgi-1 (Leucine-rich, glioma inactivated 1, a potential metastasis suppressor) and Caspr-2 (Contactin-associated protein-like 2, a paranodal protein proximate to potassium channels) antibodies were also performed.

Results: Seven (39%) VGKC-AS patients had RBD, including 5 (71%) men. VGKC-AS patients had equivalently higher manual and automated RSWA, higher than controls but lower than RBD patients without VGKC-AS (p < 0.05). LE patients had higher phasic muscle activity in AT, adjusted for antidepressant use (p = 0.03). VGKC-RBD patients had higher tonic muscle activity than those without dream enactment behaviors (p = 0.03). Only 3/18 (17%) VGKC patients were Lgi-1 positive and all 18 were Caspr2 negative. No associations between Lgi-1 and RSWA were found.

Conclusion: VGKC patients had higher overall RSWA levels than controls, but lower than RBD patients without VGKC-AS. VGKC-RBD patients had higher tonic RSWA than VGKC-AS patients without dream enactment, and LE patients had higher overall and leg phasic RSWA than other VGKC-AS patients. This data aids prompt diagnosis of VGKC-RBD, enabling application of immunomodulatory treatment, which may help decrease dream enactment behaviors. Future prospective research is needed to analyze the impact of immunotherapy on VGKC-AS RSWA metrics and clinical outcomes.

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0718
NEW ONSET TEMPORAL LOBE EPILEPSY AND REM SLEEP BEHAVIOR DISORDER: FURTHER DEMONSTRATION OF A POSSIBLE ASSOCIATION?
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Introduction: There have been reports of a possible association between epilepsy and RBD, but no reports of a close temporal association in the onset of these disorders outside of a unifying symptomatic disorder.

Methods: Report of 3 cases of newly diagnosed TLE occurring in close temporal association with RBD from a tertiary sleep disorders and epilepsy center, with accompanying neurophysiologic data.
Results: Case 1 is a 64-year-old man with a 2-year history of nocturnal wandering, unresponsiveness, and convulsions, and daytime spells of loss of awareness, tonic stiffening, and confusion. For 1.5 years, he had also developed dream enactment behaviors with partial dream recall. One of his habitual focal dyscognitive seizures was witnessed in the office. Case 2 is a 68-year-old man with a single episode of loss of awareness while driving occurring one year ago. In the past few months, he had also developed dream enactment behaviors with vivid nightmares. Case 3 is an 80-year-old man with an 11-month history of nocturnal wandering and episodes of gurgling, chest heaving, and unresponsive wandering and episodes of gurgling, chest heaving, and unresponsive. During this period, he had also developed nocturnal vocalizations with falls out of bed. None had a history of anti-depressant exposure. Video-PSG with arm EMG and 16-channel EEG showed temporal epileptiform activity, abnormal automated REM atonia index (RA1), and higher manually scored submentalis phasic muscle activity in all cases. Normal brain MRI was noted in all cases, and normal paraneoplastic antibody panels in two cases.

Conclusion: In all cases, the onset of TLE and RBD occurred within a 12-month period, suggesting an association between the two conditions. The close temporal association has not been previously reported outside of a unifying symptomatic disorder such as a paraneoplastic/inflammatory etiology. A neurodegenerative or ischemic process may be the culprit, or TLE may invoke limbic network alterations that predispose to nightmares and downstream altered REM atonia mechanisms.

0719 QUANTIFICATION OF REM SLEEP WITHOUT ATONIA IN KOREAN REM SLEEP BEHAVIOR DISORDER PATIENTS: COMPARISON OF MANUAL AND COMPUTER-ASSISTED SCORING METHODS
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Introduction: The Polysomnographic (PSG) hallmark of REM sleep behavior disorder (RBD) is loss of muscle atonia during REM sleep; REM sleep without atonia (RSWA). However, the International Classification of Sleep Disorders, third edition (ICSD-3) criteria did not suggest optimized diagnostic value of RSWA and how to score muscle activity during REM sleep. Many previous studies have been tried to figure out the objective quantitative cut-off values of RSWA. We investigated RSWA in Korean RBD patients compared with normal control, to figure out it’s cut-off value in diagnosis of RBD, using both manual and computer-assisted scoring methods (REM atonia index, RAI).

Methods: We retrospectively analyzed PSG and clinical data of 40 patients, 10 age-matched controls by ICSD-3 criteria. The quantitative analysis of chin electromyography (EMG) density during REM sleep was done by both manual and computerized method. The RSWA and RAI were compared within two groups to figure out cut-off values for distinguishing two groups.

Results: In computerized method, the mean RAI of RBD patient was 0.66 [± 0.20, standard deviation (SD)], and 0.93 [± 0.38, SD, p < 0.001] in control group. Also, in manual method, RSWA were also significantly increased within RBD patient compared with normal controls. (tonic activity : 9.1 ± 10.3 vs 0.1 ± 0.2, phasic activity : 7.5 ± 6.4 vs 1.6 ± 1.2, p < 0.002)

Conclusion: We quantitatively figured out the characteristics of RSWA in Korean RBD patients and suggest that we may diagnose RBD who have RSWA more than 41% of total REM sleep duration and RAI than 0.84.

0720 EVALUATION OF AUTONOMIC NERVOUS ACTIVITY BY COMPLEX DEMODULATION METHOD FOR SUGGESTED IMMOBILIZATION TEST IN RLS
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Introduction: Despite the efforts of international experts of RLS to establish standard criteria, the clinical diagnosis of this condition remains, in several patients, difficult to make on the basis of the clinical evaluation solely. Suggested immobilization test (SIT) as auxiliary diagnosis method. The visual analog scale of patient’s discomfort is more sensitive than the number of Periodic Leg Movements during SIT. To overcome above problems, we evaluated the autonomic nervous activity by Complex Demodulation Method (CDM).

Methods: The acquisitioned datters were analyzed by CDM and Density Spectrum Array (DSA). CDM is a type of the time domain analysis, which has used for forty years, calculates the momentary amplitudes by assigning the voluntary spectrums. It is the same principle of the radio techniques to demodulate complex products (A type of the frequency shift). Evaluated autonomic activity [eg, high frequency (HF)] of RLS, normal, and insomnia groups during SIT separated into three segments (T1, T2, T3).

Results: % HF of definite RLS group was significantly lower than normal group in only T3 (23.0 ± 20.8 vs 54.9 ± 26.7%, p < 0.01). % HF in 3rd trisection of 35.0 was found to correctly classify 85.3% of RLS patients and control subjects, with sensitivity of 84.2% and specificity of 86.7%.

Conclusion: This study showed that % HF was decreasing with time dependability as the characteristic trend of autonomic activity of RLS patients. CD-DSA method may supplement the objectivity of VAS in SIT, be available for distinguish true RLS and “mimics”.

0721 GENDER AND STIGMA ISSUES IN THE TREATMENT OF PATIENTS WITH RESTLESS LEGS SYNDROME: SEXUALITY AND CARE
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Introduction: Restless legs syndrome (RLS) is a neurological disorder characterized by an irresistible and unpleasant urge to move one’s legs. Sleep and quality of life are affected in patients with RLS. The aim of this study is to investigate the understanding and management of this disease, with a view to sociocultural dimensions, particularly those related to gender and sexuality, by analyzing the treatment and care of a group of patients with RLS in São Paulo, Brazil.

Methods: Semi structured interviews were conducted with fifteen patients (10 women aged 26–78 years and 5 men aged 29–71 years) with a confirmed diagnosis of RLS at the Neuro-Sono Outpatient Clinic, Universidade Federal de São Paulo (Brazil). Interviews were transcribed and a thematic content analysis was performed.

Results: We identified two major categories for the management of issues of sexuality in these patients: Body-Movement and The gaze of others. The discourse of female RLS patients was characterized by reports of harassment and stigma. These aspects are inextricably linked to the manner in which women’s bodies are represented and treated by our society, with attempts at submission and control, despite the achievements of women in the last century. The sexual dimension colors the gaze of others upon women with RLS, with major implications for care: the sexual connotations ascribed to RLS shift the other’s gaze.
IV. RLS, Movement Disorders and Parasomnias

0722
TOPOGRAPHY OF SYMPTOMS IN RESTLESS LEGS SYNDROME (RLS): A PILOT STUDY
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Introduction: RLS is characterized by an irresistible and unpleasant urge to move the legs while resting. Although the accepted diagnostic criteria describe the symptoms as confined mainly to the legs, in clinical practice an amount of patients report symptoms also in the upper limbs. Our aim was therefore to describe the topography and symmetry of RLS symptoms, and to identify the relationship between localization and clinical variables.

Methods: 146 RLS patients were studied. Information including the localization of symptoms, age-at-onset, ferritin values and symptoms severity were collected. The RLS topography patterns were classified according to localization in upper limbs (UL), lower limbs (LL) or both, and lateralization.

Results: Bilateral and symmetric lower limbs (LL) location was the most common (74.7%), while 4.1% of participants exhibited asymmetric lower limbs localization. Only one patient (0.7%) showed symptoms confined to the upper limbs (UL), symmetrically. Four limbs symmetrical involvement was found in 17.8% of patients; symptoms were located asymmetrically at the four limbs in 2.7%. The severity of RLS was similar across the patients, independently of the localization of symptoms. Conversely, lower ferritin values were found in patients with symptoms located at the lower limbs. Patients with asymmetric symptoms had a younger age-at-onset than the others; nevertheless, the numerosity of the two samples was skewed, therefore an extended sample is needed to assess the statistical significance.

Conclusion: RLS symptoms typically were symmetrically located in the lower extremities. LL patients had higher ferritin values, while patients with a younger age-at-onset showed more asymmetric distribution compared with older patients. A larger sample of patients is needed in order to ascertain the significance of this finding.

0723
DEFINING THE PHENOTYPE OF RESTLESS LEGS SYNDROME (RLS) : A CLINICAL AND POLYSOMNOGRAPHIC STUDY
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Introduction: RLS often has a familial component, and can be regarded as “idiopathic” or “secondary”. The clinical features of these forms has been previously investigated, with a younger age-at-onset in familial and idiopathic cases emerging. Notwithstanding, the results differ widely between different studies. Our aim was to determine the clinical and polysomnographic data in a large cohort of RLS patients.

Methods: 400 RLS patients were studied. Information including age-at-onset, comorbidities, familial history, time of symptoms onset, symptoms severity and the presence of impulse control and compulsive behaviours (ICBs) were obtained.

Results: Mean age-at-onset differed as a function of presence/absence of a familial history of RLS (40.44 years ± 16.43 vs. 49.03 years ± 15.33, p = 0.00). Clinical and polysomnographic characteristics were similar in both groups, except for WASO which was significantly longer in familial RLS (123.18 min ± 80.14 vs. 91.65 min ± 96.36, p = 0.019). No difference was found for the age-at-onset between idiopathic and secondary RLS (44.89 years ± 16.35 vs. 45.02 years ± 16.64, p = 0.94). PLM index was significantly higher in idiopathic RLS (145 ± 44.65 vs. 83 ± 31.91, p = 0.026). Time of onset of symptoms was in the evening or at bedtime in 28.04% and 37.80% of patients respectively, but in 21.34% of patients onset was > 1 h after sleep onset. ICBs were found in 23/173 RLS patients on dopamine agonist (DA) therapy. IRLS values correlated positively with the number of awakenings and with age.

Conclusion: Our analyses of age-at-onset support to some extent the hypothesis that RLS is divided into early and late onset disease, with a smaller difference than previously reported. A high percentage of patients showed a time of onset of symptoms after sleep onset. RLS patients treated with DA showed a higher risk of ICBs than previously reported.

0724
PERIODIC LIMB MOVEMENTS OF SLEEP: CLINICAL PREDICTORS AND DIAGNOSTIC DECISION MODELING
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Introduction: Elevated periodic limb movements of sleep (PLMS) has been associated with cardiovascular and cerebrovascular morbidity. However, most people with PLMS are either asymptomatic or have non-specific symptoms. Thus, predicting elevated PLMS in the absence of restless legs syndrome (RLS) represents a clinical challenge.

Methods: We undertook a retrospective analysis of demographic data, subjective symptoms, and objective polysomnogram (PSG) findings in a clinical cohort who underwent PSG in our laboratory (N = 443 with OSA, N = 209 without OSA). Correlation analysis and regression modeling were performed to determine predictors of PLMI as a continuous variable and as a binary category (using 15 as a cutoff). Markov decision analysis was performed using TreeAge software to compare strategies of in-lab PSG, home PLMS device, and clinical prediction tool based on the regression analysis.

Results: Elevated PLMI values (> 15) were observed in over 25% of patients undergoing diagnostic PSG. PLMI values in no-OSA patients correlated with age, sex, and self-reported nocturnal leg jerks, RLS symptoms, and hypertension. In OSA patients, PLMI correlated only with age and self-reported psychiatric medications. Regression models indicated only a modest predictive value of demographics, symptoms, and clinical history. Decision modeling revealed conditions under which home testing was favored compared to three alternative strategies of PSG, clinical prediction then PSG, and no testing, under a range of assumptions regarding morbidity and costs and effects of pharmacological therapy. In the setting of increased pre-test probability of PLMS, and reasonable assumptions of cost and accuracy of a home device, such testing was the preferred strategy.

Conclusion: Although elevated PLMI values were commonly observed, routinely acquired clinical information had only modest predictive utility. As the clinical importance of elevated PLMI continues to evolve, it is likely that objective measures such as PSG or home-
based limb-movement monitors will prove increasingly important tools to identify occult PLMS.

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0725
INDIVIDUALS WHO DO NOT HAVE PERIODIC LIMB MOVEMENT DISORDER BUT PERIODIC LIMB MOVEMENTS DURING SLEEP MAY HAVE SLEEP DISTURBANCE
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Introduction: Periodic limb movement disorder (PLMD), due to its daily variations, has been several debates on its clinical significance and diagnostic criteria. The current diagnostic criteria for PLMD in adults has been changed from PLMI > 5/hour in ICSD-2 to PLMI > 15/hour in ICSD-3. In this study, we aimed to investigate sleep structures in individuals who do not meet the new but old criteria for PLMD (5 < PLMI ≤ 15) compared to PLMD patients on new criteria (PLMI > 15).

Methods: Polysomnography of the 4,195 subjects were reviewed. Those diagnosed as OSA, CSA, RBD, chronic insomnia disorder, narcolepsy, or under 17 years old were excluded. Finally 666 patients were divided into three groups based on PLMI: group1 (PLMI ≤ 5), group2 (5 < PLMI ≤ 15) and group3 (PLMI > 15). Sleep Efficiency (SE), Wake after sleep onset time (WASO), Sleep latency (SL) and Epworth sleepiness scale (ESS) were compared among the three groups.

Results: There was significant difference between three groups in age (mean ± SD; group1, 40.9 ± 13.5 years; group2, 49.1 ± 13.4 years; group3, 57.4 ± 11.7 years, p < 0.001), and gender (%male; 63.6%, 46.8%, 45.1%, p < 0.001). Adjusting for age and gender, SE in group1 was significantly higher than those in group2 and 3 (85.6 ± 10.5% vs 80.7 ± 13.3% vs 78.4 ± 12.2%, p = 0.005). WASO in group1 was significantly less than those in group2 and 3 (58.6 ± 47.0 min vs 76.7 ± 57.0 min vs 89.4 ± 58.9 min, p = 0.015). However, there were no significant differences in SE and WASO between group2 and 3 (p = 0.225 and p = 0.217). SL and ESS score did not differ significantly among the three groups (22.7 ± 43.9 min vs 26.4 ± 44.0 min vs 38.9 ± 53.9 min and 10.0 ± 4.3 vs 8.9 ± 5.6 vs 5.5 ± 3.8, p = 0.096 and p = 0.813).

Conclusion: This study suggest that ICSD-3 criteria might not provide distinctive sleep quality from ICSD-2 for PLMD. In addition, we found ESS score might not be clinical characteristics for PLMD. To clarify diagnostic criteria and clinical significance of PLMD, further research will be needed.

0726
VALIDATION OF THE MAYO SLEEP QUESTIONNAIRE PATIENT VERSION IN A CLINICAL SLEEP MEDICINE PRACTICE
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Introduction: RBD is a parasomnia characterized by potentially injurious dream enactment behaviors (DEBs) and a loss of normal REM sleep atonia requiring polysomnography (PSG) for diagnosis. The MSQp was developed as an efficient and inexpensive screening tool for several sleep disorders including RBD, obstructive sleep apnea, and restless legs syndrome. Our objective was to determine the validity of the Mayo Sleep Questionnaire Patient Version (MSQp) as a screening instrument for REM sleep behavior disorder (RBD).

Methods: Patients completed the MSQp, along with a clinical interview and PSG. Chart review was carried out to confirm RBD diagnosis, PSG variables, and comorbidity and demographic data. Sensitivity and specificity analyses were performed using contingency tables for RBD diagnosis. Statistical significance was set at a < 0.05.

Results: Forty-seven patients (30 men, average age 52.8 ± 16.7 years) completed the MSQp and underwent PSG. Patients with RBD were older and had a higher frequency of smoking, depression, antidepressant use, nightmares, and presumed synucleinopathy diagnoses compared with non-RBD patients. The MSQp yielded a sensitivity of 100% and a specificity of 73% for RBD diagnosis with a positive predictive value of 50% and negative predictive value of 100%.

Conclusion: The MSQp is a sensitive and reasonably specific screening instrument useful for RBD diagnosis.

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0727
DECREASED INTERHEMISPHERIC AND INTRAHEMISPHERIC EEG COHERENCE IN PATIENTS WITH IDIOPATHIC REM SLEEP BEHAVIOR DISORDER
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Introduction: Idiopathic REM sleep behavior disorder (iRBD) is considered as a prodromal symptoms of synuclein-associated neurodegenerative disorders. Patients with iRBD are frequently associated with early signs of neurodegenerative changes. Quantitative electroencephalographic (EEG) study on waking and sleep state have revealed EEG slowing as manifesting a cortical dysfunction in patients with iRBD which could be an early marker for the development of mild cognitive impairment in patients with this disorder. Aberrant oscillatory activity and network connectivity represent a core feature of a wide range of neurological disorders such as Alzheimer’s dementia. However, it remains unclear how these neurobiological alterations change the functional connectivity between local and distant brain regions as well as the overall organization of large scale brain networks in iRBD.

Methods: Ten patients with iRBD (mean age, 71.2 ± 7.3 years old) and 5 healthy subjects (mean age, 70.5 ± 6.7 years old) as control were participated in the present study. Electroencephalographic recordings were performed during resting awake state. Global cognitive function was assessed with mini-mental status examination. The relative power of the discrete frequency band was obtained. interhemispheric and intrahemispheric spectral coherence were also calculated and compared between both groups.

Results: MMSE was not different between both groups. The relative spectral power of iRBD patients did not differ from control subjects. Interhemispheric delta coherence in central and parietal regions was significantly decreased in iRBD group. iRBD patients also showed decreased intrahemispheric coherence at delta frequency band in frontotemporal and frontoparietal regions.

Conclusion: Our study suggests that network connectivity is altered in patients with iRBD who have normal cognition.

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0728  
**QUANTITATIVE ANALYSES OF REM SLEEP WITHOUT ATONIA DISCRIMINATES BETWEEN MAJOR SYNUCLEINOPATHY PHENOTYPES OF PARKINSON DISEASE AND MULTIPLE SYSTEM ATROPHY**

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**Introduction:** REM sleep behavior disorder (RBD) is a core feature of synucleinopathies, especially Parkinson Disease (PD) and multiple system atrophy (MSA). The neurophysiologic substrate of RBD is REM sleep without atonia (RSAW), comprised of excessive phasic and tonic muscle activity during REM. RSAW differences between PD and MSA are currently unknown. We aimed to determine whether polysomnographic RSAW profiles could discriminate between PD and MSA patients.

**Methods:** RSAW was manually scored in the submentalis (SM) and anterior tibialis (AT) muscles according to established methods in 25 clinically diagnosed MSA patients and 20 PD and 25 OSA control patients. Group comparisons of phasic, tonic, and “any” muscle activity percentages, phasic burst duration, and automated REM atonia index (RAI) were completed utilizing non-parametric statistical tests.

**Results:** Automated RAI was significantly different across groups, with lowest RAI (and greatest atonia loss) in MSA patients (MSA: 0.34, PD: 0.59, OSA: 0.94, p < 0.02). Manual RSAW analyses demonstrated higher SM/AT combined “any” activity within synucleinopathy groups (MSA: 64%, PD: 70%, OSA: 17%, p < 0.0001). Manual RSAW profiles also varied across groups, with higher tonic muscle activity in MSA patients (MSA: 50%, PD: 23%, OSA: 0%, p < 0.03), but higher overall (combined SM/AT) phasic muscle activity in PD patients (PD: 67%, MSA: 36%, OSA: 17%, p < 0.0005). SM phasic burst duration was similar between PD and MSA patients (1.15 s vs. 1.02 s, p = 0.3917). Both REM atonia index and SM/AT combined activity were able to detect MSA among synucleinopathy patients with excellent sensitivity and specificity (RAI: 80%, 70%, AUC = 0.708; SM/AT: 80%, 80%, AUC = 0.81).

**Conclusion:** MSA and PD RSAW was greater than in OSA controls, with automated RAI discriminating most clearly between the three groups. Different quantitative RSAW profiles were found between the synucleinopathy groups, with comparatively higher tonic muscle activity in MSA, and higher phasic muscle activity in PD patients, suggesting that quantitative RSAW profiles could help discriminate synucleinopathy phenotypes.

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0729  
**ASSOCIATION BETWEEN PAIN AND SYMPTOMS OF RESTLESS LEGS SYNDROME (RLS) IN ADULTS WITH MODERATE-TO-SEVERE PRIMARY RLS IN A COMBINED TREATMENT POPULATION: POOLED ANALYSES FROM 3 RANDOMIZED CONTROLLED TRIALS**

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**Introduction:** We explored associations between pain and RLS symptoms in adults with moderate-to-severe primary RLS treated with gabapentin enacarbil (GEn) or placebo. Correlations between pain and International Restless Legs Scale (IRLS) total and individual item scores were investigated.

**Methods:** Data from three randomized trials were pooled across treatment groups (GEn 600 mg, GEn 1200 mg, placebo). This analysis included patients with baseline IRLS total score ≥ 15 and pain score ≥ 4. IRLS total score response was defined as a decrease in score of ≥ 6 and total score < 15 at week 12. Pain response was defined as ≥ 30% improvement on a numerical rating scale, typically considered a notable improvement. Joint responders met both criteria. Spearman rank correlation coefficients were calculated.

**Results:** 366/671 patients met analysis entry criteria (placebo, n = 133; GEn 600 mg, n = 86; GEn 1200 mg, n = 147). For all 3 groups combined, 58% of patients were joint responders for pain and IRLS total score, 24% were not responders in either category, 13% were only pain responders, and 6% were only IRLS total score responders. For change from baseline to week 12, there was a significant correlation between IRLS total score and pain score (0.70; P < 0.0001). There were moderate to strong correlations between pain score and IRLS items 1 (overall RLS discomfort, 0.62), 2 (overall need to move, 0.67), and 6 (RLS severity as a whole, 0.65; all P < 0.0001). All other IRLS items had weaker correlations with pain score. The most common treatment-emergent adverse events in the individual studies were somnolence and dizziness.

**Conclusion:** In this pooled analysis, most patients had a joint response for pain and RLS symptoms according to IRLS total score and pain score. There were significant correlations between pain and IRLS total score and individual item scores. These findings suggest that RLS symptoms and pain may be clinically related.

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**IV. RLS, Movement Disorders and Parasomnias**

**0730**
**THE EFFECT OF GABAPENTIN ENACARBIL (GEN) ON PAIN OUTCOMES AND RESTLESS LEGS SYNDROME (RLS) SYMPTOMS IN ADULTS WITH MODERATE-TO-SEVERE PRIMARY RLS: POOLED ANALYSES FROM 3 RANDOMIZED CONTROLLED TRIALS**

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**Introduction:** This pooled analysis explored whether adults with moderate-to-severe primary RLS experienced improved pain and RLS symptoms when treated with GEN. Pain and International Restless Legs Scale (IRLS) total score correlations were investigated.

**Methods:** Data were pooled by GEN (600 mg or 1200 mg) and placebo groups for 3 previous trials. Patients with baseline IRLS total score ≥ 15 and pain score ≥ 4 were included. Pain responders had a ≥ 30% pain score improvement on a numeric rating scale, typically considered a notable improvement. IRLS total score responders had a score < 15 with an improvement from baseline ≥ 6 at week 12, as defined previously. Spearman rank correlation coefficients were calculated.

**Results:** 366/671 patients met analysis entry criteria (placebo, n = 133; GEN 600 mg, n = 86; GEN 1200 mg, n = 147). Most patients were joint responders for pain and IRLS total score (placebo, 40%; GEN 600 mg, 70%; GEN 1200 mg, 67%) and some were not responders in either category (35%; 16%; 18%, respectively). Few patients were responders only for pain (placebo, 16%; GEN 600 mg, 9%; GEN 1200 mg, 12%) or IRLS total score (9%; 5%; 4%, respectively). Differences across all 4 categories were significant between GEN 600 mg vs placebo (Chi Square, P = 0.0003) and GEN 1200 mg vs placebo (Chi Square, P < 0.0001). Moderate to strong correlations were observed between IRLS total score and pain score for change from baseline to week 12 (placebo, 0.69; GEN 600 mg, 0.54; GEN 1200 mg, 0.68; all P < 0.0001). The most common treatment-emergent adverse events in the individual studies were somnolence and dizziness.

**Conclusion:** In this pooled analysis, most patients were joint responders for pain and IRLS total score, and more GEN-treated patients (600 mg and 1200 mg) had a joint response vs placebo. There were significant correlations between the change from baseline in pain and IRLS total score.

**Support (If Any):** These studies and this analysis were conducted by XenoPort, Inc., Santa Clara, CA. Medical writing support was provided by CodonMedical, a division of KnowledgePoint360 (an Ashfield Company), and was funded by XenoPort, Inc.

**0731**
**RESTLESS LEGS SYNDROME AND WHOLE BODY VIBRATION**

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**Introduction:** Vascular disturbances leading to tissue hypoxia have been named as one of possible causes for RLS. Vibration to the whole body (WBV) in healthy individuals results in increased blood flow. Catecholamines influence blood flow and can be detected in venous blood. The purpose of this investigation was to determine if WBV will 1) improve skin blood flow, as measured in flux, in individuals with RLS and thus 2) decrease symptoms associated with RLS, 3) to determine if there is a difference in catecholamines between subjects with and without RLS.

**Methods:** Twelve subjects with RLS underwent two weeks of 14 minutes of intermittent 30-second WBV. Pre- and post-two-week treatment flux and RLS symptom severity (using the IRLS questionnaire) were compared. Flux and catecholamines were compared to age and gender-matched control group.

**Results:** Baseline flux was significantly lower in RLS group compared to control (p = 0.05), both groups demonstrated similar flux values after one vibration treatment. The dopamine levels were significantly higher (p = 0.005) in the RLS group. The IRLS significantly decreased (representing less RLS symptoms) from 22 to 17, p = 0.001 after two weeks of vibration treatment.

**Conclusion:** Subjects with RLS have decreased pedal skin blood flow but are able to increase flux to the same level as normal subjects. WBV seems to have a positive effect on symptoms associated with RLS. Dopamine, which has influence on vasoconstriction, is elevated in subjects with RLS. This doesn't seem to be related to dopaminergic medication as only 2 subjects who are on medication exhibit increased dopamine levels vs. 4 subjects who don't take dopaminergic medicine have elevated DA levels.
IV. RLS, Movement Disorders and Parasomnias

0733
ANALYSIS OF THE RELATIONSHIP BETWEEN THE OLFACTORY FUNCTION AND FREQUENCY OF REM SLEEP WITHOUT ATONIA IN REM SLEEP BEHAVIOR DISORDER.
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Introduction: REM sleep behavior disorder (RBD) is commonly associated with neurodegenerative disorders characterized by α-synuclein deposition (α-synucleinopathy), including Parkinson disease, multiple system atrophy, and dementia with Lewy bodies. It has been reported that olfactory dysfunction occurs in most patients with these disorders. However, there have been few reports on the relationship between an impaired olfactory function and sleep parameters characterized by RBD and the frequency of REM sleep without atonia (RWA). To determine the relationship between the severity of olfactory dysfunction and frequency of RWA in RBD patients, the Odor Stick Identification Test for Japanese (OSIT-J) and polysomnography (PSG) were carried out in patients with RBD.

Methods: OSIT-J for analyzing the olfactory function was performed in 23 patients with RBD, aged 62 ± 17.5 y.o. (15 males: 65.2 ± 13.1 y.o., 8 females: 56.2 ± 24.1 y.o.) and 10 control subjects, aged 40.1 ± 12.4 y.o. (3 males: 50.7 ± 14.8 y.o., 7 females: 35.6 ± 8.8 y.o.). In addition, the relationship between the severity of olfactory dysfunction and frequency of RWA in RBD patients, the Odor Stick Identification Test for Japanese (OSIT-J) and polysomnography (PSG) were carried out in patients with RBD.

Results: A significant difference in OSIT-J was observed between RBD patients and control subjects (mean OSIT-J score: 6.2 ± 3.1 versus 11.2 ± 1.0, respectively, P < 0.05). At the cut-off point of 8.5 for OSIT-J, 17 out of the 23 patients with RBD (74%) were found to have an abnormal olfactory function. In addition, a significant negative correlation between the OSIT-J score and %RWA in RBD patients was observed (r = −0.4).

Conclusion: In RBD patients, an impaired olfactory function is one of the critical features and it may be correlated with the severity of clinical symptoms.

0734
RBD PATIENTS WITH DEPRESSED MOOD ARE LESS LIKELY TO RECALL ENACTED DREAMS THAN THOSE WITHOUT DEPRESSED MOOD
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Introduction: RBD (REM sleep behavior disorder) is characterized by loss of REM sleep-related muscle atonia and consequent dream enactment during sleep. Interestingly, SSRIs are known to be a risk factor of RBD, but there have been few studies on RBD and depression. In this study, we aimed to investigate on the relationship between RBD and depression.

Methods: A total of 94 patients (mean age: 61.9 ± 12.7 years, male: 70.2%) diagnosed as RBD were reviewed through detailed clinical history, nocturnal polysomnography data, Beck Depression Inventory (BDI) and Epworth Sleepiness Scale (ESS) scores.

Results: Mean BDI score of the total patients was 12.4 ± 10.3, and 50.0% of them had depressed mood (BDI ≥ 10). ‘The depressed RBD patients’ were reported to be less able to recall enacted dreams than ‘the non-depressed RBD patients’ (63.8% vs. 87.2%, p = 0.015). BDI score was higher in those who were not able to recall enacted dreams than in those who were able to do so (t = 4.121 vs. 10.9 ± 8.3, p = 0.04). Failure in recalling enacted dream was strongly associated with presence of depressed mood, when confounding variables such as respiratory disturbance index and history of psychiatric disorders were controlled (OR = 0.259, p = 0.014).

Conclusion: In this study, 50.0% of RBD patients revealed depressed mood and those depressed were less able to recall enacted dreams. We suggest routine evaluation of depression in RBD patients, particularly in relation to failure to recall enacted dreams, since it may be associated with neurodegeneration.

0735
RESTLESS LIMBS SYNDROME (RLS), BRUXISM AND MIGRAINE TRIAD: AN IMPORTANT CONSIDERATION IN THE DIAGNOSIS AND TREATMENT OF INSOMNIA
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Introduction: Restless Limb Syndrome (RLS) is estimated to affect up to 10% of the population and is a frequent cause of insomnia, although sleep disorder is not required for its diagnosis. However, the actual contribution of RLS to the prevalence of insomnia is unknown. This etiology is important since RLS is treated, distinctly from other causes of insomnia, with Dopamine Agonists (DA). Previously, we have reported the association of RLS with migraine headaches and bruxism as well as the responsiveness of RLS-associated bruxism to DA’s. Recognition of these common comorbidities can improve diagnostic accuracy and lead to specific treatments.

Methods: 985 patients who met the IRLSSG criteria for RLS completed a 35 question survey addressing demographics, symptoms, comorbidities, family history and response to therapy. Charts were reviewed and interviews conducted to complete and clarify the data.

Results: 798 patients (81%) had sleep complaints. Other symptoms included: Pain (72%); paresthesiae (70%); migraine headaches (65%); cramps (38%); bruxism (37%); and, dysesthesiae (26%). 303 (30.8%) had the full “Triad” of RLS, migraines and bruxism. Analysis of the entire study group did not reveal significant differences in the frequency of headaches or bruxism between the groups with insomnia and those without. However, when non-respondents were excluded both bruxism (Chi-Square = 8.66, p = 0.003) and migraines (Chi-Square = 15.25, p < 0.0001) were more frequent in patients with insomnia.

Conclusion: Estimates of the prevalence of insomnia (10–30%) vary widely based upon study methodology and diagnostic criteria, affecting up to 90 million Americans. Using conservative estimates, and if our data prove to be accurate, RLS, affecting 35 million Americans, may be the etiology of up to 30% of sleep disorders. Awareness of important comorbidities, including the Triad of RLS, migraine headaches and bruxism can improve diagnostic acumen and allow for appropriate treatment with DA’s. Administration of questionnaires addressing symptoms of RLS and its comorbidities and measuring bruxism in polysomnography may provide valuable future data.
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**DVP**

Results: Of the 50 participants, 22% of the caregivers indicated that they had RLS symptoms. Caregivers who reported RLS symptomatology were more likely to report their children with ASD to have more night waking and restless sleep than caregivers who did not have symptoms of RLS. Children of parents with self-reported RLS were more also reported to demonstrate more internalized behavior problems, including Sadness, lack of energy, anxiety, and somatic complaints.

Conclusion: Findings suggest relationships between biological caregivers with RLS and greater sleep/behavioral issues among their children with ASD. RLS is known to have a strong heritability component and children with ASD may have RLS, but lack the verbal ability to describe their symptoms. Further research is needed to ascertain the prevalence of RLS in caregivers of children with ASD, and the prevalence of RLS among children with ASD. Exploration of the biological mechanism related to the role dopamine plays in RLS and ASD would likely provide insights into the pathogenesis, relationships, and treatment of RLS in this population.

**0736**

**PLM INDICES IN RLS PATIENTS WITH LOW VERSUS NORMAL IRON STORES**

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Introduction: Brain iron metabolism plays a fundamental role in restless legs syndrome (RLS) and an association with body iron stores has been shown. Aim of this study was to evaluate polysomnography (PSG) characteristics and periodic limb movements (PLM) in RLS patients with low and normal ferritin values.

Methods: Patients with RLS diagnosed according to standard criteria were retrospectively selected from the RLS/WED database of Innsbruck sleep laboratory starting from 2012. Patients who underwent PSG and iron status examinations no more than 3 months apart from PSG were included and stratified according to ferritin values. In order to obtain two precisely distinguishable groups only patients with ferritin values < 50 µg/l and ferritin > 75 µg/l were included. Patients with ferritin levels between 50–75 µg/l were excluded, as well as patients with iron intake at date of PSG. PLMS-Index was calculated with a computer-assisted software integrated in PSG system, with visual plausibility check.

Results: 101 patients were eligible. 8 patients with ferritin levels between 50–75 µg/l were excluded. Ninety-two patients were included, 28 with ferritin levels < 50 µg/l (20 women, 56.4 ± 9.8 years) and 64 with ferritin > 75 µg/l (18 women, 56.4 ± 12.5 years). PSG variables did not differ between the groups. PLMS-Index was 40.6/h ± 58.7 for patients with ferritin < 50 µg/l and 28.45/h ± 45.45 in the group with ferritin > 75 µg/l (p = 0.284). L-DOPA equivalence dose differed between both groups, 77.6 ± 133.3 vs. 22.3 ± 43.0 (p = 0.04). Twenty-five percent of the ferritin < 50 µg/l group were treated with L-DOPA vs. 3.1% in the other group (p = 0.009).

Conclusion: While PSG variables and PLM indices did not differ between RLS patients with low versus normal iron stores, L-DOPA equivalence dose was higher in patients with ferritin < 50 µg/l. If this is related to a higher L-Dopa requirement in those with low iron stores or to an interaction of L-DOPA and iron remains to be determined.

Support (If Any): The study was supported by a Grant from the Translational Research Fund of the government of Tyrol Austria (coordinator: Birgit Högl).

**0737**

**SYMPTOMS OF RLS IN BIOLOGICAL CAREGIVERS OF CHILDREN WITH AUTISM SPECTRUM DISORDERS**

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Introduction: There are a number of potential connections between sleep problems of children with autism spectrum disorders (ASD) and sleep problems of their caregivers that are likely rooted in genetic factors. This study explores relationships between symptoms of restless legs syndrome (RLS) in caregivers and the sleep and behavior of their children with ASD.

Methods: A subset of 50 biological caregivers of children with ASD completed a Sleep Habits Questionnaire (SHQ). Symptoms of RLS were ascertained using four questions regarding leg sensations, body position when experiencing the symptoms, time of day, and alleviation of symptoms. Participants completed measures of the sleep and behavior of their child with ASD.
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0739
POLYSOMNOGRAPHIC FEATURES IN PATIENTS WITH COMORBID PERIODIC LIMB MOVEMENT SYNDROME AND OBSTRUCTIVE SLEEP APNEA

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Introduction: Prevalence of Obstructive Sleep Apnea-Hypopnea Syndrome (OSAHS) in Mexico is 3.2%. It is characterized by altered sleep architecture and poor quality of life. The overall prevalence of PLMS is 7.6% and 4.5%; and is featured by excessive daytime sleepiness; however, OSAHS and PLMS polysomnographic features have not yet been enough studied yet as comorbid conditions in the same patients.

Methods: The objective was to determine the Sleep Architecture in patients with comorbid OSAHS and PLMS. This was a retrospective, descriptive and comparative study that was carried out in the Sleep Disorders Center at the National University of Mexico. The study included PSG records from 110 patients, they were divided into four groups: PLMS (n = 25), OSAHS (n = 30), PLMS/Primary Snoring (n = 30) and PLMS/OSAHS (n = 25). One-way analysis of variance (ANOVA) and Bonferroni test were used to assess statistical significance.

Results: In this study 52.7% were women, mean age 52.9 + 1.4. Compared with the PLMS group; patients with PLMS/OSAHS group showed a significant increase of wakefulness (p < 0.054) and number of arousals (p < 0.006).

Conclusion: Patients with comorbid PLMS and OSAHS showed the worst sleep architecture; this could be explained by a summation of effects of each one of the studied sleep disorders.

Support (If Any): Facultad de Medicina, Universidad Nacional Autonoma de Mexico

0740
PERIODIC LIMB MOVEMENT OF SLEEP IN PULMONARY HYPERTENSION

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Introduction: Periodic limb movement of sleep (PLMS) has been associated with elevated blood pressure and heart rate, suggesting increased left ventricular afterload due to increased sympathetic tone. This can lead to an upstream elevation in pulmonary vascular resistance. We hypothesized that there may be a correlation between severity of PLMS and severity of pulmonary hypertension (PH).

Method: We conducted a retrospective chart review of patients seen in our institution PH clinic who underwent a polysomnogram. Mean pulmonary artery pressure (mPAP) data were obtained from either right heart catheterization (RHC) or echocardiogram (ECHO) derived mPAP. Diagnosis of PLMS is based on American Academy of Sleep Medicine criteria and periodic limb movement index (PLMI) > 5 was considered abnormal.

Results: A total of 1170 patients diagnosed with PH were reviewed, with 156 (13%) patients received polysomnography. Ninety three patients (60%) underwent RHC, and 63 patients (40%) did not receive RHC, which mPAP was obtained from ECHO. Number of patient in each PH diagnostic subgroups were divided into 36% in group 1, 37% in group 2, 22% in group 3, 3% in group 4, and 2% in group 5. Prevalence of PLMS (PLMI > 5) in our PH patients was 52% (81/156). Increased in limb movement index had a strong correlation with higher limb arousal index with Spearman correlation coefficient (ρ) 0.74 and p-value < 0.0001; however, limb arousal index did not have correlation with mPAP. There are also no statistically significant correlations between mPAP to AHI (ρ = 0.11, p = 0.16), and PLMI (ρ = −0.06, p = 0.44). With subgroup analysis in PH group 1–3, we also found no correlation between mPAP and PLMI.

Conclusion: In our study, PLMS is a common occurrence among PH patients. The increased prevalence of PLMS did not translate into significant increase in PLMS that potentially worsens cardiovascular stress in PH patients.

0742
COGNITIVE MARKERS OF NEURODEGENERATION IN RAPID EYE MOVEMENT SLEEP BEHAVIOR DISORDER PATIENTS
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Introduction: Rapid eye movement sleep behavior disorder (RBD) is a parasomnia considered as a risk factor for the development of certain neurodegenerative diseases (NDD), such as dementia with Lewy bodies (DLB) and Parkinson’s disease (PD). As a specific and sensitive prodromal syndrome, RBD allows the investigation of potential pre-clinical markers of NDD, such as cognition. The purpose of this study is to prospectively follow-up a cohort of RBD patients to find potential cognitive markers of neurodegeneration.

Methods: Sixty-nine RBD patients without dementia or NDD underwent a neuropsychological assessment and a neurological exam. They were subsequently followed for a mean of 3.5 years, at least for one follow-up examination ≥ 1 year after the baseline exam. Mild cognitive impairment (MCI) diagnosis was defined according to standard criteria. Clinical and neuropsychological characteristics were compared between disease-free RBD patients and RBD patients who developed NDD.

Results: Twenty-five patients (36%) converted during follow-up. At baseline, compared to disease-free RBD patients, RBD patients who developed NDD showed higher MCI frequency (72% vs 43%; p < 0.05) and poorer performance on Digit span (0.05), Trail Making Test (0.001), Semantic verbal fluency (0.015), Rey Auditory Verbal Learning Test (0.05) and Rey-O figure immediate recall (0.05) and delayed recall (0.02) tasks than disease-free patients. Subsequent analyses in NDD patients showed that patients who developed DLB showed more severe cognitive deficits at baseline characterized by a higher MCI frequency (92% vs 54%; p < 0.05) and a poorer performance in all cognitive domains than patients who developed PD.

Conclusion: Our results identify cognitive markers associated with future neurodegeneration in RBD patients, including the presence of MCI and poorer cognitive performance in executive functions and attention as well as in verbal and non-verbal learning tasks. Future prospective studies should investigate neuropsychological markers to characterize cognitive decline through years.

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0743
LESIONAL REM SLEEP BEHAVIOR DISORDER
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Introduction: REM sleep behavior disorder (RBD) is a frequent initial sign of synucleinopathy, although several reported cases have shown visible dorsal pontine lesion pathology. We report a case series of lesional RBD/RSWA with brainstem pathology on neuroimaging studies.

Methods: Ten patients fulfilling modified Iranzo/Aparicio criteria for lesional RBD were included, requiring: RBD onset temporally associated with a lesion; lesion location in a pontine or medullary area known to regulate REM sleep; and RBD not better explained by synucleinopathy, medication use, or withdrawal.

Results: Six patients (60%) were men, with an average age of sleep symptom onset of 47.2 ± 21.2 years. No patients developed parkinsonian features or cognitive impairment over an average of 74.5 ± 70.2 months follow-up. Pathologies included cerebello-pontine angle and petroclival meningiomas in 3, brain stem damage following neurosurgery in 2, and single cases each of: fibrillary astrocytoma; basilar fusiform aneurysm; vasculitis; multiple sclerosis; and epidermoid cyst. RBD symptoms began within 2 months of neurologic symptom onset, surgery, or neuroimaging identification. All patients had pontine lesions or compression, and discrete dorsal pontine tegmentum lesions were present in 5 (50%). In 2 (20%) DEB completely remitted following surgical resection or radiographic lesion remission.

Conclusion: Lesional RBD includes a range of pathology impacting the pons, providing further supportive evidence that pontomedullary lesion location, not the underlying disease process, is the principle factor causing RBD symptoms.

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0744
PILOT QUANTITATIVE ANALYSIS OF PHYSIOLOGIC RAPID EYE MOVEMENT SLEEP ATONIA IN ADULTS WITHOUT REM SLEEP BEHAVIOR DISORDER
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Introduction: REM sleep without atonia (RSWA) is seen in patients with REM sleep behavior disorder (RBD). Normative values for physiologic atonia during REM sleep are not well-established, which makes quantitatively defining RSWA difficult.

Methods: We manually analyzed phasic and tonic muscle activity in submentalis (SM) and anterior tibialis (AT) during REM, and also calculated automated submentalis REM atonia index (RAI) in neurologically normal adults who had normal polysomnography or primary snoring without RBD or other parasomnia. Statistical comparisons were made in 36 subjects subdivided into 4 age groups: 20–39 years; 40–59 years; 60–74 years; and > 75 years.

Results: SM and AT phasic burst durations were similar across the age groups (0.36 ± 0.29 seconds and 0.41 ± 0.28 seconds, respectively). Combined SM/AT phasic muscle activity and AT phasic muscle activity was significantly higher in those aged 60–74 years in comparison to the younger age groups and those aged over 75 years (p 0.9, indicating preserved REM atonia. Men over age 60 years had higher AT and combined SM/AT phasic muscle activity compared to younger men and women (20–59 years) and older women (> 60 years). No gender differences were observed in SM phasic muscle activity.

Conclusion: REM atonia may be increased in older adults, especially in men. Further study in a large number of healthy adults is planned to clarify the boundaries of physiologic REM atonia throughout the lifespan.

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IV. RLS, Movement Disorders and Parasomnias

0745
DIAGNOSTIC THRESHOLDS FOR QUANTITATIVE REM SLEEP PHASIC BURST DURATION, PHASIC AND TONIC MUSCLE ACTIVITY, AND REM ATONIA INDEX IN IDIOPATHIC REM SLEEP BEHAVIOR DISORDER PATIENTS WITH AND WITHOUT COMORBID OBSTRUCTIVE SLEEP APNEA
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Introduction: We aimed to determine whether visual and automated REM sleep without atonia (RSWA) methods could accurately diagnose idiopathic REM sleep behavior disorder (iRBD) patients with comorbid OSA.

Methods: We analyzed idiopathic RBD (iRBD) patients (n = 15) and matched controls (n = 30) with and without OSA. RSWA phasic burst durations, phasic, tonic and "any" muscle activity by 3-second mini-epochs, phasic activity by 30-second (AASM rules) epochs, and automated REM atonia index (RAI) analysis. Group RSWA metrics were analyzed with regression models. Receiver operating characteristic (ROC) curves were used to determine the best diagnostic cutoff thresholds for RBD. Both split-night and full-night polysomnographic studies were analyzed.

Results: Six RBD patients (40%) and 11 control subjects (37%) were diagnosed with OSA. All mean RSWA phasic burst durations and muscle activity percentages were higher in iRBD patients than controls (p < 0.01). Muscle activity (phasic, "any") cutoffs for 3-second mini-epoch scorings were: submental (SM) (15.8%, 19.5%), anterior tibialis (AT) (29.7%, 29.7%), and combined SM/AT (39.5%, 39.5%). Tonic muscle activity cutoff was 0.70% and RAI (SM) cutoff 0.86. Phasic muscle burst duration cutoffs were: SM (0.66) and AT (0.71) seconds. Combining phasic burst durations with RSWA muscle activity improved sensitivity and specificity of iRBD diagnosis.

Conclusion: This study provides evidence for quantitative RSWA diagnostic thresholds applicable in iRBD patients with OSA. Our findings in this study were quite similar to those seen in PD-RBD patients, consistent with a common mechanism and presumed underlying etiology of synucleinopathy in both groups.

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0746
PREGRESSION OF COGNITIVE IMPAIRMENTS IN IDIOPATHIC REM SLEEP BEHAVIOR DISORDER
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Introduction: Aims of present study were to compare cognitive performances between individuals with idiopathic REM sleep behavior disorder (iRBD) and healthy controls, and to explore how baseline cognitive deficits might evolve over time while RBD still remained idiopathic form without development of neurodegenerative disorders. We also tried to identify influencing factors for the evolution of these cognitive deficits.

Methods: Fifty-seven individuals with iRBD and fifty-seven age-, sex- and education-matched healthy controls were compared on neuropsychological performances. Patients were followed up on performance changes in each cognitive domain with medication for RBD maintained (follow-up interval 50.84 ± 25.38 months [range: 12–108 months]). Decline of cognitive performance during follow-up period was defined as more than one point fall in z-score from baseline. Subgroup analysis was performed according to the existence of cognitive decline over time to find out possible influencing factors.

Results: Individuals with iRBD showed significantly lower z-scores than controls in general cognition (MMSE: −0.746 vs. 0.120; p < 0.001), executive function (Trail Making Test A: 0.635 vs. 1.100; p = 0.001), and visuo-spatial abilities (Constructional Praxis: 0.078 vs. 0.394; p = 0.014, CLOX2: −0.433 vs. 0.180; p = 0.007). Within iRBD, subjects showed significant performance decline in memory (Digit Span Forward: 0.574 vs. 0.206; p = 0.003) and executive functions (Frontal Assessment Battery: 0.253 vs. −0.200; p = 0.007, Stroop Color Word Interference Test: 0.198 vs. −0.041; p = 0.012) at the follow-up. None of demographic or clinical characteristics were significantly associated with cognitive declines in iRBD.

Conclusion: In iRBD, cognitive impairments were observed at baseline and progressed over time. Even in idiopathic cases without development of any neurodegenerative disease, degenerative changes seem to be under way.

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0747
RETROSPECTIVE LIFE CHARTING OF RECURRENT ISOLATED SLEEP PARALYSIS
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Introduction: Retrospective Life Charting (LC) was developed as a method to examine the longitudinal course of individuals experiencing recurrent Isolated Sleep Paralysis (ISP). LC has proven valuable in advancing knowledge about complex mood disorders (e.g. bipolar disorder). However, there are no known reports regarding LC methods in ISP.

Methods: Thirty-three participants with recurrent ISP completed self-rated instruments for sleep habits, depression, anxiety, and specific features related to ISP. An initial interview was conducted by a clinician (TU) with expertise in the diagnosis and treatment of parasomnias. A LC clinician (JR) organized a “preliminary” timeline, presented to participants as a visual reference on visit 2. This LC interview, a semi-structured interview modified from LC methods of Uhde and coworkers (1985) and Leverich & Post (2002), focused on expanding from one’s first, last, and worst episodes of ISP. Additional visits to complete the LC included plotting ISP episodes, life events (rated negative 1–4, neutral 0, or positive 1–4), anxiety and depressive symptoms, avoidance, as well as additional details of medications, and drug and alcohol use.

Results: Although a large range of time (4–12 hours) was required to complete LCs and not all participants were able to fully complete due to memory difficulties, a high prevalence of co-existing parasomnias (e.g., sleep panic, recurrent nightmares, sleep hallucinations) were found. Additionally, these comorbidities occurred at various times within an individual’s life cycle.

Conclusion: 1) Retrospective life charting offers a useful clinical and research tool, 2) Similar methods can be employed prospectively to refine treatment approaches, 3) Recurrent ISP is associated with a high rate of other parasomnias, 4) Future directions will include a reliable and valid manualized method for collecting longitudinal course of illness data.
THE FREQUENCY AND SEVERITY OF ISOLATED SLEEP PARALYSIS IN AFRICAN AMERICAN AND WHITE ADULTS
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Introduction: Isolated sleep paralysis (ISP), the inability to perform voluntary movement during the transition between wakefulness and sleep, typically evokes extreme anxiety and, in some cases, fear of impending death. This research examines ISP independently from other types of fearful arousal (e.g., nocturnal panic attacks), and also begins to explore the importance of individual differences (i.e., race) on prevalence, severity, and lifetime course of ISP.

Methods: Individuals seeking treatment for sleep related disturbances were invited to participate in a sleep research data repository. Taken from the larger database, 22 individuals reported ISP, most were female (68.2%), African American (77.3%), and ranged in age from 16–56.

Results: African Americans (AA) compared to white (W) participants reported significantly more lifetime ISP episodes (p = 0.04). A repeated measures ANOVA revealed a difference in severity (1 = "not unpleasant"; 10 = "extremely unpleasant") between the “first”, “worst”, “typical” and “last” ISP episode (F(1,21) = 50.60, p = 0.000), with highest ratings for “first” and “worst” in both AA and W participants when compared to “typical” and “last” episodes. Additionally, there was a significant inverse relationship between total lifetime ISP episodes and severity of the “typical” (r = −0.61, p = 0.01) episode of ISP in AA but not W (r = −0.51, p = 0.38) participants. There was no relationship between duration of illness and severity of ISP in either group.

Conclusion: African Americans with ISP report more frequent lifetime prevalence of ISP. In addition, AA appear to experience a greater habituation in the severity of ISP compared to W participants, which is mediated in part by an increased lifetime frequency of episodes but not age.

Support (If Any): Department of Psychiatry, MUSC

0749
HEART RATE VARIABILITY IN RESTLESS LEGS SYNDROME AND PERIODIC LIMB MOVEMENTS OF SLEEP
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Introduction: The relationship between restless legs syndrome (RLS), periodic limb movements of sleep (PLMS), and the autonomic nervous system is not fully understood. A simple method to study changes in cardiac autonomic control is heart rate variability (HRV) measurement. It has been demonstrated that patients with RLS have reduced HRV, which is an indication of elevated sympathetic activity. Others have failed to demonstrate a basal autonomic disturbance (as determined via HRV analysis) in patients with PLMS. We hypothesize that patients with the combination of RLS and PLMS demonstrate altered HRV during wakefulness.

Methods: An evaluation of 16 records demonstrating RLS only, 14 records demonstrating PLMS only, 17 records demonstrating both RLS and PLMS, and 14 control records was performed, including electrocardiogram analysis of HRV parameters taken from a 5-minute sample of quiet wakefulness. Time-domain (R to R interval [RR] length and RR standard deviation) and frequency-domain measures (HRV power and very low frequency, low frequency, and high frequency bands) were ascertained and tabulated.

Results: No statistical differences were found in any of the time or frequency-domain HRV measures in the RLS only, PLMS only, and RLS and PLMS combination groups as compared to the control group, at a P value of 0.05.

Conclusion: While our initial hypothesis was incorrect, this preliminary data adds to the existing literature and argues against a disturbance of basal cardiac autonomic control in patients demonstrating both RLS and PLMS, in a fashion similar to what has been found in patients with PLMS alone. In light of conflicting data suggesting HRV alteration both in patients with RLS, and during limb movements of patients with PLMS, our study argues for the need for larger, prospective studies to help further elucidate the role of RLS/PLMS in cardiac autonomic disturbance.

0750
DEVELOPMENT OF NEURODEGENERATIVE DISORDERS IN REM SLEEP BEHAVIOR DISORDER IN KOREA
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Introduction: Idiopathic REM sleep behavior disorder (iRBD) has been implicated as an early manifestation of Parkinson’s disease (PD) or Lewy body dementia (LBD). Development of these neurodegenerative disorders in iRBD has been reported in just a few cohorts worldwide, but no data has addressed the clinical course of iRBD in a Korean population.

Methods: A follow-up study of consecutive patients with iRBD was conducted at the sleep disorder center in Seoul National University Bundang Hospital. All patients were diagnosed using time-synchronized video-polysomnography. Initial evaluation and regular follow-up for neurodegenerative disorders including PD, multiple system atrophy (MSA) and LBD have been performed by a neurologist and a psychiatrist. Cognitive function test was also carried out initially and repeated during the follow-up period. Survival analysis for the development of neurodegenerative disorders was done with Kaplan-Meier’s method.

Results: We enrolled 85 patients (M:F = 56:26) who visited the sleep disorder center between 2004 and 2012. The mean age at the diagnosis of iRBD was 65.3 ± 6.8 years and mean follow-up period from diagnosis was 4.1 ± 2.1 (range 0.6–10.3) years. Overall, 19 patients (22.4%) developed neurodegenerative diseases; PD in 12 patients, Alzheimer’s dementia in 3 patients, LBD in 2 patients, MSA in 1 patient and spino-cerebellar ataxia in 1 patient. Estimated rates of developing neurodegenerative disorders were 18.8% and 50.7% at 5 and 10 years from diagnosis of iRBD, respectively. No significant risk factors were found to predict the development of neurodegenerative disorders.

Conclusion: We found that the risk of developing neurodegenerative disorders in iRBD in a Korean population is substantially high and comparable to Western countries. Studies to find predictive factors and preventive measures for the development of neurodegenerative disorders should be warranted.
IV. RLS, Movement Disorders and Parasomnias

0751
SLEEP AND INTENSITY OF CORTICAL AROUSALS ASSOCIATED WITH PERIODIC LIMB MOVEMENTS: A NEW APPROACH FOR PREDICTING SUBJECTIVE COMPLAINTS
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Introduction: The majority of patients with RLS experience frequent periodic limb movements (PLMs), with associated EEG arousals thought to contribute to a sense of poor sleep quality. Mendelson (1996) however, reported no significant difference in PLM arousal index (PLMAI) and next day reports of non-restorative sleep. This may relate to the fact that PLM-associated arousals are scored as either present or absent without accounting for differences in arousal intensity. Azarbarzin et al. developed a method for quantifying arousal intensity. Using this method, they showed that cortical arousals vary greatly in their intensity and that average arousal intensity varies considerably within and between patients. This suggests that the intensity of arousals may contribute to the subjective complaints. We explored the characteristics of R&K scored arousals associated with PLMs and their relationship to subjective sleep quality.

Methods: PSG recordings from 12 patients meeting the International RLS Study Group criteria for moderate to severe RLS were scaled for arousal intensity using the method of Azarbarzin. PLMs arousal intensity was measured on a 9-point scale, with 1 representing arousals barely meeting diagnostic criteria and 9 representing very intense arousals. Records were also scored for R&K parameters of sleep continuity (i.e., TST, WASO, Awakenings Index, Arousal Index, PLMI, and PLMAI). Subjective sleep disruption was assessed using the Medical Outcome Study Sleep Scale (MOS-SS).

Results: Patients averaged 50.8 ± 40. PLMs/hr and a PLMAI of 9.21 ± 8.35 (2.8–34.1). Mean arousal intensity was 3.26 ± 0.63 (2.07–4.50). Arousal intensity values correlated with both objective TST (r = −0.87, p < 0.01) and subjective sleep quantity on the MOS subscale (r = −0.574, p < 0.05). None of the remaining sleep continuity parameters including PLMI and PLMAI correlated with subjective complaints.

Conclusion: The results suggest that intensity of arousals associated with PLMs may be more useful than PLMI and PLMAI in predicting subjective sleep complaints in RLS patients.

0752
CEREBRAL HEMODYNAMICS SHOW DIFFERENT PATTERNS BETWEEN PATIENTS WITH OBSTRUCTIVE SLEEP APNEA AND PERIODIC LIMB MOVEMENT SLEEP SYNDROME DURING NOCTURNAL SLEEP
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Introduction: Obstructive sleep apnea (OSA) and periodic limb movement syndrome (PLMS) are two highly prevalent sleep disorders. Previous studies showed that OSA and PLM share common features, including periodic occurrence of events, association with arousals, and changes in peripheral hemodynamics. However, whether apnea events and limb movements also show similar characteristics in cerebral hemodynamics and oxygenation has never been addressed.

Methods: In this pilot study we assessed cerebral hemodynamic changes associated with apnea events and periodic limb movements (PLMs) in patients with OSA (7 patients) and PLMS (5 patients) (age: 53 ± 12) with near infrared spectroscopy during video-polysomnographies. Fragments (at least 10 min) of NIRS signals without motion artifacts were selected and divided into 3 subgroups according to events: 1) pure PLMs, 2) PLMs+arousals and 3) apnea/hypopnea+arousals. Temporal changes of HbO2, Hb and blood volume (BV) during these 3 events were described. Signal powers of these hemodynamic parameters within the fragments were estimated with Welch’s power spectral density (PSD) method.

Results: During pure PLM events, all cerebral hemodynamic parameters remained unchanged. During apnea/hypopnea events HbO2 and BV decreased while Hb increased resulting in increasing PSDs of these hemodynamics in the frequency bands of apnea/hypopnea. By contrast, hemodynamic changes associating with PLMs and arousals were accompanied by increasing HbO2 and BV, but without a significant change in Hb.

Conclusion: The cerebral hemodynamics show different changing patterns during apnea events and limb movements, suggesting different regulations of autonomic nervous system. While PLM events alone have no influence on cerebral hemodynamics, PLMs associated with arousals change cerebral perfusion.

Support (If Any): This work was supported by Scientific Foundation of Clinic Barmelweid and the ResMed foundation.

0753
ANALYSIS OF SLOW WAVE SLEEP EEG FUNCTIONAL CONNECTIVITY IN ADULT SOMNAMBULISM
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Introduction: There has been increasing interest in examining sleep EEG data in terms of functional brain connectivity. This new and powerful investigative tool, however, remains practically unexplored in relation to sleep disorders. We studied the EEG coherence and interdependencies between brain areas before the onset of somnambulistic episodes recorded in the sleep laboratory.

Methods: 38 adult sleepwalkers were investigated with polysomnography. Patients were selected on the basis of having experienced a somnambulistic episode in the sleep laboratory during an overnight PSG recording as well as during daytime recovery sleep following 25 hrs of sleep deprivation. All of the 76 selected episodes occurred out of N3 sleep. EEG coherence in the 0.5–4 Hz EEG frequency band was investigated during the 20 seconds immediately preceding the onset of each episode and compared to the 20 seconds occurring two minutes prior to these episodes’ onset. Data from the F3, F4, C3, C4, P3, P4, O1, O2 leads were investigated for each night using two complimentary measures of brain connectivity: phase coherence and phase lag index (the latter addressing zero-lag interactions due to common sources).

Results: Indices of phase coherence and phase lag index yielded similar results. A main effect of time segment was found, revealing a significant difference between the 20-second periods immediately prior to episode onset and the 20-second segments taken 2 minutes before the episode, with greater connectivity occurring immediately before episode onset. No significant interaction with brain areas or sleep deprivation was found.

Conclusion: These findings are in line with early pilot results suggesting that episodes of somnambulism are preceded by changes in brain connectivity. The study of EEG connectivity during sleep may thus help elucidate brain processes involved the occurrence of NREM parasomnias while providing a better understanding of fundamental processes underlying normal and pathological sleep.

Support (If Any): This research was supported by research grants from the Fonds de la recherche du Québec en nature et technologies (FRQNT) and from the Canadian Institutes of Health Research (CIHR).
INCIDENCE OF NARCOLEPSY IN GERMANY
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Introduction: Several publications associate AS03 adjuvanted H1N1 pandemic influenza vaccination with narcolepsy. Our study aimed at determining background incidence rates for narcolepsy in Germany. Previously, no valid estimates were available. A further objective was to investigate a potential change in incidence rates of narcolepsy between pre- and postpandemic period.

Methods: A retrospective study on the incidence of narcolepsy was conducted in German sleep centers within the period from 1 January 2007 to 31 December 2011 including patients with an initial diagnosis of narcolepsy (ICD 10 Code G47.4). In addition, a capture-recapture analysis was performed in one of the 16 German federal states in order to consider and adjust for undercount.

Results: Adequate and suitable data were provided by 233 of the 342 sleep centers (68.1%) that were invited to participate in the study. The eligible study subjects comprised 1092 (91.2%) adults as well as 106 (8.8%) children and adolescents under the age of 18 years. With respect to the capture-recapture investigation conducted in Rhineland-Palatinate, a total of 80 incident cases of narcolepsy were included. Regarding children and adolescents, a significant increase of the age-standardized adjusted incidence rate from 0.14/100,000 person-years in the prepandemic period to 0.50/100,000 person-years in the post-pandemic period was observed (incidence density ratio, IDR 3.57; 95% CI 1.94–7.00). This upward trend already started in spring 2009. In contrast, no significant change was detectable in adults (0.56/100,000 PY in the prepandemic period, 0.67/100,000 PY in the postpandemic period; IDR 1.20; 95% CI 0.83–1.74).

Conclusion: Our study provides valid estimates for the incidence of narcolepsy in Germany. In individuals under 18, incidence rates continuously increased from spring 2009.

Support (If Any): The project was sponsored by the German Ministry of Health (chapter 1501, title 54401).

REDUCED INFLUENCE OF SATIATION ON FOOD CHOICES IN HUMAN NARCOLEPSY
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Introduction: Narcolepsy with cataplexy is a chronic sleep disorder caused by a hypocretin (orexin) deficiency. Besides sleep regulation, hypocretin signaling is important for reward motivational processes, including appetite regulation. As obesity is a common symptom in narcolepsy, we explored food-related choices and their dependence on satiation in patients with type I narcolepsy (n = 20) compared with idiopathic hypersomnia (n = 13) as well as healthy matched controls (n = 18).

Methods: After fasting for at least 5 hours, subjects were first trained on a concurrent choice task to earn their favorite savory and sweet snack before one of the snack outcomes was devalued by sensory-specific satiation. Subsequently, choice for the savory or sweet snack was tested, without feedback (i.e. in extinction). Goal-directed behavior was measured by the selective reduction in button presses associated with the devalued outcome, e.g. satiation on a savory snack, leading to less button presses associated with obtaining that savory snack in the extinction test relative to the training phase. After the tests, we measured how many calories subjects consumed spontaneously from ad-libitum available food when they were completing food-related questionnaires.

Results: After satiation, all groups reported less wanting for the satiated snack than before satiation. However, while controls and idiopathic hypersomnia patients showed goal-directed behavior, patients with narcolepsy still chose the satiated snack as often as before satiation. Narcolepsy patients also spontaneously consumed more calories when completing the questionnaires, although not reporting to eat more in daily life.

Conclusion: While narcolepsy patients do report less wanting after being satiated, they do not adjust their behavior accordingly. This discrepancy between self-report and actual behavior was also evident in their spontaneous caloric intake. We conclude that narcolepsy patients exhibit reduced goal-directed control of behavior towards food. This might contribute to the development of obesity.

PREVALENCE OF PSG NOCTURNAL SHORT ONSET REM (SOREM) AND FAILURE TO CONDUCT NECESSARY MSLTS IN SLEEPY ADULTS: PROFOUNDED MISSED OPPORTUNITY TO IDENTIFY NARCOLEPSY?
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Introduction: A diagnosis of narcolepsy is commonly delayed by more than a decade. SOREM during PSG (≤ 15 min) is highly specific and has a high positive predictive value for narcolepsy. However, little is known of the prevalence of PSG SOREM in sleep clinic patients and the clinical use of PSG SOREM to prompt MSLT testing and identification of narcolepsy.

Methods: We evaluated the prevalence of PSG SOREMs and the rate of consecutive MSLTs in a database of 134,997 adult patients undergoing routine diagnostic PSG. Data were extracted from SleepMed’s repository from 2004 to 2013 and PAP titrations were excluded from these analyses based on other findings that a PSG SOREM occurs more frequently during titrations (see corresponding abstract entitled “Predictors and Potential Confounders of SOREM in 239,047 Adult Sleep Clinic Patients”).

Results: The prevalence of SOREMs on baseline PSG was 0.8% (n = 1102/134,997) and increased slightly with increasing AHI (AHI < 5 = 0.8%, AHI 5–14.9 = 1.1%, AHI 15–29.9 = 1.0%, AHI ≥ 30 = 1.3%; p < 0.001). Characteristics of narcolepsy in patients with PSG SOREMs without OSA (AHI < 5) included excessive daytime sleepiness (ESS ≥ 10 = 59%), difficulty maintaining sleep (self-report; 50%), hypnogogic hallucinations (10%) and sleep paralysis (5%); 30% also reported regular napping. Despite these characteristics, only 6.1% of those exhibiting PSG SOREM (n = 12) had a consecutive MSLT.

Conclusions: Patients with a PSG SOREM rarely have a consecutive MSLT, suggesting that the MSLT may be critically under-utilized following PSG SOREMs. PSG SOREMs occur at a higher rate than that for the diagnosis of narcolepsy and critical opportunities to identify
Hypersomnia

V.

13-question survey was given to patients and companions (if any) in

with an MSLT.

B. Clinical Sleep Science

1

Conclusion:

functioning in this patient population are limited and little is known

Introduction:

Louis, MO

Methods:

33 items on
diagnosis, symptoms, pharmacological and non-pharmacological
strategies for managing symptoms and perceived effectiveness, mental
health history, interest and experience in psychosocial interventions, and
demographics. The anonymous survey was distributed via email to
the Wake Up Narcolepsy listserv.

Results:

We obtained 426 respondents (61% narcolepsy, 31.5% idiopathic hypersomnia, 4.7% with HD symptoms but not formally diagnosed). Cardinal symptoms of depression and anxiety were endorsed by 60–86% of individuals and only 4 participants reported that they never experienced mood or anxiety symptoms associated with HD symptoms. Referrals to mental health specialists were reported by 45% of the respondents. The majority (82%) endorsed at least some interest in support groups, 72% endorsed interest in CBT, and 68% endorsed psychological approaches that focus on psychosocial functioning and potential interest in non-pharmacological interventions to improve these symptoms (e.g., cognitive behavioral therapy, mindfulness/yoga, support groups).

Methods: We developed an online survey that included 33 items on
diagnosis, symptoms, pharmacological and non-pharmacological
strategies for managing symptoms and perceived effectiveness, mental
health history, interest and experience in psychosocial interventions, and
demographics. The anonymous survey was distributed via email to
the Wake Up Narcolepsy listserv.

Results: We obtained 426 respondents (61% narcolepsy, 31.5% idiopathic hypersomnia, 4.7% with HD symptoms but not formally diagnosed). Cardinal symptoms of depression and anxiety were endorsed by 60–86% of individuals and only 4 participants reported that they never experienced mood or anxiety symptoms associated with HD symptoms. Referrals to mental health specialists were reported by 45% of the respondents. The majority (82%) endorsed at least some interest in support groups, 72% endorsed interest in CBT, and 68% endorsed interest in mindfulness/yoga techniques. The majority (58%) indicated a preference for a BSM provider for providing non-pharmacological services for HD.

Conclusion: The participants perceived that waking up easier would lead to a more productive day. A consistent wake-up routine did not correlate with improved productivity. Although much of the current literature focuses on falling asleep and maintaining sleep, waking from sleep may be of significant importance in daytime productivity.

0759

TREATMENT EFFECTS ON PATIENT-REPORTED OUTCOMES IN CENTRAL DISTURBANCES OF HYPERSOMNOLENCE IN A TERTIARY CARE CLINICAL PRACTICE

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Introduction: Real-world effectiveness data of central disorders of hypersomnolence (CDH) treatment are sparse. We hypothesized that treatment of CDH would improve patient-reported outcomes (PROs) in our clinic population.

Methods: Subjects ≥ 18 yrs with narcolepsy or idiopathic hypersomnia (IH) presenting to the Cleveland Clinic Sleep Disorders Center between 2008–2010 with completed PROs at baseline (BL) and 2–6 months follow-up were studied. Data were obtained through the Cleveland Clinic Knowledge Program (KP), in which the Epworth Sleepiness Scale (ESS), Fatigue Severity Scale (FSS), Functional Outcomes of Sleep Questionnaire (FOSQ), and Patient Health Questionnaire-9 (PHQ9) were electronically archived. Changes in these PROs were assessed by t-tests and linear regressions, controlling for follow-up duration.

Results: 95 subjects (67F:28M; 43.8 ± 15.3 yr, 53 (55.8%) narcolepsy, 42 (44.2%) IH) with follow-up 20.6 ± 14.2 months were included. Comorbid sleep apnea was present in 42 patients (61.9% IH; 30.2% narcolepsy) and 38 used PAP. Improvements were seen for ESS (BL 14.04 ± 5.23; change 3.54 ± 5.02, [P < 0.001]), FSS (BL 47.36 ± 12.98; 3.11 ± 12.26 [P = 0.017]), FOSQ (BL 25.24 ± 25.47; 10.47 ± 25.98 [P < 0.001]), and PHQ9 (BL 9.5 ± 6.42; 2.06 ± 6.42 [P = 0.006]). At follow-up, 57 (60%) were on monotherapy, 34 (35.8%) polytherapy, and 4 (4.2%) no medications. Mean changes in ESS, FSS and FOSQ were higher, but not statistically different, in those with medication change and not statistically different between mono- and polytherapy groups. Compared with IH, subjects with narcolepsy were more likely to use polytherapy at follow-up and to have changed to polytherapy (52.8 vs. 14.3% [P < 0.001] for both), and less likely to have increased wake pro-
moting/stimulant medications (32.1 vs. 57.1% [P = 0.038]). Addition of sodium oxybate was associated with reduction in other medications in 40.7% of subjects.

**Conclusion:** Pharmacotherapy improves multiple domains of functioning in patients with CDH. These clinic-based effectiveness data enhance existing clinical trial data demonstrating reduced sleepiness in narcolepsy.

**Support (If Any):** Cleveland Clinic Knowledge Program

### 0760

#### DIFFERENT FATES OF EXCESSIVE DAYTIME SLEEPINESS: SURVIVAL ANALYSIS FOR SYMPTOM REMISSION

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**Introduction:** Excessive daytime sleepiness (EDS) is a symptom frequently presented in sleep clinics. Only a paucity of data has addressed the clinical course of sleep disorders with EDS. Therefore, we sought to elucidate comparatively the clinical outcomes of the patients presenting EDS.

**Methods:** A retrospective cohort study of patients who underwent polysomnography and multiple sleep latency test (MSLT) due to EDS was performed. The following four diagnoses were included in this analysis; 1) narcolepsy with cataplexy (N+C); 2) narcolepsy without cataplexy (N-C); 3) idiopathic hypersomnia (IH); 4) subjective hypersomnolence (SH) with mean sleep latency > 8 min in MSLT. The remission of EDS and treatment response was determined based on clinical evaluation and interview. Kaplan-Meier survival analysis was done.

**Results:** We included 108 patients diagnosed as N+C (n = 29), N-C (n = 22), IH (n = 24), or SH (n = 33). Remission rate were significantly different (p < 0.001, overall log rank test) among the four groups except those between N-C and IH groups (p = 0.489). While N+C group showed no remission, predicted remission rates of N-C and IH group were 44.6% at 5 years after diagnosis and 32.5% at 5.5 years after diagnosis. The predicted remission rate of SH group was 66.7% at 3 years after diagnosis, the highest of the four groups. However, treatment response did not differ (p = 0.953) among the four groups.

**Conclusion:** The similarity of clinical courses between N-C and IH suggest that N-C may be more related to IH compared to N+C. Considering different clinical courses but comparable treatment responses among EDS patients, thorough evaluation of EDS should be warranted before starting treatment.

### 0761

#### PATIENT GLOBAL IMPRESSION OF CHANGE CORRELATES WITH CLINICAL GLOBAL IMPRESSION OF CHANGE IN A CLINICAL TRIAL OF JZP-110 FOR THE TREATMENT OF NARCOLEPSY

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**Introduction:** JZP-110 is a wake-promoting agent with a distinct mechanism of action that improved objective and subjective symptoms of excessive sleepiness in adults with narcolepsy in a 12-week trial [Black, et al. J Sleep Res 2014;23(Supp 1):32–33]. This post hoc analysis evaluated the correlation between the patient and clinician perspectives for overall change in disease status.

**Methods:** Adult patients with an ICSD-2 diagnosis of narcolepsy were enrolled in a double-blind, placebo-controlled, parallel-group study and were randomized to 12-week treatment with once-daily placebo (n = 49) or JZP-110 (n = 44) 150 mg/day weeks 1–4 and increased to 300 mg/day weeks 5–12. Change in disease status from baseline was assessed at 1, 2, 4, 6, 8, and 12 weeks using the Clinical Global Impression of Change (CGI-C) and Patient Global Impression of Change (PGI-C) scales, both scored using a 7-point Likert-type scale from 1 = “very much improved” to 7 = “very much worse.” This analysis used a Spearman correlation to evaluate the relationship between the CGI-C and PGI-C at Week 12 using a last-observation-carried-forward imputation approach for the entire population.

**Results:** Data were available from 90 patients between the two treatment groups who were similar in demographic and clinical characteristics. At Week 12, JZP-110 resulted in significantly more patients with improvement on the CGI-C (86.0% vs 38.3%; P < 0.0001) and PGI-C (93.0% vs 38.3%; P < 0.0001) than placebo. A large percentage (74.4%) of PGI-C scores matched the CGI-C scores. The correlation between the PGI-C and CGI-C scores was strong and statistically significant (Spearman r = 0.868; P < 0.0001).

**Conclusion:** There was good concordance in the clinician- and patient-reported assessments of change in disease status among patients with narcolepsy treated with JZP 110, as indicated by a strong and statistically significant positive correlation between the CGI-C and PGI-C scores.

**Support (If Any):** This study was funded by Aerial BioPharma.

### 0762

#### UTILITY OF QR-CODED MEDICAL ALERT MATERIALS FOR PATIENTS WITH NARCOLEPSY: SURVEY RESULTS

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**Introduction:** Narcolepsy Network® is a member-based national non-profit organization dedicated to the advocacy for those with the chronic neurological condition narcolepsy. Early in 2014, QR-coded medical alert materials (wristbands and wallet-sized cards) were distributed to over 1,000 members. The QR code on the materials connects to the web page http://narcolepsynetwork.org/narcolepsy-911/, which contains links to commonly used medications, recommended treatment parameters, and a Harvard-based narcolepsy information website.
Methods: Mid-year, a survey was conducted to see if the members found the medical alert materials to be useful in providing quick, accurate information in medical situations. A total of 143 reply responses were received.

Results: Overall, 41% of members carried at least one of the medical alert materials; 52% felt the items were helpful. Many (74%) had used the information for personal reasons and 26% had used it for medical situations, including at least one urgent/emergency visit.

Conclusion: The rapid communication of critical medical information is requisite in order to provide optimal medical care. This is especially urgent when dealing with a patient with a poorly understood medical condition such as narcolepsy. The use of QR-coded medical alert materials provides an easy mechanism for transmitting this information in urgent or emergency settings. We have demonstrated that a relatively small non-profit organization can provide their members with these types of medical alert materials and that these items can prove useful in various situations. Based on feedback from the users of these products, we will continue to modify both the items and the information on the QR code-linked page in an effort to maximize the quality of the medical care provided for people with narcolepsy. We believe that this method could prove beneficial to other organizations who need to provide their members with easily retrievable information using widely available QR code readers.

0763 DEFINITION OF A RESPONDER TO NARCOLEPSY TREATMENT BASED ON THE RESULTS OF A CLINICAL TRIAL OF JZP-110

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Introduction: Responder analyses are important to assess meaningful changes to patients in clinical trials. This post hoc analysis evaluated two patient-reported outcomes, the Patient Global Impression of Change (PGI-C) and the Epworth Sleepiness Scale (ESS), to establish a preliminary estimate of the optimal cut-off criterion for defining responders to JZP-110, a wake-promoting agent that appears to have a distinct mechanism of action.

Methods: Adults with an ICSD-2 diagnosis of narcolepsy enrolled in a phase 2b, double-blind, placebo-controlled, parallel-group study were randomized to 12-week treatment with once-daily placebo (n = 49) or JZP-110 (n = 44) 150 mg/day weeks 1–4 and increased to 300 mg/day weeks 5–12. Descriptive statistics and receiver operating characteristic (ROC) analysis compared the anchor measure, PGI-C, to the percent change from baseline in the ESS to establish the patient-reported responder criterion for this sample.

Results: Patients were predominantly female (64.5%), white (74.2%), with a mean (standard deviation [SD]) age of 38.7 (12.1) years and a baseline mean (SD) ESS of 17.3 (3.3). At Week 12, patients (n = 10) who reported that they were “very much improved” on the PGI-C had a mean reduction in their ESS score of 76.7% and patients (n = 33) who reported that they were “much improved” on the PGI-C had a mean reduction in their ESS score of 49.1%. ROC analysis was used to assess the accuracy of patient outcomes in predicting a “true” response, defined as PGI-C ratings of “much improved” or “very much improved.” The ROC analysis resulted in an area-under-the-curve of 0.9 and suggested that a 25% reduction in ESS (sensitivity, 81.4%; specificity, 80.9%) may be an appropriate cut-off to use for defining a meaningful patient response to JZP-110.

Conclusion: A ≥ 25% reduction from baseline in ESS score may be used as a cut-off criterion to identify patients with narcolepsy who respond to treatment with JZP 110.

Support (If Any): This study was funded by Aerial BioPharma.

0764 EVALUATION OF QUALITY-OF-LIFE IN PATIENTS WITH NARCOLEPSY TREATED WITH SODIUM OXYBATE: USE OF THE 36-ITEM SHORT-FORM HEALTH SURVEY IN A CLINICAL TRIAL

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Introduction: Sodium oxybate (SXB) improves daytime sleepiness and cataplexy in patients with narcolepsy, but clinical trial data on its effects on patient-reported quality-of-life is limited.

Methods: A phase 3, randomized, placebo-controlled clinical trial in patients with narcolepsy (n = 228) who were randomized to placebo or SXB 4.5 g, 6 g, or 9 g nightly for 8 weeks; 6 and 9 g/night doses were titrated in weekly 1.5-g increments. In addition to previously reported measures of sleepiness and cataplexy, quality-of-life was assessed at baseline and end-of-treatment using the 36-Item Short-Form Health Survey (SF-36). Changes from baseline, using last-observation-carried-forward, were compared between active treatment groups and placebo using the Mann-Whitney test, and effect sizes (ES) were estimated (Cohen’s d; 0.20 = small, 0.50 = medium, and 0.80 = large).

Results: Baseline values on all SF-36 domains were substantially lower than normative values for the US general population. After 8 weeks of treatment, mean ± SD improvement from baseline on the Physical Component score was significantly greater than placebo (1.5 ± 6.2) with SXB 9 g/night (6.3 ± 9.1; P = 0.005), showed a moderate ES (0.616), and exceeded the minimal clinically relevant difference of 5. No significant differences versus placebo were significant. SXB 9 g/night resulted in statistically significant improvements from baseline relative to placebo (P < 0.05), demonstrated moderate ES, and exceeded the clinically significant difference of 5. On the Mental Component score, none of the differences between SXB and placebo were significant. SXB 9 g/night resulted in significantly greater improvement on the individual domains of Physical Functioning (4.4 ± 9.2 vs 1.0 ± 8.0; P = 0.016; ES = 0.394), General Health (3.1 ± 7.0 vs 0.4 ± 6.8; P = 0.036; ES = 0.395), and Social Functioning (6.8 ± 16.8 vs 1.1 ± 9.6; P = 0.033; ES = 0.417). On the Vitality domain, all SXB doses resulted in statistically significant improvements from baseline relative to placebo (P < 0.05), demonstrated moderate ES, and exceeded the clinically significant difference of 5. No significant differences versus placebo were observed on the domains of Physical Role, Emotional Role, and Mental Health.

Conclusion: SXB appeared to improve quality-of-life measures in a dose-dependent manner with positive impact at the 9 g/night dose on Physical Component score and individual SF-36 domains of Vitality, General Health, and Physical and Social Functioning.

Support (If Any): This study was funded by Jazz Pharmaceuticals.
0765
SODIUM OXYBATE TREATMENT IN PATIENTS WITH NARCOLEPSY STRATIFIED BY THE PRESENCE OF CATAPLEXY: RETROSPECTIVE SUBGROUP ANALYSIS OF A RANDOMIZED CLINICAL TRIAL
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Introduction: The effects of sodium oxybate (SXB) on narcolepsy patients without cataplexy have not been evaluated in clinical trials.

Methods: This retrospective analysis evaluated data from a phase 3, randomized, placebo-controlled trial of SXB+modafinil in adult narcolepsy patients with cataplexy (NC; n = 95) or without cataplexy (NWOC; n = 127). Cataplexy patients were identified based on medical history, concomitant medications, and sleep-onset REM periods on the nocturnal polysomnogram. Patients were randomized to 8-week treatment with placebo, SXB (6 g/nightly for 4 weeks increased to 9 g/nightly for 4 weeks), 200–600 mg/day modafinil, or SXB+modafinil. Outcomes were changes from baseline at 8 weeks on the Epworth Sleepiness Scale (ESS), Maintenance of Wakefulness Test sleep latency, and percentage of patients with improvement on the Clinical Global Impression of Change (CGI-C).

Results: In the NC group, ESS improvement was significantly greater with SXB (−2.9; P = 0.011) and SXB+modafinil (−3.8; P = 0.002) vs placebo (0.8). Similarly in the NWOC group, ESS improvement was significantly greater with SXB (−3.0; P = 0.021) and SXB+modafinil (−2.8; P = 0.015) vs placebo (0.8). In the NC group, sleep latency was significantly increased with SXB+modafinil (3.34 minutes; P < 0.001), and tended to be increased with SXB (0.90 minutes; P = 0.096) vs placebo (−2.58 minutes). In the NWOC group, sleep latency was significantly increased for all groups vs placebo (P < 0.05). Significantly more NC patients treated with SXB (69.2%; P = 0.004) and SXB+modafinil (59.1%; P = 0.001) achieved “very much improved” or “much improved” on the CGI-C vs placebo (18.8%). More NWOC patients treated with SXB (44.1%) and SXB+modafinil (41.4%) achieved “very much improved” or “much improved” on the CGI-C vs placebo (28.6%), but these differences were not significant. Adverse events were consistent with the drug profiles.

Conclusion: SXB alone or in combination with modafinil improved excessive sleepiness in both NC and NWOC patients.

Support (If Any): This study was funded by Jazz Pharmaceuticals.

0766
EFFECT OF L-CARNITINE ON THE NOCTURNAL SLEEP OF NARCOLEPSY PATIENTS
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Introduction: The gene for carnitine palmitoyltransferase 1B (CPT1B) and abnormally low serum acylcarnitine level have been linked to narcolepsy. We also reported that L-carnitine supplementation, which facilitates CPT1 activity, was effective to reduce the daytime napping in narcolepsy patients. We rechecked this data and found that among 9 patients who reported favorable outcome in general health conditions, 6 showed subjective improvement of nocturnal sleep. In order to clarify the details of nocturnal sleep improvement by L-carnitine supplementation, we performed pilot clinical study using sleep EEG recording as outcome measures to evaluate how L-carnitine improved nocturnal sleep.

Methods: Three narcolepsy patients who had reported improved general conditions by L-carnitine supplementation and two healthy controls were entered a clinical trial to find L-carnitine effect on sleep EEG record. All the participants gave written informed consent. Handy EEG home-monitoring system as well as hospital PSG recording were performed and scored. We calculate sleep stage transition probability in the latter half of nocturnal sleep record in order to evaluate sleep stability (especially REM sleep).

Results: L-carnitine supplementation resulted in the reduction of probability of sleep stage transition from REM sleep to Wake in both narcolepsy and control groups (from 1.91 ± 1.05% to 0.96 ± 0.62% in all the epochs of stage transition (p = 0.050)) and increase the REM sleep stability in both groups shown by the increased probability of sleep stage transition from REM sleep to REM sleep (from 93.2 ± 1.4% to 96.0 ± 1.3% (p = 0.028), probability was divided by the amount of REM sleep).

Conclusion: Our preliminary data showed the reduction of REM-Wake transition and the increase of REM sleep continuity at least in subgroup of narcolepsy patients and controls. This results suggest that L-carnitine was effective for nocturnal sleep stability (especially REM sleep), and fatty acid metabolism could be involved in the sleep stability. Further studies were required and on-going to find the predictor of L-carnitine supplementation responders as well as the mechanism of its effectiveness.

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0767
DROWSINESS AMONG DRIVERS IN SLOVENIA
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Introduction: Excessive daytime sleepiness (EDS) with a prevalence of 20% in the adult population represents an important cause of traffic accidents. In addition to pathological sleepiness, EDS as a consequence of sleep deprivation is common additional risk for motor vehicle accidents. The aim of the study was to raise awareness about dangerous consequences of sleepiness while driving and define driving habits among Slovene drivers and determine whether sleepy drivers pose a greater risk for traffic accidents.

Methods: On the World Sleep Day all drivers who stopped at gas stations “Petrol” received facts about the dangerous consequences of EDS while driving and advices to stop driving while drowsy. Drivers voluntarily filled anonymous questionnaire about their driving habits. Statistical analysis were performed with the program Graph Pad Prism 5, descriptive statistics was used.

Results: The survey was completed by 962 drivers (308 women, 32.0% and 654 men, 68.0%). 18.5% of the surveyed women (57) and 31% (203) of men reported that they had already fallen asleep at the wheel. Men were significantly more sleepy than women (p = 0.000). Highest percentage of sleepiness was found among young people with 54% of respondents (18–30 y) reporting drowsy driving. In 1.6% (5) of all female and 2.8% (18) of all male drivers sleepiness resulted in driving accident. 34% (128) of young drivers reported to continue driving despite feeling drowsy. Maximum % of drowsiness-related accidents was among young drivers (2.2% (12 people from 18 and 30 years)).

Conclusion: Our survey shows, that drivers in Slovenia often feel sleepy while driving. Despite sleepiness they commonly continue...
driving, posing them to higher risk for traffic accidents. We conclude, that prevention of excessive daytime sleepiness is therefore extremely important among drivers.

Support (If Any): The authors would like to thank Petrol for the support of the study.

0768

USE OF THE ODDS RATIO PRODUCT TO INVESTIGATE SUBJECTIVE EXCESSIVE SLEEPINESS
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Introduction: Subjective reports of daytime sleepiness may have multiple causes, including poor sleep quality, inadequate amount of sleep (sleep deprivation), or primary disorders of sleepiness. The Epworth Sleepiness scale (ESS) is currently the most widely used diagnostic tool for daytime sleepiness, evaluating patients’ likelihood of falling asleep in 8 different social situations. However, it does not provide insight as to any distinguishing causes of sleepiness. The Odds Ratio Product (ORP) is a new continuous index of sleep quality. We used this index to distinguish between excessive somnolence due to poor sleep quality and other factors.

Methods: 101 patients with obstructive sleep apnea of different severity (AHI 23.4 ± 5.3, range: 5–107/hr) underwent full polysomnography (PSG). Subjective sleepiness was evaluated by the 24-point ESS ORP values were calculated in 30-second epochs from the electroencephalogram (C3/A2 and C4/A1). ORP was expressed as the average of all 30-second values in total sleep time (TSTORP). This value representing the overall sleep quality during the PSG. A value < 0.8 was considered normal.

Results: 44 patients had excessive sleepiness, defined as an ESS ≥ 10 (ESS = 14.1 ± 3.0). Of these 22 had a normal TSTORP. Average TSTORP in these patients was (0.59 ± 0.13). In the other 22 patients TSTORP ranged 0.81 to 1.39 (1.05 ± 0.16). Interestingly, 18 patients had normal ESS scores (5.3 ± 2.6) despite poor sleep quality (TSTORP > 1; Average, 1.30 ± 0.22), in keeping with the common clinical observation that some patients do not show polysomnographic sleepiness despite severely fragmented sleep.

Conclusion: The Odds Ratio Product may be a useful new tool to categorize patients with subjective sleepiness into those in whom the problem may be poor sleep quality and those in whom sleep quantity is inadequate due to limited time in bed or excessive sleep needs.

0769

HUMANISTIC BURDEN OF NARCOLEPSY: RESULTS FROM THE NATIONAL HEALTH AND WELLNESS SURVEY
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Introduction: Narcolepsy has been associated with increased medical utilization and costs, as has sleep apnea, a common comorbidity. The cumulative impact of narcolepsy and concomitant obstructive sleep apnea (OSA) on medical-related costs has not been well studied.

Methods: Truven Health Analytics MarketScan® Research Databases were accessed to identify individuals > 18 years of age with ≥ 1 diagnosis code for narcolepsy (ICD9 347.0, 347.00, 347.1, 347.10 or 347.11) continuously insured between 2006 and 2010, and controls without narcolepsy matched 1:2 on age, gender, region, and payer. Concomitant OSA was defined by ≥ 1 appearance of a related diagnosis code (ICD9 327.20, 327.21, 327.23, 327.27, 327.29). Mean annual costs per patient (PP) were calculated for inpatient admissions, emergency department visits, hospital outpatient visits, other outpatient services (e.g., chiropractors, in-home oxygen/supplies, labs), physician visits, narcolepsy-related drugs, and other drugs.

Results: Of the 9312 patients with narcolepsy diagnoses in the 5-year period, 51% had concomitant OSA. Specifically, there were 4,787 narcolepsy patients with OSA (N+OSA; 45% male; 99% with diagnosis code 327.23; 22,489 matched controls) and 4,525 narcolepsy patients without OSA (N-OSA; 37% male; 21,395 matched controls). Annual allowed costs PP were significantly higher in the N+OSA group vs the N-OSA group for total medical visits ($9587 vs $7032; P < 0.0001) and total drug costs ($3535 vs $3167; P = 0.0008). All individual cost categories were also significantly (P < 0.0001) higher for N+OSA compared with N-OSA except for narcolepsy-related drugs ($1239...
vs $1313; P = 0.1495). The largest percentage difference in costs between the groups was for other outpatient services (N+OSA, $1,111; N-OSA, $728). For both narcolepsy cohorts, all evaluated costs were significantly higher (P < 0.0001) compared with their respective control groups.

**Conclusion:** These findings confirm that concomitant OSA is common among patients with narcolepsy and that narcolepsy is associated with significant medical costs, which are further increased among patients with concomitant OSA.

**0771**

**CEREBROSPINAL FLUID OREXIN LEVELS IN SYMPTOMATIC NARCOLEPSY - CATAPLEXY, NIEMANN-PICK TYPE C**

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**Introduction:** The symptoms of narcolepsy can occur during the course of other neurological conditions. Inherited disorders, tumors and head trauma were the three most frequent causes for symptomatic narcolepsy. Among inherited disorders, Niemann-Pick type C (NPC), Myotonic dystrophy type 1 (MYD1) and Prader-Willi syndrome were mainly reported. NPC is an autosomal recessive and congenital neurological disorder characterized by the accumulation of cholesterol and glycosphingolipids in the peripheral tissues and of the glycosphingolipids in the brain. Some cases frequently display narcolepsy-like symptoms, including cataplexy. Treatment by Miglustat (Brazaves) was started from 2012 in Japan. This is only one curative treatment for NPC. We had 3 cases of treatment by Miglustat, and one of these cases, orexin levels was increased and the symptom (cataplexy etc.) got better after treatment by it for one year.

**Methods:** The subjects were 8 patients with NPC (4 Male and 4 Female) Patients gave informed consent for the lumbar puncture. We checked clinical symptoms, PSG, MRI/CT and measured orexin levels. Three of them we used Miglustat. We checked orexin levels before medication and one year after medication.

**Results:** Two cases were low orexin levels (< 110 pg/ml), 2 cases were intermediate (110–200 pg/ml), 1 case was normal. Four subjects having cataplexy had low or intermediate orexin levels. Three patients were treated by Miglustat. Before medication, one case with cataplexy had intermediate orexin level, and two other cases without cataplexy had normal levels. After 1 year treatment, all three cases got better their symptoms. Two cases with normal range have no change about the orexin levels, but in one case with intermediate orexin level increased the concentration to the normal and her cataplexy frequency was decreased.

**Conclusion:** The NPC patients with cataplexy have low or intermediate orexin levels. In the cases without cataplexy, their orexin levels were normal. Cataplexy and orexin measurement would make a chance to early diagnose and treatment for NPC. It is also suggested that Miglustat is effective in NPC, especially in young and onset early stage of patients.

**0772**

**CSF OREXIN LEVELS IN HYPERSOMNIA FOLLOWING HPV VACCINATION**

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**Introduction:** There are many reports about adverse reaction associated with administration of vaccines. These reports showed that some patients had severe symptoms, such as systemic joint pain or central nervous system manifestation or motor disorder after they were vaccinated. It is known as HPV associated with neuropathic syndrome (HANS). But there are few studies that have examined hypersomnia as an adverse reaction of the HPV vaccination in detail. There are two type of HPV vaccine, Gardasil and Cervarix. Both vaccines contain adjuvant that has been found to boost the immune system response, respectively. It is well known that, in 2009–10, the incidence of narcolepsy with cataplexy (Type I Narcolepsy) was increased after H1N1 Influenza vaccination in some European countries. That vaccine contains a different adjuvant from HPV vaccine. We had 6 cases with hypersomnia following Human HPV vaccination. We would like to report the results of our investigations including the measurement of CSF Orexin levels for those cases.

**Methods:** The subjects were 6 patients with hypersomnia after HPV vaccination (Cervarix: n = 4, Gardasil: n = 2). Patients were given informed consent for the lumbar puncture. We checked clinical symptoms and CSF orexin levels.

**Results:** Mean age is 16 y.o. Mean length of period from vaccination to onset the symptom is 11 months. Mean score of Epworth Sleepiness Scale is 13 point. In all cases, CSF Orexin levels were normal (mean CSF Orexin level is 326 pg/ml). One case who has symptoms of sleep paralysis and hypnagogic hallucination showed sleep onset REM periods in Multiple Sleep Latency Test for four times. She might be affected with Narcolepsy without cataplexy (Type II Narcolepsy) after vaccination.

**Conclusion:** It shows that there is no relation between hypersomnia following HPV vaccination and Orexin system in this small number study. However, we have one case with narcolepsy without cataplexy. Further studies are needed for more large scale of examination of the patients with HANS.

**0773**

**PHYSICIAN KNOWLEDGE OF RECENT UPDATES TO NARCOLEPSY DIAGNOSTIC CRITERIA: RESULTS OF AN ONLINE SURVEY**

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**Introduction:** Narcolepsy diagnostic criteria (ICSD-3 and DSM-5) were recently revised. An earlier survey in April 2014 suggested that physician knowledge of these revisions and their clinical impact was limited.
Methods: During April and October 2014, an online survey was conducted by InCrowd among physicians (neurologists, pulmonologists, primary care, psychiatrists, and other) who treat narcolepsy patients and were either board-certified in sleep medicine (BC; n = 103; ≥ 5 narcolepsy patients/month) or non-board-certified in sleep medicine (NBC; n = 101; ≥ 3 narcolepsy patients/month). Questions elicited information on knowledge of the revised narcolepsy criteria and how these changes affect their diagnostic approach.

Results: In response to the October 2014 survey, 50% of total respondents self-reported being “very familiar” with the new ICSD-3 narcolepsy diagnostic criteria, more BC than NBC physicians were “very familiar” (rating 6 or 7 on a scale from 1 to 7, with 1–2 being “not familiar” and 6–7 being “very familiar”) with it (82% vs 19%; P < 0.05). While 35% and 34% of BC and NBC, respectively, were “very familiar” with DSM-5 narcolepsy diagnostic criteria, more NBC respondents were “somewhat familiar” with DSM-5 relative to BC (60% vs 45%; P < 0.05), and unfamiliarity among BC was high (20% vs 6%; P < 0.05). Among their sleep disorder patients not previously diagnosed with narcolepsy, respondents reclassified an average of 4 patients with Narcolepsy Type 1 and 5 patients with Narcolepsy Type 2.

Conclusion: While physician familiarity with recently updated narcolepsy diagnostic criteria improved from April to October 2014, familiarity could be further improved, especially among NBC physicians. Revisions resulted in BC and NBC physicians increasing their level of suspicion of narcolepsy and re-evaluating, re-testing, and re-classifying their patients for narcolepsy.

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0774

IMPLICATIONS OF THE NEW ICSD-3 DIAGNOSTIC CRITERIA FOR NARCOLEPSY IN PATIENTS DIAGNOSED BY ICSD-2
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Introduction: In contrast to the ICSD-2, the ICSD-3 allows one sleep-onset REM period (SOREMP) during polysomnogram (PSG) to establish the diagnosis of narcolepsy.

Methods: To evaluate the implications of this revision for patients diagnosed in accordance with ICSD-2, we reviewed records of 531 patients with hypersomnia.

Results: 90 exhibited 1 SOREMP during MSLT (mean age of 32.5, SD = 11.89; 62 females). Of these patients, 7 had narcolepsy with cataplexy according to ICSD-2 criteria, 38 had idiopathic hypersomnia (IH) and 45 had other diagnoses of hypersomnolence. Mean MSLT sleep latency (SL) was 8.38 (SD = 4.39), MSLT REM latency (RL) was 7.96 (SD = 4.03), PSG SL was 23.4 (SD = 30.49) and PSG RL was 109.5 (SD = 81.2). No differences were found between patients having narcolepsy with cataplexy and IH in MSLT and PSG variables. PSG SL and MSLT SL were positively correlated (p < 0.001), as well as PSG SL and MSLT RL (p = 0.045). Reclassification using ICSD-3 criteria resulted in a shift in diagnosis of only one patient (1%). Of the 531 patients who received a MSLT, significant correlation was found between number of SOREMPS in MSLT and PSG SL (p = 0.01) as well as PSG RL (p = 0.038). A strong correlation was found between MSLT SL and PSG SL (p < 0.001), as well as PSG RL (P < 0.001). The number of SOREMPS in MSLT was also correlated significantly with the MSLT SL (p < 0.001), as well as the MSLT RL during the 1st (p < 0.001) and 3rd (p < 0.003) SOREMPS.

Conclusion: ICSD-3 criteria for narcolepsy do not significantly alter the diagnostic sensitivity, when compared to ICSD-2. A shorter PSG SL and RL as well as a shorter MSLT SL predict a higher number of SOREMPS in MSLT. An MSLT should be considered in patients with short PSG RL and SL in the absence of significant AHI, when clinically appropriate.

0775

PREVALENCE, SENSITIVITY, AND SPECIFICITY OF NOCTURNAL SHORT ONSET REM (SOREM) DURING POLYSOMNOGRAPHY (PSG) FOR NARCOLEPSY IN PATIENTS BEING EVALUATED FOR HYPERSONMOLENCE
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Introduction: Nocturnal PSG SOREM (REM latency ≤ 15 min) is suggested to be highly specific (99.2%) but not sensitive for the diagnosis of narcolepsy with cataplexy/hypocretin deficiency. Prevalence estimates of PSG SOREM range between 35.7%-57.4% in confirmed narcolepsy cases compared to ≤ 1% in the general population and sleep clinic samples. We present data on the base rate and diagnostic utility of PSG SOREM for narcolepsy in a heterogeneous sample of patients being evaluated for hypersomnolence (including narcolepsy) via an MSLT.

Methods: Data were extracted from SleepMed’s repository of 4,318 human-edited autoscored PSG records with consecutive MSLTs from 2007–2013. The sample included pediatric and adult patients (age 1–95 yr; M_age = 37.2). MSLT findings with ≥ 2 SOREMPS and a mean sleep latency ≤ 8 min was considered confirmatory of narcolepsy.

Results: The prevalence of PSG SOREM was 1.7% (n = 73) and correlated with the number of MSLT SOREMPS observed (from ≤ 1.0% for up to 4 MSLT SOREMPS to > 26% for those with 5 MSLT SOREMPS). The majority of patients with a PSG SOREM (65.8%) evidenced narcolepsy based on MSLT characteristics. The specificity of a PSG SOREM for narcolepsy based on MSLT findings was 99.5% (95% CI: 99.2–99.7%). Positive and negative predictive values were 72.7% (95% CI: 60.4–83.0%) and 83.8% (95% CI: 82.7–85.0%), respectively.

Conclusion: PSG SOREMPS are more common in patients being evaluated for hypersomnolence compared to patients being evaluated for other sleep disorders (e.g. sleep apnea; see accompanying abstract entitled “Predictors and Potential Confounders of SOREM in 239.047 Adult Sleep Clinic Patients”). Our data support published guidelines that practitioners should consider a diagnosis of narcolepsy when a PSG SOREM is present, especially in the absence of other confounding factors (accompanying abstract).

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0776

REPEATABILITY OF THE MSLT IN PATIENTS WITH KNOWN CSF HYPOCRETIN LEVELS
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Introduction: It has been recently suggested that the multiple sleep latency test (MSLT) has poor test-retest reliability. This retrospective study was undertaken to evaluate the test-retest reliability of the MSLT in individuals with known human leukocyte antigen (HLA) DOBI*06:02 status and/or CSF hypocretin (hcrt) measurement. We hypothesized that test-retest reliability of the MSLT would be higher in individuals with versus without CSF hcrt deficiency.
Methods: Patients with at least two MSLTs and known HLA/CSF status were identified retrospectively in our clinical and research database.

Results: We identified 23 subjects (52% women, mean age 22 years old at time of first MSLT) with at least two MSLTs and known CSF hcr levels. Herc deficiency (less than 110 pg/ml) was present in 12 subjects (mean hcr = 15.7 ± 92.36, p < 0.001) at night and mean sleep latency [2.63 ± 2.04 vs. 6.00 ± 4.62, p < 0.001] during daytime. The presence of SOREM in nocturnal PSG was found in 43% of group-1 (88/206) and 22% of group-2 patients (6/27).

Conclusion: Most patients with cataplexy satisfied with the current criteria of narcolepsy, however, 14% did not. Repeated MSLT or CSF hypocretin assay may be helpful to confirm the diagnosis in patients with cataplexy who do not fulfill current criteria of narcolepsy.

Support (If Any): Jazz Pharmaceuticals SIIR 13 009

0778
THE CLINICO-POLYSOMNOGRAPHIC FEATURES IN NARCOLEPSY PATIENTS WITH CATAPLEXY
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Introduction: To investigate the demographics and sleep study data (overnight polysomnography, PSG and multiple sleep latency test, MSLT) in patients who have cataplexy.

Methods: We reviewed demographics and PSG with MSLT results in clinically diagnosed narcolepsy with cataplexy. Demographics involves history of excessive daytime sleepiness (EDS), cataplexy, sleep paralysis, hypnagogic hallucination, and nightmare. Patients are excluded who have definite obstructive sleep apnea syndrome (apnea-hypopnea index ≥ 15/h) or severe depression.

Results: All patients have definite cataplexy according to the criteria suggested by Mignot et al. Among 233 patients, 86% (206/233, group-1) of them were satisfied with the criteria of two or more sleep-onset REM periods (SOREMP) and mean sleep latency ≤ 8 min in MSLT. The remaining 27 patients (group-2) showed one or no SOREM and cataplexy on history (9: 1 SOREM, 18: 0 SOREM) in MSLT. There were no clinical or neuroradiological etiologies to provoke cataplexy. Between two groups, there were no significant differences in the distribution of following features (Epworth sleepiness scale, Stanford sleepiness scale, sleep paralysis, hypnagogic hallucination, or nightmare).

Conclusion: These data suggest that PSG SOREM are considered diagnostic for narcolepsy in the absence of other known causes. However, the majority of research has studied PSG SOREM in confirmed narcolepsy cases or hypersomnia, and little is known of the base rate and clinical correlates of the phenomenon in general sleep clinic patients. Here we present data on the prevalence of PSG SOREM in a large sample of adult patients being evaluated for various sleep disorders.

Methods: Data were extracted from SleepMed's repository of 239,047 PSGs performed from 2004 to 2013. Multiple logistic regression analyses were employed to predict the odds (odds ratio; OR) of PSG SOREM across multiple domains including demographic/anthropometrics, medical comorbidities, daytime sequelae, habitual sleep timing, and PSG outcomes.

Results: Overall, the prevalence of PSG SOREM was 0.9% (n = 2248). Race contributed the most variance in PSG SOREM (2.0%); African Americans were 2.92 times more likely to have a SOREM compared to Caucasians (3.3% vs. 1.8%). Other predictors included working night shift (OR: 2.21), male sex (OR: 1.76), taking a nap the day of the PSG (OR: 1.48), having a PAP titration (OR: 1.28), taking weekday naps (OR: 1.27), and sleepiness (ESS ≥ 10; OR: 1.26), but effect sizes were generally very small (R² < 0.004). Patients with a PSG SOREM did not have more disturbed nocturnal sleep (subjective or objectively-measured) compared to those without a SOREM.

Conclusion: These data suggest that PSG SOREM are more common than may be expected and support published guidelines that other sleep disorders and insufficient and/or poorly-timed sleep should be ruled out and/or adequately controlled for prior to conducting PSG/MSLTs. The finding that those with a PSG SOREM do not exhibit some of the “known” indications of narcolepsy (disturbed sleep, sleep paralysis, and hypnagogic hallucinations) highlights the need for more systematic research of this group. Racial differences require further exploration as well.
IS was present in 75%, 75% and 63% of children with NC, IH and OH respectively while DCRS was present in 50%, 75% and 74% respectively. Statistical significance was in the OH group (for both IS and DCRS p < 0.001). Parents reported earlier sleep onset compared with actigraphy (11 pm ± 1.4 hr vs 12 am ± 1.6, parent report vs. actigraphy, p < 0.01)

Conclusion: IS and DCRS were common findings in those with primary hypersonmelence disorders. Thus, actigraphy has an added value in the identification of other sleep disorders that potentially mimic narcolepsy.

Support (If Any): University Hospitals Case Medical Center

0780
UTILITY OF THE FIFTH NAP IN THE DIAGNOSIS OF NARCOLEPSY
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Introduction: Narcolepsy is a disabling condition whose diagnosis has significant impact on the patient. It is therefore imperative to get the diagnosis right. Multiple Sleep Latency Tests are currently used to objectively confirm the clinical suspicion with 4 and sometimes 5 naps being carried out to confirm pathological sleepiness and also confirm entry into Rapid Eye Movement sleep in at least 2 of the naps. However the utility of the fifth nap has been questioned by some. We sought to specifically look at the utility of the 5th nap in the diagnosis of narcolepsy.

Methods: Data was collected from a tertiary Sleep Disorders Centre on patients that had a 5th nap during their Multiple Sleep Latency Tests from the 12th November 2013 to 12th November 2014. Their case notes and sleep studies were reviewed.

Results: Fourteen patients had a 5th nap performed out of 5798 nap studies. In 17% of the cases a diagnosis of narcolepsy was made directly due to the inclusion of the 5th nap on the Multiple Sleep Latency Tests. In 57% of cases the Mean Sleep Latency increased due to 5th nap inclusion.

Conclusion: The 5th nap is rarely performed but when it was carried out it helped secure the diagnosis in 17% of the cases in whom it was carried out. This should be balanced against the possible false negatives, the extra time, cost, labour and increased patient anxiety involved. Perhaps greater reliance on Sleep-Onset Rapid Eye Movement sleep from the previous night’s polysomnography could obviate the need for the fifth nap. Arguably, incorporating clinicians’ judgement into the utility of the 5th nap on an individual patient basis could refine standard techniques of the Multiple Sleep Latency Tests.

0781
IDIOPATHIC HYPERSONMOMIA - DEMOGRAPHIC AND POLYSOMNOGRAPHIC FEATURES IN COMPARISON WITH NARCOLEPSY WITHOUT CATAPLEXY
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Introduction: Both Idiopathic hypersonnia (IH) and Narcolepsy without Cataplexy are characterized by increased daytime sleepiness. One of the differentiating features between these two disorders is the presence of 2 or more sleep onset REM episodes in the latter. We aim to understand other demographic and polysomnographic features that separate these two conditions.

Methods: A retrospective chart review was performed at the University of Missouri Sleep center on the patients who were diagnosed with either idiopathic hypersonmia or Narcolepsy without cataplexy since 2009.

Results: 31 and 23 patients met the criteria for IH and Narcolepsy without Cataplexy respectively. In the IH group, there were a total of 6 males (19.4%) and 25 females (80.6%) The mean age at the onset of the disease was 26.5 years in men and 37.4 years in women. The mean Epworth sleepiness score was 18.9 (19.5 in men vs 17.3 in women). The mean sleep onset latency (SOL) during the baseline study was 13.4 minutes while the mean REM sleep onset latency (ROL) was 131.1 minutes. Narcolepsy without cataplexy group also showed increased sleepiness during the baseline polysomnogram with a mean SOL of 8.5 minutes and the mean ROL was 105.1 minutes. The mean SOL during the MSLT in the idiopathic hypersonmia group (4.7 minutes) was comparable with the mean SOL in the Narcolepsy without cataplexy group (4.4 minutes). The mean age at the onset of the disease in males was 28.7 years and 25.3 years in females. Neither of the groups showed sleep onset REM during the baseline polysomnogram.

Conclusion: Our study suggests that Idiopathic hypersonmia has a female predominance. The age of onset of the disease appears to be earlier in men than in women. There was female predominance in the Narcolepsy without cataplexy group as well but the age of onset did not appear to significantly differ between men and women. Though the extent of daytime sleepiness appears to be similar in both the groups, IH differs from Narcolepsy without cataplexy in these demographic and polysomnographic features.

0782
PREVALENCE AND REPERCUSSIONS OF THE ASSOCIATED SYMPTOMS OF NARCOLEPSY IN A REPRESENTATIVE SAMPLE OF SAO PAULO CITY INHABITANTS
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Introduction: Narcolepsy is a disabling disease with a delayed diagnosis. At least 3 years before the disorder identification, several comorbidities can be observed in patients with narcolepsy. The early recognition of the narcolepsy symptoms may improve the long-term prognosis of the patients. Thus, we aimed to investigate the prevalence of the symptoms associated with narcolepsy and its social and psychological repercussions in a representative sample of Sao Paulo city inhabitants.

Methods: We performed a cross-sectional evaluation with 1,010 individuals from the Sao Paulo Epidemiologic Sleep Study (EPISONO). The associated symptoms investigated were excessive daytime sleepiness (EDS), hypnagogic or hypnopompic hallucinations, and cataplexy. EDS was assessed by the Epworth Sleepiness Scale. Volunteers were also asked about the occurrence of cataplexy, and hypnagogic or hypnopompic hallucinations. The participants underwent a full-night polysomnography and completed questionnaires about psychological, demographic, and quality of life parameters.

Results: We observed a prevalence of 13.7% of cataplexy, 36.9% of EDS, and 9.7% of hypnagogic or hypnopompic hallucinations in Sao Paulo city inhabitants. A frequency of 6.7% was observed when cataplexy and EDS were grouped. The other associations were cataplexy + hallucinations (3.9%) and EDS + hallucinations (5.3%). Symptomatic participants were predominantly women, younger, and had poor socioeconomic parameters compared with patients without symptoms. Narcolepsy symptomatology was also associated with a poor quality of life and symptoms of depression, anxiety, and fatigue.

Conclusion: Narcolepsy symptoms are associated with worst psychological outcomes and poor repercussions in the quality of life of the patients.
Support (IfAny): Associação Fundo de Incentivo à Pesquisa (AFIP), São Paulo Research Foundation (FAPESP) [#2013/14420-1 to L.J.K., #2014/15259-2 to C.H., and #2014/10255-9 to P.A.], and CNPq.

0783 PREGNANCY AND CONTRACEPTION EXPERIENCES IN WOMEN WITH NARCOLEPSY: RESULTS OF THE 2012 NARCOLEPSY NETWORK PREGNANCY SURVEY
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Introduction: We examined the experiences of narcoleptic women on issues related to pregnancy and contraception and their perception of adequacy of provider counseling and education.

Methods: Narcoleptic women were invited to complete a questionnaire posted on the Narcolepsy Network website in 2012 addressing knowledge and experiences related to relationships between narcolepsy pharmacotherapy and contraception and pregnancy.

Results: 182 women (age 41.6, range 17–87) participated. 67.6% reported 318 pregnancies resulting in 217 live births. 12.1% reported unplanned pregnancies. 22.0% of women with pregnancies took narcolepsy medications during 36 pregnancies resulting in 21 live births, 12 miscarriages, and 3 elective terminations. Medications used included modafinil (16.7%), traditional stimulants (72.2%), sodium oxybate (5.6%), and antidepressants (55.6%). Respondents took 1 medication in 58.3%, 2 medications in 33.3%, and 3 medications in 8.3% pregnancies. Complications included pre-term labor (n = 5), preeclampsia (n = 3), and cataplexy during labor (n = 1). Among 21 live births exposed to narcolepsy medications in utero, 90.5% were reported as normal, 4.8% had developmental delay, and 4.8% had a birth defect (ear deformity). 34.2% of women with pregnancies reported discontinuing medications for reasons which included fear of fetal adverse effects (92.9%), advice of narcolepsy provider (54.8%), and advice of other provider (38.1%). Management after discontinuing medications included sleep extension (83.3%), increased caffeine (40.5%), medical leave (31.0%), and driving abstinence (26.2%). Counseling from narcolepsy providers was recalled by 29.1% respondents regarding medication use, 21.4% regarding contraception, and 24.2% regarding interaction of hormonal contraception and medications. Only 21.4% respondents reported receiving adequate counseling.

Conclusion: Most women with narcolepsy perceive inadequate education/counseling relative to contraception and pregnancy, potentially increasing unplanned pregnancy and abnormal pregnancy outcomes. Although with limitations of recall bias and self-report, this research highlights the need to optimize narcolepsy education in pregnancy planning and provide relevant information to guide patient-provider decision-making.

Support (If Any): Narcolepsy Network.

0784 NARCOLEPSY WITH CATAPLEXY IN THE ELDERLY
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Introduction: There is limited evidence about health status of subjects suffering from narcolepsy with cataplexy (NC) in the elderly.

Methods: All patients aged more than 60 years who were previously diagnosed with NC according to ICSD 2 criteria were invited to participate in the study. In total, 41 patients (17 men and 24 women) underwent semi-structured interview, physical and neurological examination, and filled out a set of questionnaires. Their median age was 69 (range 61–87) years. The patient’s answers were completed from their hospital records when they were available.

Results: Median age at onset was 22 (0–59) years. The lifelong experience of hypnagogic hallucinations and sleep paralysis was reported by 46% and 46%, respectively. 83% subjects had disturbances of the nocturnal sleep continuity and 72% experienced automatic behavior. 32 (78%) patients were currently on medication against NC symptoms—26 on stimulants (63%), 19 on antidepressants (46%), and 2 on sodium oxybate (5%). The Epworth sleepiness scale median was 17 (4–24). Current median BMI was 32 (21–44). The median menopause age in women was 52 (42–58) years. Medians and ranges of scores in applied questionnaires were as follows: Beck Depression Inventory 5 (0–27), Geriatric Depression Scale 5 (0–27), European Quality Inventory 50 (30–92), Addenbrooke’s cognitive examination 90 (69–100). 17 patients scored below 88 in Addenbrooke’s cognitive examination, but the scores in some subjects were also influenced by sleepiness. OSA was previously found in 21 from 36 subjects examined polysomnographically after the age of 60 years. 6 patients suffered from RLS. Hypertension was reported by 33 (80%), coronary heart disease by 9 (22%), stroke including TIA by 6 (15%), hypothyreosis by 14 (34%), diabetes by 14 (34%), and oncological diseases by 12 (29%). One patient suffered from Parkinson’s disease.

Conclusion: Symptoms of NC persist life-long and the symptomatic therapy is needed also in old patients. The spectrum of comorbidities is similar to general population.

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0785 SLEEP AND PSYCHIATRIC COMORBIDITIES IN OBESE AND NON-OBESE NARCOLEPSY PATIENTS IN MID-MISSOURI
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Introduction: Numerous reports have suggested a link between Narcolepsy and increased body mass index (BMI). While studies have assessed the prevalence of sleep disorders like obstructive sleep apnea (OSA) in Narcolepsy patients (with the suggestion that increased BMI may predispose one to comorbid obstructive sleep apnea), there is little information about psychiatric conditions associated with Narcolepsy.

Methods: We performed a retrospective chart review of patients with Narcolepsy seen at the University of Missouri Sleep Disorders Center since 2009 with confirmed diagnosis by nocturnal polysomnogram and multiple sleep latency test. We reviewed details in their sleep history including comorbid sleep and psychiatric disorders as well as BMI. Based on the definition provided by the Centers for Disease Control and Prevention, Narcolepsy patients were divided into two groups based on their BMI: Obese (BMI ≥ 30) and Non-obese (BMI < 30).

Results: In our initial analysis, charts of 27 patients with Narcolepsy were examined. The sleep comorbidities reported were OSA, insomnia, and restless leg syndrome (RLS). The psychiatric comorbidities present were depression, anxiety, attention deficit hyperactivity disorder (ADHD), and bipolar disorder. Out of 27 patients, 14 patients were considered obese (51.9%) and 13 patients were considered non-obese (48.1%). Of 14 obese patients, OSA was the most common sleep disorder present in 5 (35.7%) patients and depression was the most common psychiatric disorder present in 8 (57.1%) patients. Of 13 non-obese patients, OSA was the most common sleep disorder present in 1 (7.7%) patient and ADHD was the most common psychiatric disorder present in 2 (15.4%) patients.

Conclusion: Based on our study, OSA is the most common sleep disorder in patients with Narcolepsy irrespective of BMI. Depression is the...
most common psychiatric disorder in obese patients with Narcolepsy, while ADHD is most common psychiatric disorder in non-obese patients with Narcolepsy.

**0786**

**NARCOLEPSY SYMPTOMS AND MORTALITY IN A LONGITUDINAL STUDY OF FAMILY MEMBERS OF NARCOLEPTIC INDIVIDUALS**

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**Introduction:** Genetic etiology in narcolepsy has been documented: Multi-family cases can be found in 8% to 10% of narcoleptics’ families. It exists however nearly no longitudinal information on the evolution of narcolepsy symptoms in the narcoleptics’ families.

**Methods:** Information on 4,397 individuals was collected: 358 subjects with narcolepsy and 4039 family members at 3 to 5 year-intervals. In both cases, interviews were conducted by telephone with the Sleep-EVAL system.

**Results:** At the follow-up, 192 family members were deceased and 54 couldn’t be interviewed due to debilitating or terminal disease. The incidence of narcolepsy among family members was 1.2%. Diagnosed obstructive sleep apnea syndrome has a 5-year incidence of 3.7% among men and 2.7% among women. 50.1% of the family remembers reported moderate to severe sleepiness at follow-up. Of them, 34.2% reported an increase in their sleepiness; it was substantial for 11.7% of the family members. 12.2% experienced sleep paralysis at the initial interview. At follow-up frequency increased in 57% and decreased in 19% of cases. The predictors of developing narcolepsy at the second interview were presence of sleep paralysis at the first interview (AOR: 4.73) and presence of excessive sleepiness (AOR: 4.95).

**Conclusion:** Risks for narcolepsy are high in family members. Prevalence of excessive sleepiness is about two times higher in narcoleptic family members compared to the general population.

**Support (If Any):** Educational grant from Jazz Pharmaceuticals
AMBULATORY MONITORING OF SLEEP IN SERVICE MEMBERS WITH POST-CONCUSSIVE SYMPTOMS FROM MILD TRAUMATIC BRAIN INJURY THROUGH ANALYSIS OF LINEAR AND NONLINEAR MEASURES OF HEART-RATE VARIABILITY.

Mirow S, Wilson SH, Churchill S, Weaver LK

Introduction:

Methods:

Results:

Conclusion:

Support (If Any):

Sleep problems and Alzheimer’s disease: A meta-analytic approach

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Introduction: Mounting evidence implicates sleep as one of the risk factors for Alzheimer’s disease (AD) but the extent of the risk is uncertain. We conducted a systematic review and a meta-analysis to quantify the effect of sleep problems/disorders on cognitive decline/AD.

Methods: Original published literature assessing any association of sleep problems/disorders with cognitive decline/AD was identified by searching four bibliographic databases (PubMed, Embase, Web of Science, and the Cochrane library). Effect estimates of individual studies were pooled and relative risks (RR) and 95% confidence intervals (CI) were calculated using random effects models. Additionally, the population attributable risk (PAR) was estimated. Heterogeneity of results across studies was quantified using I-square statistics. To explore potential causes of heterogeneity, subgroup analyses were conducted. Multivariate meta-regression analysis was undertaken to examine the effect of possible influential factors (sex, mean age, sample size and study quality).

Results: Seventy-two publications that met the selection and final inclusion/exclusion criteria were identified for the systematic review. Altogether there was substantial evidence providing support that sleep is associated with cognitive decline/AD. Sixteen observational studies (n = 63,045 participants) that provided 71 RR estimates were included for the meta-analysis. Individuals with sleep problems had a 1.35 times higher risk of cognitive decline/AD than individuals without sleep problems (RR: 1.35, 95% CI: 1.20–1.50). Approximately 9% of AD could be attributed to sleep problems. I-square was 74.9% suggesting heterogeneity among studies; this was not explained by different subgroups. No factors in the meta-regression analysis significantly influenced the effect size between sleep and AD.
Conclusion: This systematic review confirmed the association between sleep and AD and, for the first time, consolidated the evidence to provide an “average” magnitude. As sleep problems are of growing concern in the population, these findings are of interest for both sleep researchers and AD caregivers.

0790
A RANDOMIZED SHAM-CONTROLLED TRIAL OF CONTINUOUS POSITIVE AIRWAY PRESSURE IN PATIENTS UNDERGOING INTENSIVE INPATIENT REHABILITATION AFTER ACUTE STROKE
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Introduction: Obstructive sleep apnea (OSA), present in over 70% of stroke patients, predicts poor functional outcome after stroke. The impact of OSA treatment on stroke recovery is poorly understood.

Methods: This pilot randomized, double-blind clinical trial compared sham to auto-titrating CPAP during inpatient rehabilitation among patients with acute stroke. The primary outcome was feasibility of recruitment into a sham-controlled CPAP trial. Secondary outcomes were CPAP adherence, defined as ≥ 4 hours per night and the Functional Independence Measure (FIM) change from rehabilitation admission to discharge.

Results: Of 125 patients screened over an 18-month period, 65 were eligible and 40 (62%) were randomized (25 with ischemic and 15 with hemorrhagic stroke). Of the 40, 55% were men, and 58%, white. The mean age was 56 (SD = 12); mean body mass index, 29.8 (SD = 5.0); and mean NIH Stroke Scale, 7.4 (SD = 4.9). Median rehabilitation length of stay was 17.5 days (IQR 13, 25). The median apnea-hypopnea index among the 25 patients who completed polysomnography was 13, with 88% ≥ 5. Ten patients withdrew from the study (7 active, 3 sham). Patients who withdrew were significantly more likely to complain of anxiety than those who did not withdraw (p < 0.001). Median CPAP duration was 14 days, average CPAP use was 3.7 hours/night, and 15 out of 30 patients (50%) used CPAP for at least 4 hours nightly. Adherence rates did not differ by treatment assignment. Among 30 patients who completed the study, the FIM changed slightly more in active compared to sham-CPAP (29.9 [SD = 4.0] versus 21.1 [SD = 3.0], p = 0.06).

Conclusion: Although CPAP adherence fell short of goal, enrolling stroke patients in a pilot sham-controlled CPAP trial during inpatient rehabilitation was feasible. Unanswered is whether CPAP use will improve functional outcome in this population. Larger studies should examine long-term CPAP adherence and stroke recovery, recurrence, and mortality.

Support (If Any): University of Washington Institute of Translational Health Sciences Pilot Grant (ULITR000423); NIH National Center for Advancing Translational Sciences

0791
DAYTIME NAPPING IS INVERSELY ASSOCIATED WITH COGNITIVE DECLINE IN COMMUNITY-DWELLING ELDERLY
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Introduction: Subjective sleep problems are very prevalent among elderly with cognitive decline. However, objective assessment of the 24-h sleep/wake patterns in this population is very limited. The goal of this study was to assess objectively via actigraphy the 24-h sleep patterns in a community dwelling elderly population with cognitive decline.

Methods: A subsample of 211 subjects with a diagnosis of Alzheimer’s Disease (AD) [N = 63], mild cognitive impairment (MCI) [N = 115] and normal controls [N = 33] were recruited from a large population-based study in the island of Crete, Greece of 3222 older adults (> 60 yrs), of which the objective was to assess the prevalence and risk factors associated with cognitive impairment. All participants underwent a medical history/physical examination, an extensive neuropsychiatric evaluation and a 3-day 24-h actigraphy. We examined the association of key actigraphy variables (Total Sleep Time, Sleep Efficiency, Sleep Latency, Wake Time after Sleep Onset and number of naps over the 3-day recorded period) among the 3 groups using ANOVA controlling for age, gender, and BMI. Nap was considered as any sleep period during the daytime that was longer than 30 mins.

Results: Patients with AD showed a significantly longer Total Sleep Time (TST) compared to patients with MCI and normal controls (443.9 ± 11.0 min vs. 390.5 ± 7.9, p < 0.02 and vs. 396.9 ± 15.4, p < 0.01, respectively). Also, daytime napping was borderline significantly more frequent in normal controls compared to patients with AD (1.9 ± 0.25 vs. 1.3 ± 0.17, p = 0.06) and to patients with MCI (1.9 ± 0.25 vs. 1.4 ± 0.13, p = 0.07).

Conclusion: Our study shows that elderly patients with dementia sleep longer at night compared to both MCI patients and normal controls. Also, and contrary to our expectations, both groups with cognitive decline nap less than normal controls. It appears that daytime napping is a characteristic of healthy aging and may be a protective factor against cognitive decline.


0792
POLYSOMNOGRAPHIC FINDINGS IN HOSPITALIZED PATIENTS WITH SEVERELY IMPAIRED CONSCIOUSNESS
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Introduction: Polysomnography (PSG) is the only reliable tool evaluating sleep status. However, there is a paucity of sleep studies of patients with severely impaired consciousness.
Methods: We studied the consecutive five patients who showed with severely impaired consciousness from January to April in 2014. We investigated the sleep pattern and PSG findings. As all showed diffuse continuous slowing in electroencephalography (EEG), evident decreased electromyographic (EMG) amplitude compared to background with posterior background slowing in EEG or presence of sleep spindles was defined as sleep. We also defined REM sleep when there was an absence of EMG tone and/or presence of rapid eye movement.

Results: Five adults (3 males; 52 ± 18.9 yrs), with severely impaired consciousness, underwent PSG on average 77 days (range 49–130 days) during their hospital day in Rehabilitation department. They were all received the tracheostomy. Median Glasgow coma scales (GCS) were 4 (range 4–9). EMG tone increased in all who showed spastic paralysis, and it obscured EEG signals. In two patients, sleep spindles were evident. In hypnogram analysis, all had a few episodes of visually observed consecutive sleep period in night time. Total sleep time, sleep efficiency, waking after sleep onset, arousal index, periodic leg movement index, and NREM vs. REM proportion were variable to each patient. In three, reduced sleep efficiency and severely fragmented sleep was observed, but not in two. All patients remained GCS within nine after three months follow-up.

Conclusion: Studying and defining sleep is challenging in patients with severe impaired consciousness. Although our sample size was small, these findings indicate that patients with severely impaired consciousness have diverse sleep status with some night sleep tendency.

0793 SLEEP IN CHILDREN WITH AUTISM SPECTRUM DISORDERS: HOW ARE MEASURES OF PARENT REPORT AND ACTIGRAPHY RELATED?
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Introduction: Sleep disturbance is common in children with autism, resulting in a great need for effective treatments. To evaluate treatments for sleep disturbance in this population, it is critical to understand the relationship between measures of sleep captured by parent report and objective measures.

Methods: Parent report using the Children’s Sleep Habits Questionnaire (CSHQ) and actigraphy-measured data from 80 children with autism and sleep onset delay were evaluated. Responses on the CSHQ were evaluated focusing on whether or not the child had problems with sleep duration, night wakings, and/or bedtime resistance, in relation to sleep onset delay. Actigraphy measurements in children whose parent indicated the corresponding behavior was a problem on the CSHQ were compared to measurements in children who did not have a reported problem by performing Wilcoxon rank sum tests. Further, the correlation structure across CSHQ subscale item scores, questions of interest to insomnia, and the comparable actigraphy measurements was determined by calculating pairwise Spearman’s correlation coefficients (ρ).

Results: Reported problems with sleep onset delay were concurrent with sleep duration problems in 66% of children, night wakings in 72% of children, and bedtime resistance in 66% of children; 38% of children were reported to have problems with all insomnia domains. Actigraphy-measured sleep duration was correlated with estimates based on CSHQ-reported bed and waketimes. The relationship between parent report and actigraphy measures was stronger following intervention with parent education.

Conclusion: Parent report provides information regarding sleep duration that is related to sleep duration measured with actigraphy. This indicates that, in the absence of objectively-measured sleep duration data, parent-reported sleep durations derived from bedtimes and waketimes collected via the CSHQ provide estimates of total sleep time that are consistent with actigraphy measurements. This calculated variable from the CSHQ should be useful for future research studies of sleep duration in autism.

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0794 PREVALENCE OF SLEEP PROBLEMS IN CHILDREN WITH NEURODEVELOPMENTAL DISORDERS: A FOLLOW-UP STUDY
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Introduction: Importance of sleep to proper health has emerged in recent years. Sleep disturbances have significant adverse effects on the quality of life of children and their families. Individuals with neurodevelopmental disease are at particular risk because sleep disruptions lead to exacerbation of daytime behaviors and result in poor cognitive performance. We have reported results of questionnaire survey reflecting frequent occurrence of sleep problems in these patients. We are now reporting the results of 1 year follow up survey to assess the persistence of sleep problems among these groups.

Methods: Subjects with Angleman Syndrome (AS), Rett Syndrome (RTT), Prader-Willi Syndrome (PWS), and normal siblings were recruited from the Rare Disease Clinical Research Network consortium registries. Comparisons were made between neurodevelopmental disease groups and between these and control group. Study participants and parents/guardians were asked to complete these questionnaires. The questionnaires include Pediatric Sleep Questionnaire (PSQ) sleep disordered breathing subscale (SRBD); Children’s Sleep Habits Questionnaire (CSHQ) including Insomnia Subscale; Pediatric Daytime Sleepiness Scale (PDSS); Cleveland Adolescent Sleepiness Questionnaire (CASQ). The questionnaires were repeated after 1 year for follow-up assessment.

Results: AS patients had highest mean scores in CSHQ (53.73) compared to other disease groups and controls (45.51). RTT group had highest scores in CASQ and PDSS and Insomnia Subscale. All neurodevelopmental disease groups score higher in all questionnaires including insomnia subscale and SRBD as compared to control group at baseline and at 1 year follow-up. Higher scores are associated with more sleep problems. For example, 21% of RS patient report insomnia at base line and 12% at follow-up, as compared to 1.69% of controls at baseline and 2.8% at follow-up.

Conclusion: Sleep problems in general and specifically insomnia, SDB and daytime sleepiness are prevalent and chronic in patients with neurodevelopmental disorder as compared to their normal siblings.

Support (If Any): The Rare Disease Clinical Research Network, The AS, RTT and PWS Consortium and Rettsyndrome.org
THE CORRELATION OF OREXIN (HYPOCRETIN) SYSTEM AND ASTROCYTE ACTIVATION IN PARKINSON’S DISEASE WITH HYPERSONOLLENCE
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Introduction: We studied the correlation of the orexin (hypocretin) system and astrocyte activation in hypersomnolence symptom (HS) in Parkinson’s disease (PD).

Methods: In a total of 30 subjects, including 5 PD patients with HS, 8 PD patients without HS, 8 patients with narcolepsy, and 9 control subjects, orexin and glial fibrillary acidic protein (GFAP) as well as S100B levels, which are markers of astrocyte activation, in CSF were measured and compared.

Results: In the comparison of orexin levels among the 4 groups of subjects, only narcolepsy group showed significantly lower levels. The PD with HS tended to be lower orexin levels compared with those in the control group, although the difference was not statistically significant. The majority of reports have indicated that CSF orexin levels are in the normal range in most PD patients, some PD patients with severe HS showed low orexin levels. Compared with those of the control group, GFAP levels were significantly higher in the group of PD with HS and narcolepsy group, but not PD without HS. No groups showed a significant difference in S100B levels.

Conclusion: In the whole subjects with PD, narcolepsy and controls, orexin levels were inversely correlated with GFAP. Therefore, increased GFAP may indicate orexin deficiency both in narcolepsy and PD with HS.

EXCESSIVE DAYTIME SLEEPINESS IN PARKINSON’S DISEASE
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Introduction: Sleep disorders are common in Parkinson’s disease (PD). The aim of this study was to investigate the association of daytime sleepiness with other non-motor or motor manifestations of PD.

Methods: 201 PD patients were enrolled from a movement disorders clinic over two years. Using structured clinical documentation support tools built into the electronic medical record, we captured the following measures at initial office visits: disease duration, Epworth Sleepiness Scale (ESS), Geriatric Depression Scale (GDS), Montreal Cognitive Assessment (MoCA), Nine Hole Peg Test (9-HPT), Unified Parkinson’s Disease Rating Scale (UPDRS), Hoehn and Yahr stage (HY), and Schwab and England activities of daily living scale (SE).

Results: PD patients were 70.6% male, 92.0% Caucasian. Median age was 71 years (range 42–91), median age at onset was 65 years (range 28–86) and the median disease duration was 4 years (range 0–43). 71.8% were receiving dopaminergic therapy. Spearman correlation analyses showed that the ESS (median 7, range 0–23) and GDS (median 3, range 0–13) were correlated, adjusted (p = 0.23, p < 0.001) and unadjusted for dopaminergic therapy. ESS was also correlated with UPDRS mentation, behavior, and mood scores (median 1, range 0–12), adjusted (p = 0.25, p < 0.001) and unadjusted for dopaminergic therapy; and with UPDRS ADL scores (median 9, range 0–34) unadjusted (p = 0.26, p < 0.001) for dopaminergic therapy. ESS was not correlated with disease duration, MoCA, 9-HPT, UPDRS motor, UPDRS complications of therapy, HY, or SE. Principal component analysis showed that the ESS captures an important domain of variability in untreated but not in treated patients.

Conclusion: In PD, self-reported sleepiness is correlated with subjective depression or mentation, behavior, and mood measures. Interestingly, it is not correlated with objective measures of motor and cognitive impairment. In this cohort, the variance between daytime sleepiness and disease severity measures is treatment dependent.

QUALITY OF LIFE AND WILLIS-EBKOM DISEASE IN PARKINSON’S DISEASE
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Introduction: Parkinson’s disease (PD) is a progressive neurodegenerative disorder, which reduces substantially the quality of life of affected individuals. Changes in sleep occur in up to 80% of patients causing underestimated damage. Among half of PD’s patients suffers from Willis-Ekbom Disease (WED). The objective is to evaluate the quality of life in PD’s patients with and without WED in a tertiary center for movement disorders.

Methods: A cross-sectional study was conducted. Eighty eight consecutive PD patients were selected from a tertiary center of movement disorders. They were interviewed by a neurologist specialist in sleep medicine and movement disorders. The International Restless Legs Syndrome Study Group criteria was used to diagnosis WED, and the PD quality of life questionnaire (PDQ-39) was used to stratify the quality of life in these patients.

Results: Among the 88 individuals with PD, 28.4% had WED. The PDQ-39 total and domain values (mean ± standard deviation) in PD patients with and without WED were respectively: total 54.8 ± 12.2 vs 39.5 ± 17.5; p < 0.001; mobility 22.1 ± 8.3 vs 17.4 ± 10.3; p < 0.05; activities of daily living 14.6 ± 5.8 vs 11.1 ± 7.0, p < 0.05; emotional wellbeing 14.5 ± 4.2 vs 10.4 ± 5.1, p < 0.05; stigma 9.0 ± 3.3 vs 5.6 ± 4.3, p < 0.05; social support 3.7 ± 2.7 vs. 2.1 ± 2.5, p < 0.05; cognitive impairment 8.2 ± 3.0 vs 6.3 ± 3.3, p < 0.05; communication 4.7 ± 2.0 vs 3.8 ± 2.6; bodily discomfort 8.0 ± 1.7 vs 4.9 ± 2.8, p < 0.05.

Conclusion: We observed that PD patients with WED have a poorer quality of life when measure by PDQ-39 and compared with those without WED.

Support (If Any): CAPES
tion, levodopa equivalent daily dosage, use of deep brain stimulation, sleep aid use); MDS-UPDRS (Movement Disorder Society-Unified Parkinson’s Disease Rating Scale) Part IB (Non-motor subscale minus two items addressing sleep quality and daytime sleepiness) and Part II (Motor subscale), Patient Health Questionnaire-9 (PHQ-9), Generalized Anxiety Disorder-7 (GAD-7) and EuroQol (EQ5D quality of life scale). Cronbach’s α was used to determine the internal consistency of ISI. Correlations between ISI and motor and non-motor PD variables were evaluated using Spearman’s correlation. Linear models measured associations between modified MDS-UPDRS IB and ISI adjusting for key covariates.

Results: 96 subjects participated: mean age ± 6.6 ± 6.6, 59 (61.5%) male, 6.0 (4.0, 10.5) years mean PD duration. Median ISI was 7.0; 31 (32.3%) had ISI > 7 (mild symptoms); 16 (16.7%) ≥ 5 (moderate-to-severe symptoms). Cronbach’s α was 0.85, indicating good internal consistency among ISI items. Total score of MDS-UPDRS Parts IB and II, GAD-7 and PHQ-9 were positively correlated with ISI, while EQ5D was negatively correlated (P < 0.005). After adjusting for demographics, MDS-UPDRS II, GAD-7, PHQ-9 and EQ5D, modified MDS-UPDRS IB remained significantly associated with ISI (p = 0.002).

Conclusion: ISI has good internal consistency in PD patients and correlates with PD non-motor symptom severity even when eliminating items specific to nighttime and daytime sleep. This work supports the need for further investigation into the role of insomnia and its treatment in PD.

0799
SLEEPINESS, IMPAIRED VIGILANCE, AND VISUAL PROCESSING DEFICITS AFFECT PEDESTRIAN SAFETY IN PARKINSON’S DISEASE
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Introduction: Daytime sleepiness is common in Parkinson’s disease (PD) and negatively affects quality of life in these patients.

Methods: In order to evaluate the impact of daytime sleepiness and vigilance on safe pedestrian behavior, 45 subjects with Parkinson’s disease and 15 healthy older controls participated in a virtual reality (VR) pedestrian environment. Additionally, subjects were administered the Epworth Sleepiness Scale (ESS); the psychomotor vigilance task (PVT); the Useful Field of View (UFOV), a measure of visual processing speed; and the Unified Parkinson’s Disease Rating Scale (UPDRS) Part III, a measure of PD motor symptoms. The primary outcome measure was the mean time to contact (TTC), or the shortest time between an approaching vehicle and the participant, as measured by the VR task. We hypothesize a negative correlation between subjective sleepiness and TTC.

Results: Compared to control subjects, participants with Parkinson’s disease had a significantly shorter TTC (p = 0.0187) and more hits and close calls (p = 0.0044), indicating less safe pedestrian behavior. PD subjects also had more subjective sleepiness (p = 0.0186) and slower response time as measured by the PVT (p = 0.0268). In subjects with PD, TTC showed a significant negative correlation with subjective daytime sleepiness (r = −0.334, p = 0.0268) and a positive correlation with response time on the PVT (r = 0.551, p = 0.0024), indicating less safe pedestrian behavior in those who were sleepier and less vigilant. There was also a significant negative correlation between TTC and the UFOV (r = −0.481, p = 0.0011), indicating that those with more visual processing deficits have less safe pedestrian behavior. The UPDRS did not correlate with any of the other measures.

Conclusion: Patients with PD have less safe pedestrian behavior compared to healthy older control subjects and this behavior is influenced by daytime sleepiness, vigilance, and visual processing deficits.

0800
SLEEP CHARACTERISTICS OF INDIVIDUALS WITH CHRONIC STROKE: A POLYSOMNOGRAPHIC STUDY
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Introduction: Changes in sleep characteristics in individuals with chronic stroke are not well described particularly compared to healthy individuals, and it is not clear how sleep is altered according to lesion side (left vs. right) in individuals with chronic stroke. Therefore, the purpose of this study was to explore the sleep characteristics in individuals with chronic (> 6 months) stroke compared to age- and sex-matched controls as well as explore sleep characteristics according to lesion side.

Methods: Seventeen individuals with chronic stroke (> 6 months; 13 right vs 4 left-sided lesions) and 10 age- and sex-matched controls underwent two nights of polysomnographic recording. The sleep characteristics of interest included: total sleep time, sleep efficiency, and percent time as well as time in minutes spent in stages N1, N2, and N3 and stage R sleep.

Results: The individuals with chronic stroke spent less percent time in stage N3 compared to controls (p = 0.044). Those with right sided lesions spent less time in stage N3 (p = 0.017) and less percent time in stage N3 (p = 0.011) compared to those with left sided lesions. No significant difference in the other sleep characteristics was found between the stroke and control groups.

Conclusion: Individuals with chronic stroke present with altered stage N3 sleep compared to healthy controls. Furthermore, individuals with right sided lesions spent less time in stage N3 sleep compared to those with left sided lesion. These alterations in stage N3 sleep might impact recovery following stroke and should be investigated and assessed carefully. However, lesional side analysis should be interpreted with caution due to the small sample size of individuals with left-sided lesions.

Support (If Any): This work is supported by the American Heart Association Scientist Development Grant (09SDG2060618) awarded to CS.

0801
INVESTIGATION INTO THE FREQUENCY OF APNEA IN THE SETTING OF ACUTE INTRACEREBRAL HEMORRHAGE
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Introduction: The frequency of sleep disordered breathing (SDB) in those with acute intracerebral hemorrhage (ICH) is not well defined. We undertook a single center prospective observational pilot study in order to better delineate the frequency of SDB in ICH.

Methods: This was a prospective observational single center pilot study. Eligible patients were aged > 18 years with CT-confirmed spontaneous ICH and were identified within 72 hours of admission to our hospital. Hematoma volume was determined using Cartesian approximation (the ABC/2 method). Bedside unattended 4 channel polysomnograms were utilized in order to delineate the frequency of SDB. A
validated survey questionnaire, the STOP survey, was administered at the time of enrollment.

Results: A total of 24 patients were screened and three patients successfully completed enrollment. Sleep disordered breathing was found in all patients enrolled with a mean AH1 of 7.9 (range 7–9) and mean ICH volume of 16.27 cc (range 7.3–35 cc). Thalamic, Basal Ganglia and Cortical ICH were captured in the cohort studied. Main barriers to enrollment included exclusion of patients with intra-ventricular extension due to possible neurosurgical intervention, as well as declination of enrollment.

Conclusion: SDB does occur in the acute ICH setting and further study is warranted in order to replicate these findings, as well as determine whether or not treatment of SDB would impact outcomes or morbidity and mortality in hemorrhagic stroke.

0802
HIGH FREQUENCY OF NEUROPSYCHIATRIC FEATURES IN IDIOPATHIC REM SLEEP BEHAVIOR DISORDER
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Introduction: Idiopathic REM sleep behavior disorder (iRBD) has a strong association with the synucleinopathies. Our goal was to identify cross sectionally, the frequency of neuropsychiatric (NP) features in iRBD cases in order to facilitate prediction of eventual phenoconversion.

Methods: We analyzed the demographic, clinical, and neuropsychiatric (NP) features of participants in a longitudinal research program with iRBD diagnosis, who did not meet standard criteria for mild cognitive impairment (MCI), Parkinson’s disease (PD) or Dementia with Lewy Bodies (DLB) (n = 16). Frequency and severity of NP features on the 12 item Neuropsychiatric Inventory (NPI) were reviewed, excluding the item on sleep disturbances in order to avoid circularity. Automated submentalis REM atonia index (RAI) analysis was also performed.

Results: 87% (14/16) were men with mean age 63 years, mean UPDRS motor subtest score 0.625, mean Short Test of Mental Status score 36.18, mean Mini-Mental State Examination score 29.13, and mean RAI 0.69. The majority (68.75%) had ≥ 2 NP features, with irritability being most frequent (50%). 6/6 cases with subjective cognitive complaints but normal performance on neuropsychological testing had 3 NP features. Among the cases with UPDRS > 0 (n = 6), the 2 with subjective cognitive complaints had ≥ 5 NP features while 3/4 who did not have subjective cognitive complaints had ≤ 3 features. Lower RAI predicted MMSE scores (F = 6.3, R2 = 0.38, p = 0.03).

Conclusion: NP features are frequent in iRBD patients in the absence of diagnosis of MCI, PD or DLB. We hypothesize that cases with NP features and subjective cognitive complaints may be on the course of phenoconversion to MCI/DLB, whereas those with UPDRS > 0 and low NPI, but without any cognitive symptoms may develop PD. Longitudinal assessment of iRBD patients using neuropsychiatric as well as cognitive, motor, and REM muscle atonia measures may provide insights into subsequent phenoconversion.

0803
THE USE OF DATSCAN IN IDIOPATHIC REM SLEEP BEHAVIOR DISORDER (iRBD) AS A SCREENING TOOL TO IDENTIFY PATIENTS AT RISK FOR DEVELOPING PARKINSONISM SYNDROMES (PS)
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Introduction: DaTscan (l Io f l upane I 1 2 3 In j e cti on ) is a radiophar- macutical indicated for striatal dopamine transporter visualization using single photon emission computer tomography (SPECT) brain imaging to assist in the evaluation of adult patients with suspected Parkin- sonism syndromes (PS). Studies have demonstrated that the motor symptoms of PS become apparent when about 80% of basal ganglion dopamine neurons are lost. In one study, researchers found that up to 75% of patients with REM Sleep Behavior Disorder (RBD) went on to develop a PS years later.

Methods: Patients with identified idiopathic RBD (iRBD) have been identified and counseled about the association between RBD and PS and agreed to dopamine transporter imaging. Imaging consists of l Of l upane I 1 2 3 In j e cti on 111–185 MBq administered intravenously and SPECT images are taken 3–6 hours after administration. Quantitative analysis methods are being assessed with the data but qualitative image interpretation divides abnormal scans into three categories: (1) asymmetric putaminal dopaminergic activity, (2) absent putaminal dopaminergic activity in both hemispheres with activity confined to the caudate nuclei, and (3) absent putaminal dopaminergic activity bilaterally with greatly reduced activity in one or both caudate nuclei.

Results: We have at this time identified 10 patients that fit the criteria and are going forward with SPECT striatal dopamine transporter visualization testing. Preliminary data show abnormal striatal dopaminergic activity in the aforementioned patterns that have been associated with PS. Analysis of the data will be presented along with additional patients beyond the current ten. Qualitative assessment and results from new quantitative methods will be presented.

Conclusion: This trial in iRBD will determine whether SPECT striatal dopamine transporter visualization testing can be used as a viable tool to screen which of these patients are at greatest risk for developing PS. This will open the window to initiate treatments that may hinder the progression of PS.

0804
RAPID EYE MOVEMENT SLEEP BEHAVIOR DISORDER IN PATIENTS WITH PROBABLE ALZHEIMER’S DISEASE
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Introduction: The rapid eye movement (REM) sleep behavior disorder (RBD) is commonly associated with neurodegenerative disorders characterized by α-synuclein deposition, including Parkinson’s disease (PD), multiple system atrophy (MSA), and Lewy body dementia (DLB). However, this tendency in the tauopathy-mediated diseases is rare and only sporadically reported. Our study aimed to systemically illustrate
the occurrence of RBD and sleep features among a cohort of patients with Alzheimer’s disease (AD), a nonsynucleinopathy.

Methods: We recruited 105 clinically probable AD patients. Fifteen AD patients who complained of sleep-related abnormal behaviors underwent a video-polysonmography (vPSG) examination, neuropsychological tests and MRI/CT examination.

Results: Five patients with probable AD showed RBD. One of the patients performed repeated touching of the head and face with his hands and flailed his arms. Three patients showed hands twisting, exploring, prominent limb kicking, and jerking. The last patient had all of the features of RBD (he could recall a dream about fighting animals), and his wife was awakened by his screaming. Of the five patients, one patient took the acetylcholinesterase inhibitor drug, donepezil. The patients with AD +RBD demonstrated increases in both tonic and phasic EMG activity during REM sleep, but the sleep architecture did not differ between the AD+RBD and AD groups.

Conclusion: RBD can occur in patients with AD. The occurrence of RBD in patient with dementia does not completely rule out the diagnosis of AD.

0805 PROLONGED SLEEP LATENCY AND SLEEP ONSET REM IN A NEURODEGENERATIVE TAUPATHY DISEASE
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Introduction: Though there has been little research in the area to date, tauopathies are typically thought to be associated with sleep disturbance. Of the tauopathies, sleep in individuals with Progressive supranuclear palsy (PSP), a 4 repeat (4r)-tauopathy, may be particularly affected as early neurodegenerative processes start in the brainstem. We hypothesized that individuals with PSP have a higher incidence of sleep disorders, poorer night-time sleep and are sleepier during the day compared to controls.

Methods: Individuals with PSP (n = 13; 8 men; mean age: 61.5 ± 6.4 years) and clinically healthy older adults (n = 9; 5 men; mean age: 72.7 ± 4.5 years) were studied in the UCSF clinical research center with overnight polysomnography and a multiple sleep latency test (MSLT) the next day.

Results: We found an increased incidence of periodic limb movements but not sleep apnea in PSP. Individuals with PSP took longer to fall asleep (p = 0.005), spent less time asleep (p = 0.03), less time in REM sleep (p = 0.02) and overall had poorer sleep efficiency (p = 0.004) and maintenance (p = 0.01). Unexpectedly, on the MSLT, 3/13 PSP never fell asleep. Of those that did fall asleep (10 PSP, 9 controls), individuals with PSP took longer to fall asleep (p = 0.02) and 3/10 individuals entered REM sleep. REM sleep was absent in the daytime sleep periods in controls.

Conclusion: As expected, PSP had a higher incidence of some sleep disorders and greater nighttime sleep disturbance. Contrary to our hypotheses, PSP individuals appeared less able to sleep though had increased incidence sleep-onset REM episodes. Sleep-onset REM sleep during an MSLT with prolonged sleep latencies are both unexpected and novel. Based on our current findings, regulatory mechanisms for sleep/waking, as well as REM sleep are disrupted in PSP. Future work includes increasing our sample and adding an additional 4r-tauopathy cohort (Corticobasal Degeneration).

Support (If Any): Tau Consortium and R01AG032289 (Kramer)

0806 VALIDATION OF TURKISH VERSION OF REM SLEEP BEHAVIOR DISORDER QUESTIONNAIRE
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Introduction: This study aim to validate the Turkish version of the REM sleep behavior disorder questionnaire and to investigate its reliability, validity, and responsiveness of this instrument for diagnostic and monitoring purposes.

Methods: For the Turkish adaptation of the REM sleep behavior disorder questionnaire (RBDSQ), the objectives of this study were explained to the Stiasny-Kolster and approval was given to translate the original version of RBDSQ to establish the first RBDSQ-Turkish. This study enrolled 78 non-patients population, 17 patients with REM sleep behavior disorder (RBD) and 28 consecutive patients with obstructive sleep apnea syndrome (OSAS)

Results: One hundred and twenty three subjects participated in the present validation study. Seventeen RBD patients were identified in sleep clinics (5 females and 12 males; mean age 68.6 ± 6.3 years, range 55–77 years), twenty eight OSAS patients were identified in sleep clinics and they all had their polysomnographic recordings (9 females and 19 males; M age 50.04 ± 10.8 years, range 34–77 years), and seventy eight healthy adults were recruited from general population (57 females and 21 males; M age 40.01 ± 6.9 years, range 30–58 years). 57.7% of the participants: (n: 71) were female and 42.3% (n: 52) were men. Mean age was 46.2 ± 12.6. Data revealed that there are significant differences between these three groups [F(2, 120) = 57.04, p = 0.000, η² = 0.49]. RBDSQ-T can discriminate RBD patients from healthy group with a sensitivity of 100% and specificity of 87% at a cut-off level of five.

Conclusion: The RBDSQ-T had high sensitivity, specificity, and reliability and would be applicable as a screening method for RBD in the Turkish population. These results indicate that RBDSQ-T is a valid and reliable tool.

0807 NOCTURNAL FRONTAL LOBE EPILEPSY (NFLE): PRELIMINARY EXPERIENCE WITH LACOSAMIDE AS A NEW AGENT FOR TREATMENT
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Introduction: Nocturnal frontal lobe epilepsy (NFLE) is a partial epilepsy syndrome with seizures characterized by a spectrum of stereo-typed motor behavior occurring predominantly or exclusively during sleep. There are two recognized forms of NFLE, sporadic and autosomal dominant. In the autosomal dominant form mutations coding for the nicotinic acetylcholine receptor subunit (nAChR) genes and corticotropin-releasing hormone gene have been identified, suggestive of a channelopathy. Carbamazepine is the agent that has been highly effective therapy for up to 70% of patients, however, a substantial portion of NFLE patients fail to respond or have adverse events with standard medications, and might benefit from alternative agents. Our study evaluate the potential value of a newer and different sodium-channel mediating agent, lacosamide (LCM), for treatment-resistant NFLE.

Methods: A retrospective analysis of all patients diagnosed with NFLE at the University of Maryland Epilepsy Center from 2008 to 2011 was performed. Patient response to current treatment was assessed and those who were treatment-resistant or had adverse effects from medications were offered alternatives, including lacosamide. Among patients given lacosamide, responses were evaluated.

Results: We identified 18 patients diagnosed with NFLE. Twelve (67%) reported satisfaction with seizure control and lack of adverse effects.
For the remaining 6 patients, 4 chose to add lacosamide on as adjuvant therapy. Two patients discontinued lacosamide due to intolerable side effects. The other two patients reported improved seizure control and tolerability after one year follow-up, with one patient seizure-free and the other experiencing rare, mild episodes when sleep-deprived. **Conclusion:** A substantial portion of patients diagnosed with NFLE and treated with standard medication report unsatisfactory seizure control or adverse effects warranting consideration of alternative treatments. Based on our preliminary experience, lacosamide, a new sodium-channel mediating agent, may be an alternative treatment for NFLE, and warrants consideration in future prospective studies.

**0808**

**THE EPWORTH SLEEPINESS SCALE IN EPILEPSY: INTERNAL CONSISTENCY AND DISEASE-RELATED ASSOCIATIONS**


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**Introduction:** Daytime sleepiness is one of the most common complaints of people with epilepsy (PWE). No validated instruments have been explored in this population. We investigated the internal consistency of items of the Epworth Sleepiness Scale (ESS) and correlations between total ESS and disease-specific variables in an observational study exploring the prevalence of sleep disorders in PWE.

**Methods:** 117 subjects underwent sleep testing and completed ESS, Insomnia Severity Index (ISI) and Beck Depression Inventory (BDI). Cronbach’s α and factor analysis were performed to assess the internal consistency and validity of ESS. Spearman’s correlation was used to evaluate relationships between total score and item scores, and to assess associations between total score and demographic and disease-specific variables (seizure frequency, antiepileptic drug [AED] number, standardized dose). Analysis was performed using an overall significance level of 0.05 and SAS software (version 9.3, Cary, NC).

**Results:** Sample characteristics: mean age 39 ± 13, 33.3% female, BMI 28.6 ± 6.9, median seizures/month 0.50. Mean ESS was 7.9 ± 4.3 and 44 (37.6%) had ESS ≥ 10. All items had statistically significant Spearman’s correlation with total score (p < 0.001). Cronbach’s α was 0.75, indicating a good internal consistency among items. Only one factor was generated in factor analysis (eigenvalue 2.22). The loadings of each item in the factor were balanced, from 0.4 to 0.6. Significant correlations were found between total ESS and AED polytherapy (rho = 0.20, p = 0.029), BDI (rho = 0.27, p = 0.007) and ISI (rho = 0.25, p = 0.018).

**Conclusion:** Internal consistency of the ESS was good. Correlations between ESS and ISI/BDI suggest that self-reported sleepiness may be related to depressive symptoms and sleep satisfaction in this population. Among disease-specific variables, AED polytherapy was associated with higher ESS, but not standardized dose or seizure frequency as expected. This work is a step toward developing a sleepiness scale that could be incorporated into clinical trials and routine care of PWE.

**Support (If Any):** This research was funded in part by the Research Programs Committee of the Cleveland Clinic.

**0809**

**EFFECT OF SEIZURES ON SLEEP QUALITY IN PATIENTS WITH CHRONIC EPILEPSY**

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**Introduction:** Epilepsy patients have high prevalence of various sleep disturbance compared to general population. The aim of this study was to investigate sleep quality in epilepsy patients according to the seizure control.

**Methods:** We enrolled the consecutive 111 epilepsy patients (M: F 84:27, age 20–65 y) from January 2009 to May 2013. All completed overnight polysomnography (PSG), sleep-habit questionnaire, Epworth Sleepiness Scale, and Beck Depression Inventory. Patients were divided into well-controlled group (WC, n = 62, no seizures ≥ recent 6 m) and uncontrolled group (UC, n = 49, seizure persisting 1/m). Data was compared between patients and controls and patients with WC and UC.

**Results:** Patients had poorer sleep quality (lower sleep efficiency, higher apnea-hypopnea index & arousal indices) than controls. UC had a longer duration of epilepsy (mean 14.4 ± 10.6 y vs. 6.6 ± 9.5, p < 0.01) and a higher number of antiepileptic drug (2.5 ± 1.1 vs. 1.1 ± 0.7, p < 0.01) than WC. No significant difference was observed in frequency of nocturnal seizure between UC and WC. UC reported significantly longer sleep time during weekday (454.2 ± 100.5 vs. 392.8 ± 70.7 min, p < 0.01) and weekend (479.2 ± 90.4 vs. 428.3 ± 97.3 min, p = 0.01) than WC, however, other sleep habits were not different. Objective sleep time in PSG was longer in UC than WC (382.0 ± 71.8 vs. 366.2 ± 61.6 min, p = 0.04), while sleep efficiency and arousal indices were not significantly different between them. In patients with uncontrolled seizures, BDI seems to be higher than patients with controlled seizures (13.0 vs. 9.8, p = 0.08), but not significant.

**Conclusion:** These findings showed that epilepsy patients had deteriorated sleep compared to controls, however, sleep quality was not remarkably influenced by seizure control. It remains whether sedative antiepileptic drugs may affect sleep quality in UC patients as a future study.

**0810**

**INVESTIGATING THE RELATIONSHIP BETWEEN H1N1 INFECTION, VACCINATION AND THE DEVELOPMENT OF NARCOLEPSY USING IMMUNOPHENOTYPIC ANALYSIS**

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**Introduction:** Narcolepsy is a life-long neurological disorder characterized most commonly by hypersomnia and cataplexy, which is caused by the destruction of the approximately 70,000 neurons responsible for generating the wake-promoting neurotransmitter hypocretin (hcrt). Narcolepsy has a strong genetic linkage to HLA, with more than 98% of narcoleptic patients expressing HLA DQB1*06:02, suggesting antigen presentation by this allele to CD4+ T cells is crucial to disease development. Numerous studies have indicated that the development of narcolepsy may also be associated with H1N1 infection or vaccination, suggesting that the presentation of antigenic peptides to CD4+ T cells by DQB1*06:02 following influenza infection/vaccination is capable of triggering an autoimmune cascade that ultimately leads to the loss of hcrt-producing neurons and the onset of narcolepsy.

**Methods:** To further our understanding about the relationship between H1N1 and the development of narcolepsy, we tested the T cell reactivity of patients and DQB1*06:02 controls, before and after seasonal influenza vaccination, to various seasonal H1N1 vaccines, H1N1-specific peptides, and to the functionally active forms of hcrt using fluorescently activated cell sorting (FACS) analysis.

**Results:** Seasonal influenza vaccination resulted in an increased Th1 memory response in both patients and controls to various H1N1 vaccines, with both groups responding in a similar manner. Vaccination also modulated the immune response to various H1N1 and hcrt peptides in some patients and controls, an observation that is currently being investigated.
B. Clinical Sleep Science

**Conclusion:** We find that seasonal vaccination results in increased Th1 memory response various influenza vaccines in both narcoleptic patients and DQBI*06:02* controls in a similar manner. Vaccination also altered the response to hcrt peptides in many individuals, a result that has the potential to substantially further our understanding of the connection between H1N1 infection, vaccination, and the development of narcolepsy.

0811

**COMPARISON OF PANDEMRIX AND AREPANRIX, TWO PH1N1 AS03-ADJUVANTED VACCINES DIFFERENTIALLY ASSOCIATED WITH NARCOLEPSY DEVELOPMENT**

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**Introduction:** 2009 influenza A H1N1 pandemic and vaccination with Pandemrix have been associated to narcolepsy onset in children. However, this was not clearly observed with other adjuvanted pH1N1 vaccines, such as Arepanrix or Focetria.

**Methods:** We used 2D-DIGE and mass spectrometry to identify some differences between Pandemrix (batch 2009) and Arepanrix (batch 2009 and 2010) as well as additional H1N1 vaccines that might explain the risk to develop narcolepsy after Pandemrix vaccination.

**Results:** The firsts vaccine batches we analyzed (Pandemrix 2009 and Arepanrix 2010) contained 5 main viral proteins: hemagglutinin HA1 and HA2 subunits, neuraminidase NA, nucleoprotein NP, and matrix protein MA1 and non-viral proteins from the Gallus gallus growth matrix used in the manufacturing of the vaccines. Latticed patterns of HA1, HA2 and NA indicated charge and molecular weight heterogeneity, a phenomenon likely caused by glycosylation and sulfation. Overall, NP and NA were more present in Pandemrix, whereas Arepanrix displayed a larger diversity of viral and chicken proteins, with the exception of five chicken proteins (PDCD6IP, TSPAN8, H-FABP, HSP and TUB proteins) that were relatively more abundant in Pandemrix. Glycosylation patterns were comparable in both vaccines. A higher degree of deamidation and dioxidation was observed in Pandemrix, probably reflecting differential degradation across batches. Interestingly, in Arepanrix, HA1 146N (residue 129N in the mature protein) displayed a 10-fold higher deamidation when compared to Pandemrix. Moreover, in Focetria and recent vaccine strains, 146N is mutated to D, which is associated with increased production yields, suggesting that 146N deamidation may have also occurred during the manufacturing of Arepanrix.

**Conclusion:** The presence of 146N in large relative amounts in Pandemrix and the wild type virus and in lower relative quantities in Arepanrix or other H1N1 vaccines may have affected predisposition to narcolepsy. The analysis of more H1N1 vaccine batches will be performed to confirm this hypothesis.

0812

**INTERMEDIATE DECLINE OF CEREBROSPINAL FLUID OREXIN (HYPOCRETIN) LEVEL AND SIGNIFICANT OBESITY IN PRADER - WILLI SYNDROME PATIENTS COMPARED WITH NARCOLEPSY AND IDIOPATHIC HYPERSONMIA**


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**Introduction:** Prader-Willi syndrome (PWS) is an acquired neurodevelopmental disorder caused by deletion in chromosome. Patients with PWS often exhibit excessive daytime sleepiness, increased appetite, and obesity. As well as in narcolepsy, orexin (hypocretin) may be responsible for the symptoms. However, report regarding the correlation between obesity and orexin level in PWS is scarce. Here we discuss the relationship between obesity and orexin level in PWS patients, compared with narcolepsy and idiopathic hypersomnia (IHS) patients.

**Methods:** We examined orexin levels in the cerebrospinal fluid (CSF) of 10 patients with clinically and genetically confirmed PWS with excessive daytime sleepiness, compared with 37 cases of narcolepsy patients with cataplexy, and 13 cases of IHS patients. Patients’ body mass index (BMI) at the time of CSF examination was determined. All patients are Japanese and aged 15 to 50 years old.

**Results:** CSF orexin levels (mean ± S.D.) in PWS, narcolepsy, and IHS were 194 ± 45 pg/ml, 79 ± 75 pg/ml, and 291 ± 74 pg/ml, respectively. BMI (mean ± S.D.) in PWS, narcolepsy, and IHS was 34.4 ± 8.5, 23.4 ± 4.0, and 22.6 ± 2.1, respectively. Orexin levels in PWS were significantly higher than narcolepsy, and lower than IHS. BMI was significantly higher in PWS than narcolepsy and IHS.

**Conclusion:** Orexin level and BMI was higher in PWS than narcolepsy patients. Intermediately decreased orexin level in PWS patients suggests that both impaired secretion and receptor function of orexin may play a role in exhibiting symptoms such as sleepiness, increased appetite and obesity.

0813

**DEEP BRAIN STIMULATION OF THE AMYGDALA: A POTENTIAL SURGICAL INTERVENTION FOR NARCOLEPSY WITH CATAPLEXY**

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**Introduction:** Laughter is associated with brief periods of postural instability and coincides with increased activity in the amygdala, an integrator of emotional-motor networks. Sustained activation of the amygdala has been observed during cataplexy, the sudden loss of postural tone with preserved consciousness that can be elicited by laughter in patients with narcolepsy. Thus, amygdala activity may induce or maintain cataplexy. We hypothesized that deep brain stimulation (DBS) of the amygdala would modulate Hoffmann-reflex (an EMG metric of postural tone) and cataplexy.

**Methods:** (1) We enrolled four inpatients with epilepsy that had depth electrodes surgically implanted into their amygdala for clinical monitoring of seizures. Subjects watched stand-up comedy while receiving sham stimulation versus high frequency DBS to either amygdala or lat-
er al temporal cortex at amplitudes below patient awareness. Throughout the duration of the session, we measured the Hoffmann-reflex as well as measures of laughter and autonomic arousal (galvanic skin conductance [GSC] and heart/respiratory rates). (2) A narcoleptic orexin/ataxin-3 transgenic mouse was implanted with stimulating electrodes in bilaterally amygdala and underwent restricted feeding to elicit cataplexy. Behavior was video-monitored to determine how various stimulation frequencies affected cataplexy.

**Results:** (1) DBS was well tolerated by patients. Amygdala DBS rapidly increased GSC and reduced heart rate by ~10% without any objective impact on laughter or subjective change in mood compared to controls. Amygdala DBS specifically preserved postural tone compared to control conditions in 3/4 test subjects as measured by maintenance of Hoffmann-reflex during laughter. (2) In the narcoleptic mouse, high frequency amygdala stimulation decreased the frequency of cataplexy events more effectively than lower frequencies.

**Conclusion:** Amygdala DBS preserves postural tone during laughter in humans and reduced cataplexy frequency in the narcoleptic mouse. Amygdala DBS may be a viable therapeutic strategy for treating narcolepsy with cataplexy. Further studies are on-going.

**Support (If Any):** NREF, SRSF

### 0814 TARGETING SUBGROUPS OF PATIENTS WITH ALS: A STEP TOWARDS INDIVIDUALIZED THERAPY

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**Introduction:** Amyotrophic Lateral Sclerosis (ALS) is a progressive neurodegenerative disorder causing muscle weakness, respiratory failure and death. Global cervical (GC) and bulbar (GB) ALS are the two subtypes most commonly associated with respiratory failure and sleep disordered breathing. Early ALS subtype classification, serial monitoring and early introduction of noninvasive mechanical ventilation (NIMV) may improve outcomes.

**Methods:** Demographics, spirometry, portable sleep study data (Portable type 3-Nox T3® device, Carefusion, Inc), and need for either treatment with NIMV and/or tracheostomy data of patients with ALS in a veteran population were analyzed (1/1/2010 to 1/31/2014). Standard clinical criteria were used to determine when to initiate NIMV with average volume assured pressure support (AVAPS™, Respiration, Inc).

**Results:** The GC (N = 8) and GB (N = 11) ALS subgroups were similar in age (64.7 ± 10.3 vs 68.3 ± 10.4), nadir SpO2 (81.4 ± 14 vs 80 ± 14), sitting FVC % predicted (73.5 ± 21.4 vs 67.3 ± 21.4) and supine FVC % predicted (64.8 ± 20.8% vs 61.5 ± 24.5%). Both GC and GB groups had a tendency towards lower supine (12% decline) vs sitting FVC (8% decline). There was a trend to a higher AHI (28.4 ± 17.2 vs 16.7 ± 17.2) on the GC vs GB ALS group. However, the use of AVAPS was greater in the GB (7/11) vs GC (2/8) group despite equal subsequent need for tracheostomy (GC 3/8 vs GB 4/11).

**Conclusion:** Early identification and intervention in the GB group with NIMV may delay need for tracheostomy. Further data are needed to determine if a decrease in FVC from sitting to supine can be used to guide NIMV intervention.

### 0815 PREVALENCE AND PREDICTORS OF NOCTURNAL HYPOVENTILATION IN AMYOTROPIC-LATERAL-SCLEROSIS PATIENTS WITH PRESERVED RESPIRATORY FUNCTIONS: A TWO-CENTER TRIAL

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**Introduction:** Nocturnal hypventilation (NH) is not uncommon in amyotrophic-lateral-sclerosis (ALS) patients with forced vital capacity (FVC) < 50% of predicted and daytime hypercapnia. However, it is unclear if NH is common in patients with relatively preserved respiratory function. This study aimed to determine the prevalence of NH and predicting factors in normocapnic ALS patients with FVC 40–80% of predicted.

**Methods:** Patients with ALS were screened in the neurologic clinics in two medical centers in Taiwan. Patients who had FVC of 40%–80% of predicted, maximal inspiratory pressure (Pimax) < −60 cmH2O, and daytime normocapnia (Paco2 < 50 mmHg) were eligible. All enrolled subjects received a polysomnography (PSG) with transcutaneous carbon dioxide (PtcCO2) monitored where NH was defined as increment of PtcCO2 ≥ 10 mmHg at sleep compared to supine awake. Nighttime symptom, subjective sleepiness, sleep quality, and ALS functional rating scale revised (ALSFRS-R), arterial blood gas, and PSG parameters were compared between patients with and without NH to identify factors independently associated with NH. Predictive ability of those factors was assessed by multivariate logistic regression and area under receiver operation curve (AUROC).

**Results:** From Apr 2010 to May 2012, totally 61 patients were eligible. Twenty-eight patients were enrolled where NH was diagnosed in nine (32.1%). Patients with NH were older (68.8 ± 55.6 y/o, P = 0.006) and had lower ALSFRS-R (19.0 ± 25.7, P = 0.040), less deep sleep (0 vs 5.0 ± 8.5%, P = 0.028), higher TiSpO2 < 90% (20.6 ± 28.5 vs 2.0 ± 3.3%, P = 0.014), and higher daytime PaCO2 (47.5 ± 11.1 vs 40.1 ± 4.3 mmHg, P = 0.027). Multivariate logistic regression analysis identified age (OR:1.16, P = 0.020) and ALSFRS-R (OR:0.86, P = 0.041) were predictors for NH where the AUROC were 0.80 and 0.71, respectively.

**Conclusion:** One-third of normocapnic ALS with relatively preserved respiratory function had NH where age and ALSFRS-R could predict the development of it.

**Support (If Any):** This work was supported by Ministry of Science and Technology (MOST 103-2314-B-002-139-MY3) and Taiwan Foundation of Rare Disorders

### 0816 CONTINUED EXCESSIVE DAYTIME SLEEPINESS AFTER REMOVAL OF A FOURTH VENTRICLE EPENDYMOMA

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**Introduction:** Excessive daytime sleepiness (EDS) is common with intracranial tumors located in proximity to prominent sleep centers such as the thalamus, hypothalamus and pons. Even with resection and/or radiation there is usually no change in the EDS. There is no standard in screening this group of patients.

**Methods:** A 33 year old non-obese female with past medical history significant for a fourth ventricle ependymoma status post resection four years back. She continued to have EDS, which had initially pre-
sent 4 years ago at the time of her diagnosis, and was referred to the sleep clinic for evaluation. Her overnight polysomnogram showed moderate obstructive sleep apnea with an apnea-hypopnea index (AHI) of 22.5. She was assessed for CPAP titration and on 30 day follow-up she had 97% compliance of over four hours per night of use with a reduced AHI of 3. She continued to complain of excessive daytime sleepiness in the form of sleep attacks leading to a daily nap and nightmares which comprised of dream enactment behavior. She states that these episodes started only after she had the cranial surgery. She denied any symptoms of cataplexy, hypnogogenic or hypnopompic hallucinations. She deferred the multiple sleep latency test to a later date. She was given the option of stimulant medications but declined due to palpitations. She was started on an antidepressant to reduce the rapid eye movement stage as well as clonazepam to prevent episodes of thrashing in her sleep.

Results: The coincident timing between symptoms of EDS and the fourth ventricular ependymoma is likely due to disruption of sleep pathways within the pons. The new onset REM behavior disorder (nightmares, sleep-related erections with increased muscle tone) suggests an increased REM presence (that has worsened since the treatment of the ependymoma) that points towards narcolepsy. With the persistence of hypersonmia despite cpap therapy leads to an inquiry of secondary causes for excessive daytime sleepiness or narcolepsy.

Conclusion: Intracranial tumors causing initial symptoms of EDS are unlikely to resolve after treatment. This group of patients require overnight polysomnograms as well as multiple sleep latency tests due to increased incidence of obstructive sleep apnea as well as secondary causes of hypersonmia respectively. If EDS does not resolve despite CPAP therapy, the patient can be given a trial of stimulant medication and assessed for symptom improvement.

0817

BILATERAL PHRENIC NEUROPATHY FREQUENTLY REQUIRES BI-LEVEL POSITIVE AIRWAY PRESSURE THERAPY

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Introduction: Diaphragmatic paralysis due to bilateral phrenic neuropathy (BPN) frequently causes dyspnea and orthopnea. Sleep-related breathing disorders are also common in these patients with associated symptoms of fatigue, somnolence, and frequent awakenings during sleep. We review here clinical, sleep, and polysomnographic features of 15 cases of bilateral phrenic neuropathy.

Methods: We retrospectively reviewed bilateral phrenic neuropathy cases who had polysomnography between 2004–2014. Data regarding pulmonary function, nerve conduction, electromyography, and polysomnography were obtained.

Results: 15 (8 men and 7 women) BPN patients were identified, with mean age of 61.5 years (range 42–84 years) and mean BMI of 33 kg/m\textsuperscript{2}. The most common presenting symptoms were dyspnea (100%), fatigue (100%), daytime sleepiness (70%) and snoring (60%). Etiology for BPN included 12 (80%) idiopathic, 2 (14%) autoimmune and 1 (6%) traumatic. 10 had complete bilateral neuropathy, while it was incomplete in 5. Functional vital capacity (FVC) was < 50% predicted in 10/15 (66%), and maximal inspiratory pressure (MIP) was < 60 mmHg in 12/15 (80%). 8 patients qualified for bi-level PAP based on FVC (< 50%) and/or MIP (< 60 mmHg) criteria. Satisfactory bi-level PAP titration in spontaneous mode (S) was obtained in 50% and remaining 50% needed spontaneous/timed (S/T) mode. 7 patients underwent diagnostic and therapeutic polysomnography studies, which revealed OSA in 4 (58%), sleep related hypoxemia in 1 (14%), sleep related hypo-ventilation in 1 (14%), and no sleep disordered breathing in 1 (14%). Satisfactory PAP titrations included CPAP in 3, bi-level PAP-S in 2, and bi-level PAP-S/T in 1. Only 7/15 patients had follow-up data (6 month–5 years), and all tolerated PAP therapy well. 2 underwent subsequently successful Bi-level PAP re-titration.

Conclusion: Bilateral phrenic neuropathy patients have frequent need for bi-level PAP therapy modalities for their sleep disordered breathing, with CPAP successful in only a minority of patients.
to determine risk factors for aspiration associated with nocturnal swallowing in SCI.

Methods: Four SCI [3 males; age 46.8 ± 21.6 years; BMI 30.0 ± 0.8 kg/m²] and 4 matched able-bodied subjects with sleep disordered breathing (SDB) completed in lab polysomnography with pharyngeal catheter. Swallowing (SW) was defined as a positive spike in the pharyngeal pressure to calculate the swallow index defined as # SW events/total recording time (SWI). Each SW event was assessed for relationship to the respiratory cycle [(beginning to peak inspiration (phase 1), peak to end inspiration (phase 2), beginning to peak expiration (phase 3) and peak to end expiration (phase 4)], associated arousals (A) and chin activation (CHA).

Results: SCI had similar SWI compared with able-bodied group (9.8 ± 3.5 vs. 7.0 ± 5.6 event/h, P = NS). Majority of SW events occurred during expiratory phases and no significant difference were found between SCI and able-bodied groups (34.0 ± 19.0 and 62.0 ± 19% vs. 48 ± 27 and 49 ± 25% of SW events occurred during phase 3 and 4, respectively, P = NS). The majority of SW events occurred during wake or after arousals and no significant difference was found between SCI and able-bodied groups (56.0 ± 35.0 vs. 69 ± 38% of SW events, respectively, P = NS). SW resulted in ChA in both groups (55.0 ± 30.0 vs. 70 ± 33.0%, respectively, P = NS).

Conclusion: Our findings suggest that nocturnal swallowing is common in both SCI and able-bodied individuals who have SDB. Nocturnal swallowing occurs mainly during expiration in both groups and is less likely to explain the increased risk of respiratory complications and aspiration in SCI compared to the general population.

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0820 POLYSOMNOGRAPHIC PREDICTORS OF VISUOSPATIAL FUNCTIONING IN MULTIPLE SCLEROSIS Braley TJ1, Kratz AL2

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Introduction: Sleep disturbances affect up to 50% of patients with multiple sclerosis (MS). Although the detrimental effects of sleep disturbances on cognitive functioning are well-established in the general population, little is known about the effects of sleep disturbances on cognitive dysfunction in MS, and in particular, effects on visuospatial functioning.

Methods: Thirty-seven MS patients completed a validated neuropsychological battery (Minimal Assessment of Cognitive Function in MS—MACFIMS), followed by full, overnight polysomnography (PSG). The MACFIMS includes: the Brief Visuospatial Memory Test (BVMT)—a test of visuospatial learning and memory that evaluates immediate and delayed recall of six geometric figures. Additional MACFIMS components include the Judgment of Line Orientation Test (JLO)—a test of visuospatial processing; and the Symbol Digit Modalities Test (SDMT)—a test of attention, visual tracking, and motor speed. For all tests, higher scores indicate better functioning.

Results: In regression models adjusted for age, disability, and education, the oxygen desaturation index and minimum oxygen saturation (MinO2) explained significant amounts of variance (R² = 0.18, regression parameter = −0.482, p = 0.014; and R² = 0.20, regression parameter = 0.466, p = 0.009, respectively) in BVMT delayed recall scores (BVMT-DR). Wake time after sleep onset, total sleep time, and sleep efficiency significantly predicted BVMT immediate recall Trial 1, BVMT immediate recall total, and BVMT-DR scores, explaining 13.3–21.5% of the variance across models (p < 0.05 for each). MinO2 also marginally predicted JLO (R² = 0.07, regression parameter = 0.277, p = 0.097) and SDMT scores (R² = 0.075, regression parameter = 0.290, p = 0.062).

Conclusion: Our findings suggest that sleep disturbances contribute to impairments in visuospatial function in MS, and in particular, impairments in immediate and delayed visuospatial memory. If a causal role exists, the identification and treatment of such sleep disturbances could offer a new opportunity to improve cognitive function in patients with MS.

Support (If Any): This study was supported in part by a CTSA/Michigan Institute for Clinical and Health Research (MICHIR) Seed Grant (ULITR000433)

0821 SLEEP AND PAIN SENSITIVITY IN ADULTS: A LARGE POPULATION-BASED STUDY Sivertsen B1, Lallukka T2, Petrie KJ3, Steinrimsdottir O4, Stubhaug A1, Nielsen C4

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Introduction: Sleep problems and pain are major public health concerns, but the nature of the association between the two conditions is inadequately studied. The aim of this study was to determine whether a range of sleep measures is associated with experimental increased pain sensitivity.

Methods: A cross-sectional large population-based study from 2007–2008, the Tromsø 6 Study, provided data from 10,412 participants (mean [SD] age, 58 [13] years; 54% women). Self-reported sleep measures provided information on, sleep duration, sleep onset latency, and sleep efficiency, as well as frequency and severity of insomnia. The main outcome measure was pain sensitivity tests, including assessment of cold-pressor pain tolerance.

Results: We found that all sleep parameters, except sleep duration, were significantly associated with reduced pain tolerance. Both the frequency and severity of insomnia, in addition to sleep onset latency and sleep efficiency, were associated with pain sensitivity in a dose-response manner. Adjusting for demographics and psychological distress reduced the strengths of the Hazard Ratios, but most associations remained significant in the fully adjusted models. There was also a synergistic interaction effect on pain tolerance when combining insomnia and chronic pain.

Conclusion: We conclude that impaired sleep significantly increases the risk for reduced pain tolerance. As comorbid sleep problems and pain have been linked to elevated disability, the need to improve sleep among chronic pain patients, and vice versa, should be an important agenda for future research.

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0822
SLEEP DISORDERS ASSOCIATED WITH MILD TRAUMATIC BRAIN INJURY USING SPORT CONCUSSION ASSESSMENT TOOL 3 (SCAT-3)
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Introduction: Sleep problems affect 30–80% of mild traumatic-brain-injury (mTBI) patients. We assessed the prevalence of sleep disorders following mTBI and its correlation with other symptoms.

Methods: Data from 95 patients was retrospectively analyzed. Inclusion criteria were patients assessed in the Concussion-Center during 2013–2014 with available SCAT3 following mTBI or at follow-up. Relationship between symptoms of sleep-disturbances (drowsiness, trouble sleeping, fatigue/low energy), psychiatric symptoms (sadness, nervous/anxious), headache and dizziness was analyzed by spearman correlation and logistic regression analysis using moderate/severe vs. none/mild categorization for symptoms.

Results: Median age was 31 ± 16 years (41 males). There was a positive correlation between: dizziness with drowsiness (r = 0.51, p < 0.0001) and trouble sleeping (r = 0.36, p = 0.0003), headache with drowsiness (r = 0.41, p < 0.0001) and trouble sleeping (r = 0.39, p = 0.0001), sadness with drowsiness (r = 0.51, p < 0.0001) and trouble sleeping (r = 0.49, p < 0.0001), anxiety with drowsiness (r = 0.55, p < 0.0001) and trouble sleeping (r = 0.52, p < 0.0001), fatigue with drowsiness (r = 0.77, p < 0.0001) and trouble sleeping (r = 0.49, p < 0.0001), irritability with drowsiness (r = 0.52, p < 0.0001) and trouble sleeping (r = 0.53, p < 0.0001) and all psychiatric symptoms and sleep problems (r = 0.47, p < 0.0001). Patients with moderate/severe psychiatric symptoms were associated with moderate/severe sleep symptoms: dizziness with drowsiness (OR = 8.34, p = 0.0039) and trouble sleeping (OR = 3.64, p = 0.006); headache with drowsiness (OR = 2.96, p = 0.02) and trouble sleeping (OR = 5.28, p = 0.001); sadness with drowsiness (OR = 1.66, p = 0.008) and trouble sleeping (OR = 7.11, p = 0.0001); anxiety with drowsiness (OR = 6.15, p = 0.0003) and trouble sleeping (OR = 7.19, p < 0.0001); fatigue with drowsiness (OR = 69.24, p < 0.0001) and trouble sleeping (OR = 3.50, p = 0.008); irritability with drowsiness (OR = 5.78, p < 0.0003) and trouble sleeping (OR = 6.63, p < 0.0001); all psychiatric problems and all sleep problems (OR = 23.1, p = 0.0004). All 3 sleep symptoms became more severe with increased time interval from mTBI to SCAT3 administration (OR = 1.005, 1.006, and 1.008, p < 0.05).

Conclusion: Our data demonstrates that patients who report moderate/severe headache, dizziness, and psychiatric symptoms have a higher likelihood of reporting moderate/severe sleep disorders following mTBI and should be counselled and initiated with early interventions.

0823
SLEEP-ASSOCIATED ABNORMALITIES IN MILD OR MODERATE TRAUMATIC BRAIN INJURY OR CONCUSSION, AS IDENTIFIED BY DENSE ARRAY ELECTROENCEPHALOGRAPHY (DEEG)
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Introduction: Electro cortical abnormalities associated with mild traumatic brain injuries have been reported but have not been well-char-acterized electroencephalographically. The frequency of occurrence and types of abnormalities identified during both wake and sleep by 128 channel Dense-array ElectroEncephaloGraphy (DEEG) in patients with mild to moderate brain injury or concussion are described.

Methods: DEEG of 100 traumatic brain injury (TBI) patients presenting to a general neurology clinic with mild or moderate brain injury or concussion were evaluated. Abnormalities were noted as occurring during wake, during sleep, or during both wake and sleep. Abnormalities were described by brain regions as being frontal, temporal, parietal, or occipital. DEEG was acquired at 500 Hz for at least 60 minutes in a wake and sleep protocol using EGI, 128 channel System 300. Patients underwent strobe and hyperventilation, and performed a mathematics task (Counting backwards from 100 by 7). Frequency bands reviewed were Delta (0.1–3.5 Hz), Theta (3.5–7.5 Hz), Alpha (7.5–12.5 Hz), Beta (12.5–20 Hz), Upper Beta (20–30 Hz), and Gamma (30–40 Hz).

Results: 90 of 100 DEEG's were abnormal (P < 0.0001). 34% showed abnormalities only during wake, and 65% during both wake and sleep. None of the records showed abnormalities only during sleep. Of the 90 normal DEEG's 25 showed single focus abnormalities (27.8%) and 47 showed multi-focus abnormalities (52.2%). 54 showed spikes (60.0%), 81 sharp waves (90.0%), and 43 slow waves (47.8%).

Conclusion: Abnormalities seen during hyperventilation mirrored abnormalities seen during sleep. We believe that hyperventilation triggered the emergence of abnormal activities that may otherwise have been seen only during sleep. DEEG identified abnormalities in 90% of 100 patients with mild to moderate brain injury or concussion, with 65% having abnormalities during both wake and sleep. Representative of abnormalities are spikes, sharp waves, and slow waves in single and multiple focal regions.

0824
CENTRAL SLEEP APNEA IN TRAUMATIC BRAIN INJURY
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Introduction: Sleep disorders in traumatic brain injury (TBI) are common and impact recovery in this population. Previous literature has demonstrated sleep-disordered breathing (SDB) manifested predominantly as obstructive sleep apnea (OSA) in about 23% of patients with TBI. We sought to explore the occurrence of central sleep apnea (CSA) in this group of patients.

Methods: A retrospective chart review of attended polysomnograms (PSGs) was performed on TBI subjects at a tertiary care rehabilitation hospital. Subjects were referred for suspected SDB. PSGs were analyzed according to 2007 AASM guidelines. Patients > 14 years who were at least 3 months from the date of TBI were included.

Results: There were 21 subjects (4 female, 17 male) aged 14–68 years who were included. Mean Body Mass Index (BMI) was 26.7 ± 4.9 (SD) kg/m². Sixteen (16) patients had severe TBI, 1 had moderate and 3 had mild TBI. Subjects were 4.3 ± 7.5 years from occurrence of injury. There were 16 patients (76%) with clinically significant SDB. These had 18.7 ± 15.5 apneas and hypopneas per hour of sleep. There were 4 patients (19%) with pure CSA, 2 (9.5%) with complex sleep apnea (CompSA) and 10 (48%) with pure OSA. Thus CSA was seen alone or in combination with OSA in 28.5% of subjects. Only one subject was on opiate medication and he had no SDB. Three subjects had ventriculostomy catheters, and one each had OSA, CSA and CompSA. Both patients with CompSA, one with CSA and one with OSA were on baclofen. Cheyne-Stokes respiration was not seen in any of the patients with CSA.
Conclusion: In patients with TBI and SDB, OSA is the predominant form of SDB. However, CSA was seen either alone or in combination with OSA in about 28.5% of these TBI subjects. CSA in this population may be multifactorial, consequent to either the primary injury itself or medications used.

0825
ACUTE SLEEP LOSS AFFECTS SYMPTOM REPORT BUT NOT PERFORMANCE ON IMMEDIATE POST-CONCUSSION ASSESSMENT AND COGNITIVE TESTING (IMPACT)
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Introduction: Immediate Post-Concussion Assessment and Cognitive Testing (ImpACT) is used in the management of concussion. Recent research has shown that subjects reporting to sleep less than 7 hours the night prior to baseline testing had worse cognitive, affective, and vegetative symptoms and had poorer objective performance on verbal memory, visual memory, and reaction time tasks when compared to those that slept 7 to 9 hours. We chose to study the effects of acute sleep loss on both subjective symptom report and objective neurocognitive performance with the ImpACT.

Methods: 70 non-concussed participants (31 male, 23.3 mean years old) were randomly assigned to habitual sleep, sleep restriction (50% of habitual duration) and total sleep deprivation conditions. The ImPACT was administered at baseline, after sleep loss condition, and again after a night of recovery sleep (100% of habitual sleep). One-way repeated measures ANOVA was utilized with α of 0.05 to assess for sleep loss conditions resulted in worsened next day cognitive and sleep symptoms, but not neurocognitive performance. These findings contrast with previous research which found objective performance impairments. Chronic sleep loss may be necessary to cause detectable impairments in objective measures of neurocognitive performance as assessed by the ImpACT.

Results: When adjusting for age and sex, repeated measures ANOVA revealed significant group differences in total reported symptoms as well as all symptom clusters, except for affective symptoms. Pairwise comparisons with Bonferroni correction revealed a dose-dependent effect of acute sleep loss on increased symptom report on both cognitive and sleep symptom clusters. However there were no differences between groups on verbal memory, visual memory, reaction time, or visual-motor processing performance.

Conclusion: Both acute sleep restriction and sleep deprivation conditions resulted in worsened next day cognitive and sleep symptoms, but not neurocognitive performance. These findings contrast with previous research which found objective performance impairments. Chronic sleep loss may be necessary to cause detectable impairments in objective measures of neurocognitive performance as assessed by the ImpACT.

Support (If Any): Department of Defense 11293006
VI. Neurological Disorders and Sleep

ASSOCIATION OF SLEEP DISTURBANCE, INSOMNIA, AND SLEEPINESS WITH CORTICAL ACTIVATION ON A GO-NOGOTASK IN VETERANS WITH AND WITHOUT HISTORY OF MILD-MODERATE TRAUMATIC BRAIN INJURY

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Introduction: For many Veterans, mild-moderate traumatic brain injury (mTBI) can be associated with persistent sleep disturbances and increased sleepiness, which are not always synonymous. Dissociating these symptoms at a neural level may help identify underlying mechanisms of symptomatology and could have beneficial prognostic and diagnostic implications.

Methods: 53 Veterans with a history of mTBI (age: 32.5 ± 6.7; education: 14.3 ± 1.4; 94% male) and 25 Veterans with no history of mTBI (age: 31.8 ± 8.1; education: 14.6 ± 1.7; 68% male) were studied. The Pittsburgh Sleep Quality Inventory (PSQI), Insomnia Severity Index (ISI), and Epworth Sleepiness Scale (ESS), and a Functional Magnetic Resonance Imaging (fMRI) Go-No-Task were administered. BOLD signal from the NoGo condition (inhibition) relative to non-NoGo condition was obtained for several regions of interest and correlated with sleep scores.

Results: mTBI Veterans reported greater impairments on the PSQI (p = 0.009), ISI (p < 0.001), and ESS (p < 0.001). For both groups, PSQI and ISI scores were negatively correlated with response in bilateral middle, transverse, and/or inferior temporal regions (r values: −0.577 to −0.279; p values ≤ 0.01–0.05). In mTBI Veterans, additional significant correlations were observed, namely, between the PSQI and ISI and middle frontal and left inferior parietal regions (r values: −0.29 to −0.38) and between the ESS and response in the left caudate and right lateral and medial orbital-frontal regions (r values: 0.28–0.35; p values ≤ 0.01–0.05).

Conclusion: Two novel findings emerged in this preliminary investigation: 1) Sleep disturbance and sleepiness were associated with more numerous areas of inhibitory brain response in mTBI relative to non-TBI Veterans; 2) Sleep disturbance was associated with lower responsiveness of middle frontal and parietal regions, and sleepiness was associated with higher inhibition-related response in the basal ganglia/orbitofrontal regions, and these associations were not evident in controls. Overall, these results suggest that sleep disturbance and sleepiness following mTBI may lead to differing and more widespread cortical demands during cognitive tasks requiring executive function/inhibitory response.

RESTING-STATE FUNCTIONAL CONNECTIVITY AND SUBJECTIVE SLEEP-WAKE DISTURBANCES IN INDIVIDUALS WITH TRAUMATIC BRAIN INJURY

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Introduction: Chronic sleep-wake disturbances are frequently reported following a traumatic brain injury (TBI), but their pathophysiological mechanisms are still poorly understood. The aim of the present study was to investigate whether brain connectivity abnormalities within the default mode network (DMN) are associated with subjective reports of poor sleep quality, fatigue and daytime sleepiness in individuals with TBI.

Methods: Sixteen subjects (11M/5F; age: 32.3 ± 12.0 years) were tested 24.2 ± 11.4 months following a moderate to severe TBI (Glasgow Coma Scale Score at emergency room: 8.1 ± 3.3) with resting state functional magnetic resonance imaging (3 Tesla magnetic resonance imaging scanner) and questionnaires (Pittsburgh Sleep Quality Index, Fatigue Severity Scale and Epworth Sleepiness Scale). Slice timing and realignment were performed using SPM8. A data-driven spatial independent component analysis was applied to extract the DMN. A measure of hierarchical integration was used to quantify functional connectivity between the sub-systems of the DMN. Pearson correlations were performed between measures of connectivity and scores on questionnaires.

Results: Increased functional connectivity within the DMN was associated with higher levels of fatigue and poorer subjective sleep quality (r values: 0.52–0.63, p < 0.05), but not with daytime sleepiness. When the DMN was divided into sub-systems, higher lateral prefrontal cortex and hippocampus connectivity was correlated with poorer sleep quality (r values: 0.62–0.69, p < 0.05). However, lower connectivity of the parietal sub-system was associated with more fatigue and more severe subjective sleepiness (r values: −0.53–0.63, p < 0.05).

Conclusion: Our preliminary results showed a specific pattern of connectivity changes associated with sleep-wake disturbances that particularly involved the lateral prefrontal cortex, the parietal lobes and the hippocampus. Further studies in TBI patients should investigate whether these changes in brain connectivity are associated with objective modifications of the sleep architecture.
INTERPLAY OF SHORT SLEEP DURATION AND IMPAIRED COGNITION ON ALL-CAUSE MORTALITY

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Introduction: Short sleep duration has been associated with increased risk of neurocognitive, cardiovascular, and cerebrovascular morbidity. It is unknown, however, whether short sleep duration plays a significant role in the relationship between neurocognitive impairment and all-cause mortality.

Methods: We addressed this question in a general population sample of 1,741 men and women (48.7 ± 13.5 years) who were followed-up for 15.5 ± 4.1 years (Penn State Adult Cohort). A neuropsychological battery assessed processing speed and executive attention. Polysomnographic sleep duration was classified into three categories: ≥ 6 hours (i.e., ≥ 50th percentile), 5–6 hours (i.e., 25–50th percentile), and ≤ 5 hours (i.e., ≤ 25th percentile). We tested the interaction between neurocognitive functioning and objective sleep duration on all-cause mortality, while controlling for sex, age, race, obesity, diabetes, history of heart disease and stroke, smoking, depression, insomnia, and sleep apnea.

Results: The multivariable-adjusted odds ratio (OR) of all-cause mortality associated with impaired processing speed and executive attention were 2.14 (95% CI: 1.47–3.12) and 1.93 (95% CI: 1.26–3.01), respectively. We found significant interactions between objective sleep duration and impaired processing speed or executive attention on all-cause mortality (p < 0.05). For example, the multivariable-adjusted ORs associating impaired executive attention and all-cause mortality were 1.40 (95% CI: 0.77–2.56), 2.59 (95% CI: 1.01–6.66), and 3.91 (95% CI: 1.47–10.39) for individuals with ≥ 6 hours, 5–6 hours, and ≤ 5 hours of sleep, respectively.

Conclusion: Objective sleep duration modifies the relationship between impaired cognition and all-cause mortality in a dose-response manner, with the largest magnitude of association observed in those who slept ≤ 5 hours. Short sleep duration in individuals with neurocognitive impairment may be biologically driven, behaviorally induced, or a marker of the severity of cognitive decline per se or of an underlying cerebrovascular dysfunction.

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INSOMNIA COMORBid WITH FIBROMYALGIA: SLEEP DIARY IMPROVEMENTS REALIZED VIA COGNITIVE-BEHAVIORAL INSOMNIA THERAPY LEAD TO IMPROVEMENTS IN THE COMORBID CONDITION

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Introduction: Research has indicated that insomnia can worsen the symptoms of comorbid medical conditions, therefore suggesting that sleep improvements following insomnia treatment may also result in an improvement of the medical condition itself. In a sample of patients with insomnia occurring comorbid with fibromyalgia (FM), we explored whether treating and improving sleep with cognitive-behavioral insomnia therapy (CBT) would also exert a positive and enduring effect on other FM symptoms.

Methods: Sixty-one individuals (59 women; ages 24–65) meeting research diagnostic criteria for insomnia and American College of Rheumatology criteria for FM were randomized to: treatment as usual (TAU; n = 21), TAU+ sham therapy (ST; n = 20), or TAU+CBT (n = 20). The primary sleep outcome considered herein was mean total wake time (TWT) derived from sleep diaries completed for two weeks at post-treatment (POST). The severity and impact of FM symptoms were evaluated with scores on the Fibromyalgia Impact Questionnaire (FIQ) and with the Brief Pain Inventory (BPI), the latter providing two separate scores for the subscales Pain intensity and Pain interference with daily activities. We conducted mediation models using a non-parametric bootstrapping procedure to ascertain whether there was an indirect effect of CBT via sleep improvement on these 3 FM-related outcomes at POST and 6-month follow-up (FU) assessments.

Results: Compared to individuals receiving TAU and TAU+sham therapy, those receiving CBT showed statistically significant shorter TWT at POST (p = 0.004). Our mediation model indicated that there was a beneficial and statistically significant indirect effect of CBT on the 3 FM-related outcomes at POST occurring through a reduction of nocturnal TWT (FIQ score: point estimate = −4.48, 95% bootstrap confidence interval (CI) = −7.98/−1.56; pain intensity = −0.39, 95% CI = −0.79/−0.06; and pain interference = −0.50, 95% CI = −0.91/−0.17). The indirect effects of CBT on these 3 FM-related outcomes at FU, occurring through a reduction of TWT at POST, were also statistically significant.

Conclusion: Our results indicate that, in patients with FM, CBT can improve self-reported nocturnal sleep which, in turn, can improve FM-related symptoms. These beneficial indirect effects of CBT on FM symptoms seem to persist long term, well beyond treatment termination. This supports the notion that disturbed nocturnal sleep may exacerbate other FM symptoms and highlights the usefulness of CBT for insomnia for the overall management of FM.

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gender (p < 0.05) among pre-kidney transplant patients, more negative mood among post-transplant patients (p = 0.09), and decreased quality of life among post-transplant patients (p < 0.05) were uniquely related to increased insomnia symptoms. At the daily level, days of above average caffeine consumption predicted greater total wake time [X2 (N = 10) = 1246.43, p < 0.001] and greater than average fatigue was associated with greater total sleep time [X2 (N = 10) = 1270.95, p < 0.001].

Conclusion: Not only are sleep problems highly common, these results also suggest that insomnia symptoms are uniquely related to specific biopsychosocial factors that may be worthwhile areas for intervention in treating insomnia among pre- and post-transplant patients. Furthermore, daily variations in sleep related behaviors appear to be meaningful predictors of sleep disturbance and should be considered in treatment planning.

0832
LATER SLEEP AND CIRCADIAN TIMING ARE ASSOCIATED WITH LOWER ESTIMATED INSULIN SENSITIVITY
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Introduction: Emerging research suggests that later sleep timing is associated with impaired glucose metabolism. The goal of this study was to determine the association between glucose metabolism, habitual sleep timing, and a direct measure of endogenous circadian timing (dim light melatonin onset, DLMO).

Methods: This ongoing study is enrolling non-diabetic adults aged 21–50 years. Habitual sleep duration, sleep onset and sleep end are estimated from approximately one week of wrist actigraphy. The DLMO is assessed from saliva samples collected every 30 minutes in dim light in the 6 hours before habitual bedtime. Subjects spend one night in the laboratory at the University of Chicago and undergo a 5-hour, 12-sampling night of glucose and insulin from the OGTT. Spearman’s correlations were used to analyze the primary predictor: spectral HRV indices [low frequency power (LF), high frequency power (HF) and LF/HF] and secondary predictors: time domain indices [time between normal beats (SDNN), short term variability (STV), long term variability (LTV) and STV/LTV] derived from the PSG electrocardiogram per standard deviation change in relationship to AF (HR and 95% CI presented). The interaction of HRV indices and SDB (apnea hypopnea index ≥ 15) with AF was examined. Models were adjusted for age, race, body mass index (BMI), waist circumference, cardiac medications, alcohol use and history of co-morbid disease (hypertension, diabetes, cholesterol level, coronary artery disease and heart failure).

Results: Participants were 75.9 ± 5.3 years of age, 89.8% Caucasian with BMI 27.2 ± 3.7 kg/m². LF/HF (HR = 1.19: 1.01–1.39) per SD decrease and HF (HR = 1.15: 1.01–1.31) per SD increase; STV (HR = 1.15: 1.03–1.28) and STV/LTV (HR = 1.12: 1.01–1.25) per SD increase significantly predicted AF in adjusted models. Other indices did not significantly predict AF. A significant SDB interaction was observed with SDB for all spectral indices, driven primarily by obstructive apnea (obstructive apnea hypopnea index ≥ 15) and significantly predicted AF in adjusted models.

Conclusion: Sleep-related increased parasympathetic tone (HF) and reduced sympathovagal tone (LF/HF) served as predictors of future AF risk. This relationship was modified by SDB (mainly obstructive apnea) suggesting SDB-related enhanced vagoal influences as a risk for “cholinergic” AF development.

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0834
LONG, RATHER THAN SHORT SLEEP, IS A PREDICTOR OF STROKE RISK: A COMPARATIVE ANALYSIS OF MULTIPLE LINEAR REGRESSION MODEL AND BAYESIAN BELIEF NETWORK MODEL
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Introduction: Short and long sleep durations are linked to stroke and cardiovascular disease. However, results have relied primarily on regression analysis, which may not be optimal to model associations between sleep and medical outcomes. Big-data and complex-system analyses provide unique opportunities to quantify dynamic interactions between sleep and medical outcomes, adjusting for multiple risk factors.

Methods: The current study utilized two types of analyses: logistic regression and Bayesian Belief Network, a form of complex system analysis, to assess sleep-related stroke risk. We used data from the 2004–2013 National Health Interview Survey, yielding 231,111 cases, to investigate how short (8 hrs) sleep durations impact stroke risk. In both analyses, we assessed the contribution of 34 demographic, medical, behavioral, and psychosocial factors. We used SPSS 20 to conduct regression analyses and Bayesia Lab’s Tree Augmented Naïve Bayes learning algorithm for complex system analysis. We compared results of both analytic models to determine their ecological and clinical utility.

Results: Forty-eight percent of volunteers were ≤ 45 yrs; 77.40% were White; 15.96%, Black/African American; and 45.1% made < $35K annually; 29.55% reported short sleep and 8.9%, long sleep; 61.55% were average sleepers (7–8 hrs.). Adjusted regression models indicated that relationships between short sleep and stroke were not significant (OR = 0.97, 95% CI = 0.92–1.02, p = 0.21); however, long sleep was associated with stroke (OR = 1.43, 95% CI = 1.32–1.52, p < 0.001). Results from Bayesian analysis indicated both short and long sleep were associated with stroke, but that long sleep doubled stroke risk (7.48%) relative to short sleep (3.74%). Regression model had a R2 of 0.24 for short sleep and long sleep, while the R2 for Bayesia was 0.73.

Conclusion: Bayesian Belief Network analysis is superior to regression modeling because it provides ecologically and clinically valid findings. Although both short and long sleep durations are associated with stroke risk, long sleep seems a stronger predictor.

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0835
IMPACT OF SLEEP DURATION AND QUALITY ON CANCER SURVIVAL
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Introduction: Indicators of poor sleep quality and short sleep duration are associated with elevated risk for several types of cancer. However, the relationship between sleep and cancer outcomes has not been well-characterized. Using data from the Women’s Health Initiative (WHI), we assessed the relationship between pre-diagnostic sleep measures and subsequent cancer survival.

Methods: We identified WHI participants diagnosed with a first primary invasive cancer during follow-up (N = 18,552). Participants provided information on several sleep attributes at study baseline, including sleep duration, snoring, and components of the WHI Insomnia Rating Scale. Cox regression was used to calculate hazard ratios (HRs) and 95% confidence intervals (CIs) for associations between these pre-diagnostic sleep measures and cancer-specific survival for all cancers combined and separately for common cancers. Analyses were adjusted for age at enrollment, study arm, cancer site, marital status, household income, smoking, physical activity, and time-lag between baseline data collection and cancer diagnosis.

Results: In analyses stratified by cancer site, short sleep duration and frequent snoring were associated with significantly poorer breast cancer-specific survival [HR = 1.45, 95% CI: 1.05–2.00 for ≤ 5 vs. 7–8 hours/night, HR = 1.44, 95% CI: 1.04–2.00 for frequent vs. never-snor ing]. In analyses combining information on these attributes, women with breast cancer who were frequent snorers and reported ≤ 6 hours sleep/night had the poorest prognosis [HR = 2.27, 95% CI: 1.53–3.37 vs. never-snorers who slept 7–8 hours/night]. This pattern of association with combined sleep duration/snor ing was also noted in women with lung cancer [HR = 1.40, 95% CI: 1.00–1.97] and analyses of all cases combined [HR = 1.36, 95% CI: 1.16–1.59]; however, no individual sleep measures were significantly associated with cancer-specific survival in analyses of all cases combined, or in women with lung, colorectal, or ovarian cancers.

Conclusion: Pre-diagnostic short sleep duration and frequent snoring were associated with significantly poorer cancer-specific survival, particularly among women with breast cancer.

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Introduction: While overweight and obesity are known risk factors for obstructive sleep apnea (OSA), it is unclear whether OSA is associated with successful weight loss in persons participating in a behavioral weight loss study. The purpose of this study is to examine whether the presence and severity of OSA is associated with less favorable weight loss outcomes.

Methods: 125 overweight adults (Mean age = 51.5 ± 9.8 years; 90% female; 82% Caucasian) completed the first 6-months in a 12-month behavioral weight loss intervention study that focused on sustained weight loss. Baseline measures included height and weight for calculation of body mass index (BMI kg/m²), a sociodemographic questionnaire, and use of an at-home ApneaLink Plus device to measure the presence and severity of OSA device. Participants attended weekly group counseling sessions to learn how to adopt healthy lifestyle habits. Assessments of weight and OSA were repeated at 6 months. Descriptive statistics and ANOVA were performed.

Results: The mean baseline BMI was 34.3 ± 4.6; over 50% of the participants had OSA (Apnea + hypopnea index [AHI] ≥ 5). The mean percent weight loss at 6 months was 9.2% ± 6.0 of baseline body weight. Participants who did not have OSA (n = 57) lost an average of 10.24% ± 6.77 of baseline weight, those (n = 42) with “mild” OSA (AHI 5–14/hr) lost an average of 8.96% ± 4.79 baseline body weight and those (n = 4) with “moderate to severe” OSA (AHI ≥ 15) lost an average of 7.43% ± 6.18 baseline body weight. Post hoc tests revealed that participants without OSA (baseline and 6 months) had significantly more weight loss (mean difference -4.82%) than participants who did not have OSA at baseline but met the criteria for OSA at 6 months (p = 0.008).

Conclusion: The presence at OSA at baseline and/or at 6 months is associated with less favorable weight loss. Further study is needed on the effect of OSA on sustaining weight loss.

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0836
IS OBSTRUCTIVE SLEEP APNEA ASSOCIATED WITH POORER OUTCOMES IN A BEHAVIORAL WEIGHT LOSS INTERVENTION STUDY?
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Introduction: Using the Transtheoretical Model of behavioral change, this study evaluates the relationship between sleep quality and the motivation and maintenance processes of healthy behavior change.

Methods: Data collected in 2008 from the Kansas State employee wellness program (N = 13,322). Sleep quality was assessed by describing the frequency of “Trouble Sleeping” as “Never,” “Seldom,” “Sometimes,” “Often,” or “Always.” Stage of change was assessed with the question, “Right now, are you planning to make any of the following changes to keep yourself healthy or improve your health?” with the following behaviors: “Limiting the amount of alcohol,” “Increase physical activity or exercise,” “Quit or cut down smoking,” “Cope or deal with stress better,” and “Lose weight.” Stage of change was coded as precontemplation, contemplation, preparation, action, or maintenance.

Multinomial logistic regression analyses were adjusted for age, sex, race/ethnicity, education, and income.

Results: Poor sleep quality was generally associated with an increased likelihood of contemplation, preparation, and in some cases action when engaging in the health behavior change process, but generally a lower likelihood of maintenance of healthy behavior. For example, poor sleep quality “Always” (vs “Never”) was associated with greater likelihood of contemplation for managing stress (OR = 3.32, p < 0.0001), weight (OR = 4.99, p = 0.0006), and smoking (OR = 2.70, p = 0.0026), relative to precontemplation. Poor sleep “Always” (vs “Never”) was associated with preparation and action for managing stress (OR = 2.47, p < 0.0001; OR = 2.04, p = 0.0006; respectively) and weight (OR = 3.45, p = 0.0076; OR = 2.94, p = 0.0204; respectively). Contrastingly, it was associated with decreased likelihood of maintenance of behaviors aimed to improve stress (OR = 0.64, p = 0.0375) and physical activity (OR = 0.41, p = 0.0024).

Conclusion: Poor sleep quality was associated with an elevated likelihood of contemplating or initiating behavior change, but a decreased likelihood of maintaining healthy behavior change. It is important to include sleep improvement as one of the lifestyle management interventions offered in wellness programs to comprehensively reduce health risks and promote health.

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0838
SLEEP AND QUALITY OF LIFE AMONG CAREGIVERS OF CHILDREN WITH AUTISM SPECTRUM DISORDERS
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Introduction: Autism Spectrum Disorder (ASD) holds potential for significantly impacting the primary caregiver and family, as well as the child with ASD. In particular, sleep problems occur frequently among children with ASD, and their poor sleep may negatively affect that of their caregivers. Health-related quality of life (HRQoL) and Family Quality of Life (FQoL) are salient indices of caregiver and family wellbeing. This pilot study explored associations between sleep problems on HRQoL and FQoL of caregivers who have children with ASD.

Methods: Family caregivers (N = 62) of children (M = 7.6, range 6 to 11 years old) with ASD participated in this survey study. Participants completed the Sleep Habits Questionnaire (SHQ), the SF-12, the Beach Center Family Quality of Life Scale, and the Children’s Sleep Habits Questionnaire (CSHQ).

Results: Caregivers with longer sleep duration reported better mental health and better FQoL. Caregivers who reported insomnia symptoms, non-restorative sleep, and insufficient sleep were more likely to report poorer mental health than caregivers who did not report these sleep disorder symptoms. Caregiver-reported child sleep problems were significantly and negatively associated with caregiver sleep duration (i.e., shorter sleep duration and more child sleep problems), and with other caregiver sleep disorder symptoms, including difficulty staying asleep, early morning awakening with difficulty returning to sleep, and insufficient sleep.
Conclusion: The physical and mental health of the primary caregiver is essential to the support of the child with ASD and to the family functioning. The results of this study support findings from many prior studies and point to salient approaches for future research and interventions to promote healthy caregiver sleep and a better quality of life.

0839
RELATIONSHIPS BETWEEN SLEEP CONTINUITY, SOCIAL JETLAG, AND BODY MASS INDEX
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Introduction: Health behaviors, in general, and sleep, in particular, are increasingly recognized for their propensity to increase BMI (body mass index). For example, total sleep time is inversely related to BMI through alterations in satiety hormones, greater caloric intake, and decreased metabolic efficiency. Few studies, however, have examined the potential contribution of other aspects of sleep, such as sleep continuity or circadian dysregulation. Toward this end, the present study sought to examine the extent to which sleep efficiency (as an index of sleep continuity) and social jetlag (as an index of circadian dysregulation) are associated with BMI.

Methods: Data were culled from a larger study in which college students (N = 208) completed self-report measures including a demographic questionnaire and the Sleep Timing Questionnaire (STQ). The demographic questionnaire was used to obtain participants’ weight and height to calculate BMI. Responses from the STQ were utilized to calculate participants’ total sleep time (TST), sleep efficiency (SE), and social jetlag (SJ), which was operationalized as the absolute value of the difference between the midpoint of sleep on workdays (MSW) and free days (MSF), represented as [MSW – MSF].

Results: Results from three linear regressions, with TST, SE, and SJ as predictor variables and BMI as outcome variable, indicated that SE (B = −0.31, p = 0.001, R2 = 0.09), SJ (B = 0.16, p = 0.02, R2 = 0.03), and TST (B = −0.20, p = 0.003, R2 = 0.04), were associated with BMI. SE predicted the largest amount of variance. Post-hoc analysis indicated that SOL was correlated with BMI (r = 0.24, p = 0.01), while WASO was not.

Conclusion: SE and SOL may be improved through behavioral sleep strategies and thus, may be important variables to target when concerned with both sleep and BMI. Additionally, given that sleep efficiency is lowered in several sleep disorders (e.g., insomnia), future studies should assess the relationships between sleep disorders, their treatment, and BMI.

0840
ASSOCIATIONS OF SHORT SLEEP, BMI, PHYSICAL ACTIVITY AND EMOTIONAL DISTRESS ON CHRONIC DISEASES
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Introduction: The prevalence of short sleep (< 7 hours) has gradually increased over the last four decades, warranting an in-depth analysis of its influence on health outcomes. This study explored influences of body mass index (BMI), physical activity, and emotional distress on associations between short sleep and chronic diseases.

Methods: Data for the present analysis came from the National Health Interview Survey, an ongoing nationally representative cross-sectional study of non-institutionalized US adults (≥ 18 years) from 2004–2013 (N = 911,773). They provided health data including physician-diagnosed hypertension, coronary heart disease, diabetes, stroke, kidney disease, cancer, and history of heart attack. We used the recommended criterion of ≥ 150 minutes/week of moderate physical activity or ≥ 75 minutes/week of vigorous to define physical activity and Kessler’s 6 scales to measure emotional distress. Structural equation modeling was used to assess effects of physical activity, BMI, and emotional distress on relationships between short sleep and chronic diseases.

Results: Analysis showed 51.6% of the sample was female; 76.2%, white; and 15.6%, black with a mean age of 35.79 ± 22.4 yrs. Physical activity negatively mediated relationships between short sleep and cancer, stroke, coronary heart disease, heart attack, hypertension, and diabetes (path coefficient estimate = −0.053), (p < 0.001). BMI positively mediated relationships between short sleep and smoking, hypertension, and diabetes (point coefficient estimate = 0.828), (p < 0.001). Emotional distress also positively mediated relationships between short sleep and hypertension, diabetes and coronary heart disease (point coefficient estimate = 0.743), (p < 0.743). Adjusted covariates included age, race, gender, marital status, and income.

Conclusion: Results are consistent with previous reports regarding associations between short sleep and chronic diseases. Of interest, emotional distress and increased BMI had significant effects on relationships between short sleep and chronic diseases. Increased physical activity however, was not associated with short sleep.

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0841
HIGH SELF-EFFICACY MAY BENEFIT SLEEP QUALITY AND FATIGUE
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Introduction: Self-efficacy has been shown to correlate with adherence to positive health outcomes and serves as a pre-condition to promote heart healthy behaviors. Although prior studies associate self-efficacy scores with healthy diet and exercise behaviors, little is known about the association with sleep quality. Given the critical role of healthy sleep behaviors for cardiovascular (CV) disease we sought to correlate the role of self-efficacy with sleep quality and symptoms of fatigue.

Methods: The Integrative Cardiac Health Project (ICHP) CV health registry focuses on improving lifestyle behaviors in nutrition, exercise, sleep and stress. Consecutive patients (n = 89) in the ICHP registry completed validated questionnaires, specifically the Pittsburgh Sleep Quality Index (PSQI, range 0–21), Fatigue Visual Analog Scale (range 0–10), Rate Your Plate diet questionnaire (RYP, range 24–72), a question estimating minutes of aerobic exercise per week and a Self-Efficacy Questionnaire for CV health behaviors (range, 0–45). In this retrospective analysis, patients were sorted by a median of 36 into low (18–35) and high (36–45) score groups for self-efficacy. Groups were compared utilizing t-tests.

Results: At baseline, subjects scoring high for self-efficacy (n = 44) were not different from those scoring low (n = 45) with regard to age (56.2 ± 11.9 vs 54.8 ± 13.1 years, p = 0.60), gender (50% vs 51% men, p = 0.90), or race (p = 0.66). The high self-efficacy group did show better sleep quality (PSQI = 6.4 ± 3.0 vs 7.9 ± 4.1, p = 0.05), less fatigue (3.5 ± 2.3 vs 4.9 ± 2.5, p = 0.007), better RYP score (64.4 ± 7.8 vs 60.0 ± 8.5, p = 0.01) and greater exercise minutes (216 ± 131 vs 107 ± 86, p < 0.001).

Conclusion: Our findings agree with prior reports that high self-efficacy correlates with healthful diet and exercise habits. We extend this
association to include better sleep quality and less fatigue. These findings suggest that efforts to increase self-efficacy may benefit both traditional measures of CV health as well as to encompass non-traditional measures, such as sleep health.

0842
ASSOCIATION BETWEEN SELF-REPORTED SLEEP DURATION AND SERUM VITAMIN D LEVEL IN ELDERLY KOREAN ADULTS
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Introduction: Inadequate sleep duration is relatively common in elderly patients and sleep disturbance is also related to the change of various hormone levels and metabolic diseases. However, there are few studies on the association between sleep duration and vitamin D in the aged person. Therefore, we attempted to investigate the association between self-reported sleep duration and serum vitamin D level in the Korean elderly.

Methods: The data of non-institutionalized adults aged 60 to 80 (N = 1,614) from the 2010 Korean National Health and Nutrition Examination Survey were used for this research. The confounding variables were serum 25-hydroxy vitamin D level, age, sex, body mass index, smoking history, alcohol consumption, and self-reported daily sun exposure and sleep duration. Self-reported daily sleep duration was divided into four groups: Q1 (≤ 4 hours), Q2 (5–6 hours), Q3 (7–8 hours), and Q4 (≥ 9 hours).

Results: Mean serum vitamin D levels of subjects in the Q1, Q2, Q3, and Q4 groups were 44.18, 48.08, 48.83, and 51.78 nmol/L, respectively. On multivariate linear regression analysis, subjects in the Q2 (B = 3.80, 95% confidence interval (CI) = 0.42–7.19), Q3 (B = 4.89, 95% CI = 1.54–8.24), and Q4 (B = 5.18, 95% CI = 0.78–9.58) groups had significantly higher serum vitamin D levels than subjects in the Q1 group.

Conclusion: Serum vitamin D level is positively associated with self-reported daily sleep duration in elderly Korean individuals. These results suggest that inadequate sleep duration may be associated with lower vitamin D levels in elderly adults.

0843
SLEEP AS A MEDIATOR BETWEEN SOCIOECONOMIC STATUS AND HEALTH OUTCOMES
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Introduction: A paper published in 1999 theorized that the detrimental effects of low socioeconomic status (SES) on health were partially mediated by curtailments in sleep duration and quality. Low SES is often associated with pressured work conditions and crowded, unsafe, and noisy neighborhood environments that can compromise sleep duration and quality. Sleep restriction, in turn, is associated with negative health outcomes. Despite the wide dissemination of this theory, to our knowledge no published studies have been conducted to test it using a large nationally representative sample.

Methods: We analyzed longitudinal data from multiple waves of the NHANES I. Initial analyses involved the estimation of models regressing health outcomes (hypertension, heart attack, diabetes, mortality) on indicators of SES (education, income, occupation). Subsequent analyses added sleep variables (sleep duration; early, middle, late insomnia; daytime sleepiness) to explore whether these variables acted as partial mediators of the relationship between SES and health outcomes. Separate models were conducted for each SES variable and health outcome. An attenuation of ≥ 10% in the β coefficients of the SES exposure terms after the inclusion of the sleep variables in the multivariate models was deemed sufficient to be consistent with mediation.

Results: Consistent with the sleep variables acting as partial mediators, the significant associations between education, income, and health outcomes (hypertension, heart attack, diabetes, and mortality) were appreciably attenuated (range 10.5% to 31.0%) with the inclusion of the sleep variables in the multivariate models. The sleep variables did not appreciably attenuate the relationships between occupation and health outcomes.

Conclusion: Our results are congruent with the hypothesis that the adverse impact of low SES on health is partially mediated by decrements in sleep duration and quality. Physical health improvements among the disadvantaged could therefore be achieved through targeted public health and policy interventions designed to promote sleep quality.

0844
RELATIONSHIPS AMONG HABITUAL SLEEP DURATION, RACE/ETHNICITY, AND CARDIOMETABOLIC DISEASE OUTCOMES: DATA FROM > 450,000 US ADULTS FROM THE 2013 BEHAVIORAL RISK FACTOR SURVEILLANCE SYSTEM
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Introduction: Habitual sleep duration is associated with race/ethnicity and cardiometabolic disease risk. Previous studies have been limited in terms of which groups were examined. Also, few previous studies have explored whether cardiometabolic risks depend on race/ethnicity. Finally, the degree to which disparities in health outcomes are mediated by sleep duration has generally not been explored.

Methods: The 2013 BRFSS was used (N = 483,495). Habitual sleep duration was categorized as “Very Short” (≤ 4 h), “Short” (5–6 h), “Normal” (7–8 h, reference), and “Long” (≥ 9 h). Cardiometabolic outcomes assessed were self-reported hypertension, diabetes, and obesity. Covariates included age, sex, race/ethnicity, education, income, smoking, BMI (except for obesity) and overall health. Weighted regression analyses examined whether sleep duration categories were disproportionately distributed among race/ethnicity groups and whether sleep duration was associated with cardiometabolic outcomes. Interaction terms were computed for sleep by race/ethnicity interactions. To test whether sleep mediates race differences in obesity/diabetes/hypertension, regression models with these outcomes and race/ethnicity as predictor tested sleep as a mediator. Sobel tests evaluated partial mediation.

Results: Very short sleep was more prevalent among Blacks/African-Americans (OR = 1.96; p < 0.0001), Native-Americans (OR = 1.82; p < 0.0001), Others (OR = 1.85; p < 0.0001), and Multiracial (OR = 2.08; p < 0.0001), and less prevalent among Hispanics/Latinos (OR = 0.7; p < 0.0001). Short sleep was more prevalent among Blacks/African-Americans (OR = 1.69; p < 0.0001), Asians (OR = 1.34; p < 0.0001), Native-Americans (OR = 1.28; p < 0.0001), Others (OR = 1.54; p < 0.0001), and Multiracial (OR = 1.48; p < 0.0001). Long sleep (≥ 9 h) was more prevalent among Blacks/African-Americans (OR = 1.53; p < 0.0001), Native-Americans (OR = 1.27; p < 0.05), and Multiracial (OR = 1.42; p < 0.05), and less prevalent among Hispanics/Latinos (OR = 0.84; p < 0.0001). Very short, short, and long sleep were associated with obesity, diabetes, and hypertension, and all race/ethnicity interactions were significant (p < 0.0001). Partial mediation was found for many relationships between race/ethnicity and cardiometabolic outcomes. For example, Black-White differences were significantly partially explained by sleep duration for hypertension (7.3%), diabetes (8.4%), and...
obesity (9.7%), and 16% of Hispanic/Latino-White differences in hypertension are explained by sleep duration.

**Conclusion:** Very short, short, and long sleep duration were associated with cardiometabolic risk, and this relationship depended on race/ethnicity. Further, several relationships between race/ethnicity and outcomes were partially mediated by sleep duration.

**Support (If Any):** K23HL110216, R21ES022931

### 0845
**ASSOCIATIONS BETWEEN SELF-REPORTED SLEEP DURATION AND PHYSICAL ACTIVITY IN WORKED-AGED HISPANIC/LATINO ADULTS IN THE US: RESULTS FROM THE HISPANIC COMMUNITY HEALTH STUDY/STUDY OF LATINOS (HCHS/SOL)**

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**Introduction:** The role of physical activity as a potential mediator in the association between sleep duration and obesity is unclear. To initially address this relationship, we tested the hypothesis that short sleep duration is related to lower levels of physical activity.

**Methods:** The analysis included baseline data from 13,316 non-retired adults age 18–74 years from the HCHS/SOL, a community-based cohort study in 4 metropolitan areas of the US. Participants self-reported on usual times into bed and waking up, age, sex, immigrant generation, hours worked weekly, marital status, educational attainment, income, Hispanic background, insomnia, daytime sleepiness, heart disease, depressive symptoms, alcohol use, smoking, and the Global Physical Activity Questionnaire. Weight and height were measured, and diabetes was assessed with laboratory testing. We used negative binomial regression to examine the relationship between daily sleep duration (<7.0, 7.0–7.9, 8.0–8.9, and ≥ 9 hours) and physical activity (min/day) by domain (transportation, recreation, work), adjusting for potential confounders. Analysis accounted for the complex survey design and sampling weights.

**Results:** Of the target population, 80% had > 0 minutes of all daily physical activity. The mean daily total physical activity in those sleeping < 7 hours was 178 minutes, compared to 125 minutes in those sleeping 8–8.9 hours and 102 minutes in those sleeping ≥ 9 hours. In a fully adjusted model, sleeping < 7 hours was associated with 38% greater physical activity. The mean daily total physical activity in those sleeping < 7 hours was 178 minutes, compared to 125 minutes in those sleeping ≥ 9 hours. In a fully adjusted model, sleeping < 7 hours was associated with 38% greater physical activity. The mean daily total physical activity in those sleeping < 7 hours was 178 minutes, compared to 125 minutes in those sleeping ≥ 9 hours. In a fully adjusted model, sleeping < 7 hours was associated with 38% greater physical activity.

**Conclusion:** Among non-retired US Hispanic adults, short sleep duration is associated with higher levels of work-related physical activity. Sleep duration may not be a useful target in encouraging physical activity.

**Support (If Any):** The HCHS/SOL was carried out as a collaborative study supported by contracts from the National Heart, Lung, and Blood Institute (NHLBI) to the University of North Carolina (N01-HC65233), University of Miami (N01-HC65234), Albert Einstein College of Medicine (N01-HC65235), Northwestern University (N01-HC65236), San Diego State University (N01-HC65237). The following Institutes/Centers/Offices contribute to the HCHS/SOL through a transfer of funds to the NHLBI: National Institute on Minority Health and Health Disparities, National Institute on Deafness and Other Communication Disorders, National Institute of Dental and Craniofacial Research, National Institute of Diabetes and Digestive and Kidney Diseases, National Institute of Neurological Disorders and Stroke, NIH Institution-Office of Dietary Supplements.

### 0846
**ASSOCIATION BETWEEN EMOTIONAL DISTRESS, SLEEP, AND DIABETES: ANALYSIS OF THE NATIONAL HEALTH INTERVIEW SURVEY DATA**

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**Introduction:** Stress influences blood glucose control and cardiovascular risk factors, including hypertension, among individuals with type 2 diabetes. Evidence also shows that stress might be associated with type 1 diabetes. We examined associations of emotional distress and type 2 diabetes and evaluated interactions between sleep duration with emotional distress on diabetes risk.

**Methods:** We used 2004–2013 NHIS dataset, which applied a multistage area probability sampling design. Diabetes was self-reported and the Kessler-6 (K6) scale was used to assess emotional distress; a score ≥ 13 indicated distress. Descriptive statistics and logistic regression modeling were used to evaluate hypothesized relationships.

**Results:** Of the 425,510 individuals surveyed, 53.0% were female; mean (± SEM) age and BMI were 35.3 ± 0.02 years and 26.1 ± 0.07 kg/m2, respectively. Prevalence of diabetes was 6.6%, with 56.0% being female. Individuals reporting diabetes were older (60.7 ± 0.08 versus 35.1 ± 0.03; p < 0.01) and had higher BMI (30.3 ± 0.04 versus 26.7 ± 0.01; p < 0.01). Prevalence of hypertension was higher among diabetics (72.0% versus 26%; p < 0.01). Of those with diabetes, 5.6% reported daily exercise, compared to 22.7% among non-diabetics, p < 0.01. Prevalence of dyslipidemia was also higher among diabetics (59.1% versus 24.3%; p < 0.01). There was higher prevalence of diabetes among short sleepers [8 hrs] (10.9%), compared to healthy sleepers [7–8 hrs] (7.7%); p < 0.01. Individuals with diabetes had higher frequency of emotional distress (7.07% versus 3.3%; p < 0.01). Based on logistic regressions, emotional distress was associated with diabetes (OR = 1.45; 95% CI = 1.27–1.66; p < 0.05), after adjusting for diabetes risk factors: age, race, BMI, hypertension, dyslipidemia, physical activity, sleep duration, and marital, educational and poverty status.

**Conclusion:** Our study indicates high risk of diabetes associated with emotional distress, even with adjustment for traditional diabetes risk factors. Further research is needed to delineate the pathophysiological factors underlying associations of diabetes with stress and to determine whether stress could induce diabetes.

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B. Clinical Sleep Science

0847
SLEEP EFFECTIVENESS AND GLUCOSE AND INSULIN HOMEOSTASIS
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Introduction: Evidence from experimental studies supports the general hypothesis that fragmented and insufficient sleep contribute to impaired glucose and insulin homeostasis. The sleep spectrogram, an EEG-independent measure of sleep effectiveness, maps coupled oscillations of heart rate variability and ECG-derived respiration. We previously explored the association between ECG-spectrogram derived biomarkers and glucose metabolism in a sample of non-diabetic subjects with and without sleep apnea and found that the spectrographic marker of effective sleep, High Frequency Coupling (HFC), is associated with reduced diabetes risk (increased Disposition Index, DI). HFC is also enhanced by sedative medications (benzodiazepines, zolpidem, and eszopiclone).

Methods: In this study we 1) explore the relationship between sleep effectiveness and insulin sensitivity across the sleep period, by frequently sampling (simultaneous, in the CRC) glucose and insulin during nocturnal polysomnography in healthy subjects (n = 9 completed); and 2) evaluate the impact of pharmacologic enhancement of effective sleep with nightly eszopiclone (1 week, home environment) on glycemic profiles (CGM system X 72 hours) in diabetics (n = 4 completed) compared to pretreatment baseline.

Results: In healthy subjects (n = 5 analyzed) HFC was associated with lower cortisol levels compared to low frequency coupling (LFC) at the 0.05 level of significance. All other comparisons were not significant. Using pharmacologic enhancement of effective sleep with nightly eszopiclone, diabetic subjects (n = 2 analyzed) report subjective improvement in sleep quality and demonstrate improved 72-hour continuous glucose profiles compared to baseline.

Conclusion: Preliminary data demonstrates a relationship between sleep state and cortisol in normal healthy subjects. The spectrographic HFC (a marker of stable or “effective” sleep) duration is associated with decreased cortisol levels compared to LFC (a marker of unstable or “ineffective” sleep) duration. The primary significance of this study is a novel approach, that of measuring and manipulating “sleep effectiveness”, in relation to glucose/insulin metabolism in health and disease.

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0848
PERCENTAGE OF N3 SLEEP IS DECREASED IN OBESE PATIENTS WITH METABOLIC SYNDROME
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Introduction: The prevalence of Metabolic Syndrome (MetS) is high in the Mexican population and its prevalence increases with obesity. It is well known that obstructive sleep apnea (OSA) in patient with MetS has a detrimental effect on cardiovascular risk and glycemia. The aim of this study was to compare the sleep characteristics in obese men with and without MetS.

Methods: Sixty-three obese men with mean (SD) age of 40.4 (10.3) y/o and body mass index of 42.1 (9.8) kg/m² who underwent standard in-laboratory polysomnography for suspicion of OSA at INCMNSZ were assessed for the presence of MetS according to the NCEP ATP-III.

Results: Sixty-five percent of the subjects were diagnosed with MetS and 86% had OSA defined by an apnea-hypopnea index (AHI) ≥ 5. There were no statistically significant difference in age (non-MetS = 38.6 ± 10.8 vs. MetS = 41.4 ± 10.0, p = 0.294), BMI (non-MetS = 42.9 ± 10.0 vs. MetS = 41.7 ± 9.84, p = 0.630) and in total sleep time (non-MetS = 393.3 ± 57.1 min vs. MetS = 386.6 ± 55.23 min). The percentage of N3 sleep was decreased in the obese MetS group = 6.4 ± 6.7 vs. non-MetS = 12.3 ± 6.8, t = 3.330, p = 0.001. AHI and arousal index were higher in the MetS group (51.0 ± 34.6 vs. 32.5 ± 29.9, t = −2.118, p = 0.038 and 25.7 ± 17.9 vs 15.5 ± 13.5, t = −2.327, p = 0.023, respectively. There was no correlation between the presence of MetS and AHI, oxygen desaturation variables or arousal index. However, there was a correlation between N3% and AHI (r = −0.470, p = 0.0001). In the regression model the only variable that predicted the presence of MetS was N3%, B = 0.349 (95% CI 0.171–0.712), p = 0.004.

Conclusion: In obese men, low levels of N3 deep sleep as opposed to severity of OSA is associated with the presence of MetS. Whether the impact of OSA in increasing the risk of MetS is mediated by reduction in N3% requires further investigation.

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0849
SLEEP DURATION AND INSULIN RESISTANCE: A META-ANALYSIS
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Introduction: A U-shaped association exists between sleep duration and various medical co-morbidities such as hypertension, coronary vascular disease and mortality. However, data on the association between insulin resistance (IR) and sleep duration has been rather conflicting. In this first of a kind meta-analysis, we sought to synthesize data from current literature on the magnitude of I R observed in short and long sleep.

Methods: We searched in the databases of PubMed, Web of Science and Ovid from inception to October 4th, 2014 for cross-sectional stud-
ies in adolescents and adults, in which I.R was assessed by homeostatic model assessment (HOMA-IR). Pooled mean difference in HOMA-IR was analyzed between short sleepers (< 6 hours) and those reporting normal sleep duration, along with 95% confidence intervals (CIs). Similar analysis was separately conducted between long sleepers (> 9 hours) and those reporting normal sleep duration.

**Results:** Based on 8 studies enrolling a total of 7392 participants, the pooled mean difference in HOMA-IR between participants reporting short sleep duration and normal sleep duration was 0.075 (95% CIs: 0.006 to 0.145), \( p = 0.03, \ I^2 \ 96\% \). Based on a 6 studies enrolling a total of 7204 participants, the pooled mean difference in HOMA-IR between those reporting long sleep duration and those with normal sleep duration was 0.06 (95% CIs: 0.04 to 0.08), \( p < 0.001, \ I^2 \ 64\% \). No publication bias was observed. In the funnel plot, the intercept (B0) was 0.70 (95% CIs: \(-4.48 \) to 5.90), \( p\text{-value (1-tailed)} = 0.37 \).

**Conclusion:** Both short and long sleep duration are significantly associated with insulin resistance.

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**0851**

**THE RELATIONSHIP BETWEEN GLUCOSE VARIATIONS AND SLEEP EEG WITH TYPE 1 DIABETES**

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**Introduction:** Glucose homeostasis is disrupted in type 1 diabetes (T1DM) which can have negative effects in the brain, a predominantly glucose dependent organ. Sleep plays an important role in glucose homeostasis, but the relationships between sleep and glucose homeostasis have not been systematically investigated in individuals with T1DM. Quantitative EEG analysis (qEEG) represents a useful tool for characterizing brain function. The purpose of this investigation was to determine the relationship between qEEG measures and glucose variations during sleep in young adults with T1DM.

**Methods:** Twelve participants with T1DM (6 males), age 18–30, wore a continuous glucose monitoring system (CGMS) to provide interstitial glucose values every 5 minutes and underwent in-laboratory overnight polysomnography (PSG). qEEG metrics included delta, theta, alpha, sigma, beta and gamma band power at 5-minute intervals. Additionally, activation ratio (AR) \( [alpha + sigma / delta + theta] \) was quantified as a marker for EEG activation during the sleep period. Cross correlation function and wavelet coherence analyses were used to quantify the relationships between glucose and qEEG measures.

**Results:** Cross-correlation analysis revealed highly significant correlations of glucose with power in each of the EEG bands (\( p < 0.0001 \) for each band). In particular, the peak correlation between glucose and AR demonstrated a mean amplitude of 0.82 ± 0.07 (\( p < 0.0001 \)) with AR lagging 10.0 ± 3.0 minutes (\( p = 0.01 \)) behind glucose variations. Moreover, wavelet coherence analysis revealed that the coupling between AR and glucose was most consistent during rapid variations (periods between 10 and 20 minutes) with significant coherence observed for \( f \geq 0.7\% (p < 0.0001) \) of recording time.

**Conclusion:** Our findings suggest a potential causal relationship between variations in glucose and brain activation in young adults with T1DM. Larger scale, intervention studies will be necessary to confirm and determine the causal mechanisms underlying these findings.

**Support (If Any):** 5TL1TR000049-05 (NIH)

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**0852**

**NOCTURIA AND NEXT-DAY PHYSICAL ACTIVITY IN ADULTS WITH TYPE 2 DIABETES**

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**Introduction:** Previous studies suggest that nocturia has a negative effect on daytime function. The purpose of this study is to examine the association of nocturia with subjective physical energy and objective time in sedentary activity in adults with excessive daytime sleepiness (Epworth Sleepiness Scale \( \geq 10 \)) and type 2 diabetes.

**Methods:** A secondary analysis of baseline data (R21 HL 089522) examined 7-day sleep diaries (nocturia [yes/no]), sleep duration, wake after sleep onset [WASO], 100 mm visual analog scales on nightly sleep quality (“poor” to “excellent,” and next-day subjective physical energy “exhausted” to “energetic”). Date-matched physical activity data (average metabolic equivalent [METs] \( < 3 \) MET) were obtained from the BodyMedia Sensewear armband. Linear mixed effects modeling was used to examine the associations between the daytime outcomes of subjectively measured physical energy and time in sedentary physical activity the following day and the sleep predictor variables of nocturia.
B. Clinical Sleep Science

0853
THE IMPACT OF SLEEP DEBT ON ADIPOSE AND INSULIN SENSITIVITY IN PATIENTS WITH EARLY DIABETES
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Introduction: To cross-sectionally and prospectively assess potential associations between baseline weekday sleep debt and obesity, as determined by body mass index (BMI), as well as HOMA-insulin resistance in a large sample of newly diagnosed type 2 diabetes mellitus patients.

Methods: Participants (n = 522), recruited into the Early Activity in Diabetes trial, were randomized into one of three groups (usual care, physical activity intervention or diet and physical activity intervention). Information was obtained at baseline and then at six and 12 months post-intervention. Seven-day sleep diaries were completed and weekday sleep debt calculated. Objective height (cm) was obtained at baseline and weight (kg) ascertained at all visits to determine obesity status (BMI ≥ 30 kg/m²), and fasting blood samples were drawn to determine insulin resistance using a standardized technique.

Results: At baseline, compared to those without weekday sleep debt, those with positive weekday sleep debt were 72% more likely to be obese (OR = 1.72 [95% CI: 1.03–2.88]). At six months post-intervention, positive weekday sleep debt was significantly associated with obesity and insulin resistance after adjustment, where OR = 1.80 (95% CI: 1.05–3.08) and OR = 2.04 (95% CI: 1.01–4.11), respectively. A further increase was observed, 12 months post-intervention, for positive weekday sleep debt with obesity and insulin resistance OR = 1.83 (95% CI: 1.01–3.29) and OR = 2.96 (95% CI: 1.31–6.67), respectively. For every 30 minutes of positive weekday sleep debt at baseline, the risk of obesity and insulin resistance at 12 months post-intervention was significantly increased by 17% and 39%, respectively.

Conclusion: The long-term effects of weekday sleep debt may cause metabolic disruption, which may exacerbate the progression of type 2 diabetes mellitus. Future interventions designed to slow progression, or reverse metabolic disease, should consider all factors that impinge on metabolic function. Consistent optimum sleep hygiene/education may be a key component for driving successful future trials in metabolic disease control.

0854
THE RELATIONSHIP OF PAIN, SLEEP, MOOD AND FUNCTION IN A COMMUNITY SAMPLE
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Introduction: In studying the affects of the high prevalence of sleep disorders and the high incidence of pain disorders, we can begin to understand the suffering of people in a community as well as tailor interventions to individualize treatment. In this study, we assessed the relationships of sleep, pain, mood, and function.

Methods: The design for this study was cross-sectional and included a sample (n = 299) of participants recruited from the community at large using posters, research match, and the university recruiting website. Data was collected for a larger study; this is a secondary analysis of study variables. Variables included demographics, the PROMIS-57 profile component standard scores, Insomnia Severity Index (ISI) total score and Epworth Sleepiness Scale (ESS) total score, actigraphy measures of total sleep time in hours, and the AHI as measured by the Apnealink device. Analysis procedures were descriptive and correlational.

Results: Two hundred ninety-nine subjects completed all study procedures. Age M (sd) 40 (17), BMI M (sd) 27 (6), Physical Functioning M (sd) 55 (6.5), Anxiety M (sd) 50 (8.9), Depression M (sd) 46 (7.9), Social Role M (sd) 52 (8.3), Fatigue M (sd) 49 (8.6), Pain Interference M (sd) 47 (7.7), ISI Total M (sd) 8.1 (5.6), AHI M (sd) 4.32 (8.04), Total Sleep Time M (sd) 6.93 (0.8). Significant correlations with Pain Interference were Sleep (r = −0.219, p = 0.000), Fatigue (r = 0.381, p = 0.000), Physical Function (r = −0.618, p = 0.000), Depression (r = 0.316, p = 0.000), and Anxiety (r = 0.221, p = 0.000).

Conclusion: Patients with pain are likely to also suffer from poor sleep, increased fatigue, decreased physical functioning, depression, and anxiety. Caring for patients with pain should also assess for and address associated symptoms.

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0855
UNPLANNED PHYSICAL ACTIVITY IS POSITIVELY ASSOCIATED WITH STAGE N3 SLEEP AMONG WOMEN WITH TEMPOROMANDIBULAR JOINT DISORDER
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Introduction: Patients with chronic pain, including temporomandibular joint disorders (TMJ), frequently report that their sleep is non-restorative, and show disrupted slow wave (N3) sleep. Slow wave sleep (SWS) is a marker of homeostatic sleep drive and is believed to underlie restorative aspects of sleep. Physical activity (PA) is associated with improved sleep quality and reduced clinical pain levels. Moreover, research suggests that compared to planned PA (PPA: deliberately scheduled PA), unplanned PA (UPA: PA, excluding PPA, that occurs during daily living, including climbing stairs/ heavy housework) is easier to maintain and may occur more regularly during daily demands. However, the relationship between PA (PPA & UPA) and sleep (especially SWS) among chronic pain patients is poorly understood. The current study tested the hypothesis that greater self-reported PA (PPA & UPA) would be associated with enhanced N3 sleep in a sample of female TMJD patients.
**B. Clinical Sleep Science**

**0856 PATIENT AWARENESS AND RISK OF SLEEP APNEA USING STOP-BANG IN THE PAIN CLINIC POPULATION**

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**Introduction:** It is known that patients utilizing chronic opiate therapy are at high risk for sleep-disordered breathing. Opiates have been shown to both decrease central respiratory drive and the patency of the upper airway. The STOP-BANG questionnaire has been validated in several populations and determined to be of the highest methodological quality and sensitivity, but it has not been used to date to screen for sleep apnea in patients using opiates. It is also unclear whether patients consuming opiates are aware of their increased risk for sleep apnea.

**Methods:** A total of 340 consecutive patients presenting to the UC Davis Pain Clinic were invited to participate in an anonymous sleep survey. The survey included questions regarding demographics and opiate use, as well as, the STOP-BANG questionnaire and Epworth Sleepiness Scale. The survey also included questions about patient’s knowledge of, testing, diagnosis, or treatment of sleep apnea and if their health care providers have discussed with them their increased risk of sleep apnea.

**Results:** Among the 340 consecutive patients, 84.7% (n = 288) of them agreed to participate in the survey. Among these patients 69.4% (n = 200) screened positive for sleep apnea based on the STOP-BANG questionnaire. Among the 171 patients on opiate therapy 78.4% (n = 134) were STOP-BANG positive. Of these 134 patients, only 44.7% (n = 60) discussed their risk of sleep apnea with a health care provider and only 38.8% (n = 52) underwent testing.

**Conclusion:** A significant percentage of the pain clinic population on opiates screened positive for sleep apnea. The vast majority of these patients were unaware of their increased risk of sleep apnea and denied undergoing the necessary testing. Greater attention to screening, testing and educating for sleep apnea needs to occur in the pain clinic population given the potentially dangerous ramifications of opiate induced sleep apnea.

**0857 PHYSICAL ACTIVITY PREDICTS POLYSOMNOGRAPHIC SLEEP EFFICIENCY IN FEMALES WITH TEMPOROMANDIBULAR JOINT DISORDER**

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**Introduction:** Sleep disturbance and pain have a bidirectional relationship. Recent studies using sophisticated statistical methodologies suggest that in some pain conditions, such as temporomandibular joint disorder (TMJD), sleep disturbance might be a more robust predictor of subsequent pain than vice versa. High levels of self-reported daily physical activity are associated with enhanced sleep quality in the general population and reduced clinical pain ratings in chronic pain patients. The present study investigates the effects of self-reported physical activity (PA) on polysomnographic (PSG) sleep in a sample of females diagnosed with TMJD and self-reported poor sleep. We hypothesized that increased PA would be associated with better objective sleep assessed through PSG.

**Methods:** Forty-seven women with TMJD (mean age = 35.85, SD = 12.92) completed measures of clinical pain and PA (Godin Leisure-Time Exercise Questionnaire), and underwent home sleep testing and a Research Diagnostic Criteria (RDC) exam to confirm TMJD.

**Results:** Hierarchical multiple regression assessed the association between PA and PSG sleep, controlling for age and body mass index (BMI). 17% of the variance in PSG sleep efficiency was explained by age and BMI (step 1) and 10% by PA (step 2) [F change (1, 43) = 6.03, p = 0.02]. The final model accounted for 27.2% of the variance [F(3, 43) = 5.36, p < 0.01]; only age (beta = -0.35, p = 0.01) and PA (beta = 0.33, p = 0.02) were independently associated with PSG sleep efficiency. PA showed a trend toward significance (p = 0.057) in predicting PSG total sleep time.

**Conclusion:** Participants reporting increased PA (combined mild, moderate, strenuous) had greater sleep efficiency than those reporting lower levels of PA. Our findings are consistent with previous literature and suggest that PA is associated with objectively measured sleep efficiency. Consequently, PA, a modifiable risk factor, may represent a pathway through which persistent pain may be ameliorated via enhanced sleep. Future work should examine whether increased PA improves sleep and reduces pain in TMJD.

**0858 DIFFERENCES IN SLEEP CONTINUITY BETWEEN CRISIS AND NON-CRISIS PAIN DAYS IN ADULTS WITH SICKLE CELL DISEASE**

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**Introduction:** In previous work we demonstrated daily variation in sleep continuity impacts pain in adults with Sickle Cell Disease (SCD). Specifically worse sleep continuity (i.e. increased sleep latency and sleep fragmentation and decreased sleep duration and sleep efficiency) were associated with increased clinical pain during the day. Building upon previous work, the present analyses examined sleep continuity on sickle cell crisis and non-crisis days. We were particularly interested in modeling differences in sleep continuity around crisis days.

**Methods:** Seventy-five adults with SCD who completed daily morning (sleep) and evening (pain) diaries over a three-month period were included ($M_{age}$ 38.5 years). Data were analyzed using descriptive statistics and one-way ANOVA with correction for multiple comparisons.
Results: During the three-month diary period, 4,411 morning diaries and 4,549 evening diaries were completed. Approximately 29.3% of participants (n = 22) never reported a crisis, while 8% of participants (n = 6) reported a crisis on 50% or more of their diary days. Compared to consecutive non-crisis nights, nights preceding and during a crisis were characterized by longer sleep latency (M_d=10.9 min and M_d=17.1 min, p < 0.01, respectively) and greater sleep fragmentation (M_d=23.4 min and M_d=30.1 min, p < 0.001, respectively). Additionally, sleep duration (M_d=-43.2 min and M_d=-49 min, p < 0.01, respectively) and sleep efficiency (M_d=-7% and M_d=-9% min, p < 0.001, respectively) were lower on nights before and during a crisis compared to consecutive nights without a crisis (p < 0.001). With the exception of sleep latency, all other sleep continuity parameters trended toward improvement the night after a crisis (ps < 0.01).

Conclusion: We demonstrate that sleep continuity is disrupted during a sicken cell crisis. Future analyses should examine whether changes in sleep continuity can be used to predict the onset of a sicken cell crisis.

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0859 RESISTANT HYPERTENSION AND SLEEP DURATION AMONG BLACKS WITH METABOLIC SYNDROME

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Introduction: Resistant hypertension (RHTN) is an important condition affecting 3–29% of the US population, albeit more common among blacks. We evaluated associations of RHTN with short sleep among blacks.

Methods: Data came from the Metabolic Syndrome Outcome Study (MetSO), an NIH-funded cohort study characterizing metabolic syndrome (MetS) among blacks. Analysis was based on 883 participants (mean age: 62 ± 14 years; female: 69.2%). MetS was defined according to criteria from the Adult Treatment Panel (ATP III). RHTN was defined as failure to achieve blood pressure goal (BP) of <140/90 mmHg or <130/80 mmHg among patients with diabetes or kidney disease when on maximal doses of a three-drug regimen. This also includes patients requiring more medications to achieve BP goal. Short sleep, derived from subjective reports, was defined as <7 hours, referenced to healthy sleep (7–8 hours). OSA risk was assessed using the Apnea Risk Evaluation System (ARES™); patients with a score ≥ 6 were considered at high OSA risk, based on validated studies.

Results: Most (90.4%) were overweight/obese; 61.4% had diabetes; 74.8%, dyslipidemia; 30.2%, heart disease; and 48% were at OSA risk. Overall, 92.6% had HTN, and 20.8% met criteria for RHTN. Analyses showed no significant difference in HTN prevalence comparing short (91.4%) and healthy sleepers (93.1%), but those with RHTN were more likely to be short sleepers (26.8% vs. 14.9%, p < 0.001). Based on logistic regression analysis, adjusting for effects of age, sex and medical comorbidities, patients with RHTN had increased odds of being short sleepers (OR = 1.90, 95% CI: 1.27–2.90, p = 0.002). Of interest, odds of being short sleepers among those at OSA risk were similar (OR = 1.92, 95% CI: 1.38–2.68, p < 0.001).

Conclusion: Among blacks with metabolic syndrome, patients meeting criteria for RHTN showed a twofold greater likelihood of being short sleepers. Adjusted odds of short sleep were remarkably similar to those observed for patients at OSA risk.

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0860 ANALYSIS THE RELATED FACTORS OF ESSENTIAL HYPERTENSION WITH OBSTRUCTIVE SLEEP APNEA-HYPOPNEA SYNDROME IN RENAL FUNCTION

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Introduction: To study the related factors of the renal function in patients with hypertension associated with obstructive sleep apnea-hypopnea syndrome (OSAHS).

Methods: Hypertensive who complaining of snoring at night from the First Affiliated Hospital of Xinjiang Medical University were enrolled and conducted the polysomnography. The patients were divided into 4 groups according to the hypoa vapitentilation index (AHl): AHl < 10/h for the simple hypertension group (EH group, n = 106), 10–15/h for the hypertension associated with mild OSAHS group (mild group, n = 102), and 15–30/h for hypertension with moderate OSAHS group (moderate group, n = 153), AHl ≥ 30/h for hypertension with severe OSAHS group (severe group, n = 96). The quantitative level of blood urea, creatinine, 24 hour urinary total protein (24 h UTP), 24 hours urinary microalbumin, cystatin C (Cyst C) were compared among each groups, and analyzed the related factors of above results.

Results: The baseline data of gender, age, body mass index (BMI), 24-hour systolic blood pressure (24 h SBP), fasting blood-glucose had significant difference between the four groups (P < 0.05). 24 h UTP and 24 h urinary microalbumin in the sever group were higher than those in the mild group and simple hypertension group; the Cyst C in each of the group with OSAHS were higher than the simple hypertension group (all P < 0.05). The multi-factor Logistic regression analysis indicates that: BMI (OR = 1.555, 95% CI 1.082–2.235), severe OSAHS (OR = 4.112, 95% CI 1.311–12.897) were the influencing factors of the Cyst C.

Conclusion: In the patients of the hypertension associated with OSAHS, BMI, severe OSAHS as influencing factors for 24 h UTP; blood pressure control, BMI as influencing factors for 24 h urinary microalbumin; Age, blood pressure control, severe OSAHS as influencing factors for Cyst C. OSAHS as risk factor for early renal damage.

0861 WITHIN-PERSON SHORTER SLEEP DURATION LEADS TO INCREASES IN BLOOD PRESSURE

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Introduction: Short sleep is associated with detrimental health effects, including higher blood pressure. However, the mechanisms and timing of how short sleep duration impacts blood pressure are unclear. In this
DISCORDANCE BETWEEN SELF-REPORTED SLEEP QUALITY, DAYTIME SLEEPINESS, AND OBJECTIVELY MEASURED BEHAVIORAL ALERTNESS IN PATIENTS WITH HEART FAILURE

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Introduction: Although sleep disordered breathing is common in persons with heart failure, less is known about daytime sleepiness and behavioral alertness in this population. The primary aim of this study was to describe characteristics of sleep in community-dwelling adults with heart failure across three domains; subjective sleep quality, subjective daytime sleepiness and objective behavioral alertness.

Methods: A community-based sample of 280 participants with chronic heart failure was recruited from medical centers in the Northeastern United States. Data were collected at baseline using widely used measures validated to be sensitive to sleep quality (Pittsburgh Sleep Quality Index (PSQI)), sleepiness (Epworth Sleepiness Scale (ESS)), Stanford Sleepiness Scale (SSS)), and behavioral alertness (Psychomotor Vigilance Test (PVT)).

Results: Participants had a mean age of 62 years, were predominantly white male, and were functionally compromised. The majority of the sample (73%) reported poor sleep quality on the PSQI and 76% reported routine daytime napping with an average length of 1.5 (± 0.13) hours. Behavioral alertness was poor as evidenced by a slow PVT mean response time (3.09 ± 0.76), a high number of lapses (8.52 ± 13.10), and a long mean duration of lapses (slowest 10% response time: 1.92 ± 0.70). However, only 14% of the sample reported feeling sleepy on the SSS and the mean (± SD) ESS was low (7.0 ± 4.6), indicating they did not perceive daytime sleepiness.

Conclusion: We found a distinct mismatch between self-reported sleepiness and behavioral alertness. The observation that the typical match between daytime sleepiness and behavioral alertness was not found in patients with heart failure highlights the importance of objective measures of neurobehavioral performance when assessing sleep parameters in heart failure patients. The mechanism underlying this mismatch requires further research.

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0863 SLEEP DISTURBANCE, SYMPTOMS AND PHYSICAL FUNCTIONING IN PULMONARY ARTERIAL HYPERTENSION

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Introduction: The aim of this study was to determine if there are differences in self-reported sleep disturbance, pulmonary arterial hypertension (PAH) symptoms and health-related quality of life (HRQOL) among New York Heart Association (NYHA) functional class (FC) groups in people with PAH.

Methods: This was a cross-sectional design. A convenience sample included 191 adults with PAH. Participants completed a socio-demographic and clinical data form, the Pulmonary Arterial Hypertension Symptom Scale (PAHSS) which measured sleep difficulty (scores range 0–10), and the Medical Outcomes Survey Short Form 36 (SF-36) (scores range 0–100). The sample was categorized into the four NYHA FC groups. NYHA FC I are those with no symptoms with ordinary physical activity, in contrast to those categorized as NYHA FC IV who have symptoms at rest. Descriptive statistics described the sample. Analysis of variance (ANOVA) and chi square determined differences among continuous and categorical variables with post hoc analyses to account for multiple comparisons.

Results: Eighty-five percent of the sample were female with a mean age of 53 years. Twelve percent (n = 22) were NYHA FC I; 19% (n = 36) NYHA FC II; 28% (n = 54%) NYHA FC; and 41% (n = 79) NYHA FC IV. Mean sleep difficulty scores were significantly different among the NYHA FC groups (p < 0.0001) with higher sleep difficulty reported as the NYHA FC groups increased. All symptoms measured by the PAHSS were significantly different (p < 0.0001) among the NYHA FC groups except for syncope. HRQOL measured by the SF-36 were significantly worse (< 0.0001) as NYHA FC increased except for role emotional and emotional subscales.

Conclusion: Sleep difficulty was significantly worse as the NYHA FC increased. PAH symptoms and HRQOL were also significantly worse in the higher NYHA FC groups. As disease severity increases assessing and employing strategies to improve sleep is needed.

Support (If Any): This study was partially funded by a Bouve College of Health Sciences, Northeastern University intramural grant and Sigma Theta Tau International Gamma Epsilon grant.
**VII. Medical Disorders and Sleep**

**0864**

**PERIPHERAL NEUTROPHILIA : RISK FACTOR FOR CARDIOVASCULAR DISEASE IN PATIENTS WITH COPD-OSA OVERLAP SYNDROME**

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**Introduction:** Obstructive sleep apnea (OSA) and chronic obstructive pulmonary disease (COPD) co-exist as overlap syndrome (OS) in up to 1% of the adult male population. These patients have higher cardiovascular (CVD) morbidity and mortality than either OSA or COPD-only patients, likely due to the increased chronic intermittent hypoxia (IH) that leads to increased neutrophils survival, inflammation and endothelial dysfunction. We therefore hypothesized that OS patients have increased neutrophils survival compared with COPD-only patients.

**Methods:** A cross-sectional study of patients with COPD and severe comorbidities as defined by the Care Assessment Need score above 95 were seen in the Pulmonary Tele-Health Clinic at the Salem VAMC over a 1 year period of time. Demographic and polysomnographic data, FEV1 and Charlson Comorbidity Index (CCI) were extracted from the Electronic Medical Records. OSA was defined as per AASM guidelines. Serum WBC with neutrophils’ percentages were obtained after the Tele-Health appointment. Age, body mass index (BMI), FEV1, and CCI were analyzed as predictors. The outcome was the percentage of neutrophils in OS patients. Data was analyzed using multivariable logistic regression, adjusted for potential confounders.

**Results:** Data was available on 38 patients with COPD, 14 (36%) of whom also had OSA and were considered OS. The COPD severity in the OS patients was as follows: mild 7%; moderate 29%; severe 50%; and very severe 14%. In OS patients the age, BMI, FEV1, CCI and WBC with neutrophils’ percentages were as follows (mean ± SEM): 69 ± 5.9 years; 34 ± 7.5; 47 ± 17.5%; 6 ± 2.1; 79 ± 0.3 mg/L and 67.8 ± 1.8%. No differences in age, FEV1 and CCI were found between OS and COPD-only patients. There was a statistically significant difference (p = 0.04) in the mean percentage of neutrophils of OS (74 ± 8.3) vs COPD-only (63 ± 9). Patients with OS had a higher percentage of peripheral neutrophils (OR 1.14; 95% CI 1.01–1.29) compared with COPD independent of BMI.

**Conclusion:** Peripheral neutrophils were 14% percent higher in OS than in COPD-only patients. These findings suggest that one of the mechanisms by which IH contributes to worse CVD outcomes in OS is inflammation due to increased neutrophils survival.

**Support (If Any):** This project titled “Integrated rural care for COPD disease in severely-comorbid geriatric veterans (IRC-COPD)” is funded by the Office of Rural Health N06-FY14Q1-S1-P00855

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**0865**

**PULMONARY REHABILITATION IN SEVERELY COMORBID PATIENTS WITH COPD-OSA OVERLAP SYNDROME**

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**Introduction:** The co-existence of both OSA and COPD in a single patient is called “Overlap Syndrome” (OS) and is associated with worse outcomes than that of OSA or COPD-only patients. As in COPD patients pulmonary rehabilitation (PR) reduces symptoms, disability, number of hospitalizations, emergency department or physician office visits and improves the overall quality of life and survival, PR could be a promising strategy towards improving outcome of OS patients. Little is known about the need of PR in OS patients. Therefore, our project aimed to evaluate the prevalence and possible predictors of PR in a cohort of OS patients.

**Methods:** Individuals with COPD and severe comorbidities (CAN score above 95) were selected from the Salem VAMC outpatient clinics for Tele-Health services over 1 year period of time. Information on age, body mass index (BMI), home oxygen therapy (HOT), FEV1, and comorbidities (Charlson Comorbidity Index) were available from the Electronic Medical Record. OSA was defined as per AASM guidelines. The need for PR in OS patients was determined by applying GOLD recommendations.

**Results:** Data was available on 38 patients with COPD and severe comorbidities, 14 (36%) of whom also had OSA and were considered OS. In COPD patients the age, BMI, FEV1 and CCI were as follows (mean ± SEM): 72 ± 1.2 years; 29 ± 1.2; 50 ± 2.4%; 5.7 ± 2.9, respectively. No differences between age, FEV1 and CCI were found between OS and COPD-only patients. Only one patient with OS had mild COPD. Patients with more severe COPD had a higher frequency of HOT (OR 2; 95% CI) independent of age, BMI and CCI.

**Conclusion:** A third of COPD patients with severe comorbidities had OS. A majority of these patients qualified for PR. HOT predicted need for PR in OS. OS patients need to be identified within the OSA and/or COPD population and targeted for PR intervention.

**Support (If Any):** This project titled “Integrated rural care for COPD disease in severely-comorbid geriatric veterans (IRC-COPD)” is funded by the Office of Rural Health N06-FY14Q1-S1-P00855

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**0866**

**SLEEP QUALITY, SYMPTOMS AND AFFECTIVE DISTRESS IN CHRONIC OBSTRUCTIVE PULMONARY DISEASE**

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**Introduction:** People with chronic obstructive pulmonary disease (COPD) experience multiple symptoms that affect daytime functioning. The theory of unpleasant symptoms suggests interaction among symptoms in COPD, but there is limited empirical evidence to support this. The purpose of this research was to identify and examine clusters of symptoms that commonly occur in COPD and their predictors.

**Methods:** This was a cross-sectional, secondary analysis of two data-sets totaling 150 subjects (86 men, 64 women) with moderate to severe COPD (Mean (SD) FEV1 percent predicted = 48 (19)). Measures included the Chronic Respiratory Disease Questionnaire Dyspnea scale, the Profile of Mood States, the Pittsburgh Sleep Quality Index and the Functional Performance Inventory. Data were analyzed using linear regression and two step cluster analysis to determine clusters.

**Results:** Three distinct clusters were identified. Thirty-one subjects (21%) fell into cluster 1 (greater affective distress (anxious and depressed mood), dyspnea, fatigue and poorer sleep quality), 72 subjects (48%) fell into cluster 2 (less affective distress, dyspnea, fatigue and better sleep quality), and 47 (31%) fell into cluster 3 (lowest affective distress, fatigue, dyspnea and normal sleep quality). Anxious mood was the most important predictor of cluster, followed by depressed mood, fatigue, sleep quality and level of dyspnea. Age, but not gender, body mass index or amount of airflow obstruction predicted cluster membership. Cluster was significantly associated with daytime functioning (r = 0.48, p = 0.000).

**Conclusion:** Results support the notion that there are distinct symptom clusters in people with moderate to severe COPD that are associated with functioning. Understanding symptom clusters has important implications for treatment strategy in COPD.

**Support (If Any):** This abstract is funded by: NIHKO1NR010749 and NIHRO1NR013937.
NOCTURNAL OXYGEN SATURATION PROFILES OF LUNG CANCER SURVIVORS COMPARED TO MATCHED HEALTHY CONTROLS
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Introduction: Research on nocturnal oxygen saturation has been reported for patients with obstructive sleep apnea, neurologic diseases (ALS and MS) and lung disease such as chronic obstructive lung disease; however, data on lung cancer survivors is lacking. Low nocturnal oxygen saturation may contribute to fatigue symptoms in these patients. The purpose of this study was to obtain a profile of oxygen saturation (SpO2) that represent reference ranges of nocturnal SpO2 recordings from a cohort of lung cancer survivors compared to matched controls.

Methods: Twenty participants > 6-weeks surgery for stage I/II non-small cell lung cancer were included. Healthy controls were matched for age, BMI, gender and smoking history. Healthy controls were obtained from data on healthy sleep study that was conducted by one of the authors (CJ). All subjects were screened with the Apnea-Link device (overnight at-home screening). A Board Certified sleep medicine physician reviewed the results for obstructive sleep apnea and referred those patients for definitive diagnosis and treatment if their AHI was greater than > 5. Outcome measures included number of apneas, hypopneas, snoring events, as well as oxygen saturation (SpO2) at baseline, lowest saturation and percentage of time during the night at 90, 85 and less than 80% saturation.

Results: Lung cancer survivors had a mean baseline SpO2 of 93 (4.89) range 78–99. The lowest saturation mean was 80 (6.66) range 69–89. Healthy controls baseline saturation 96 (sd 7.03) range 69–100, and lowest saturation was mean 82 (sd 12.7) range 40–93. Profiles are depicted in reference curves representing SpO2 saturation and percentage of night in each saturation.

Conclusion: This pilot study demonstrated differences between lung cancer survivors and healthy controls in nocturnal SpO2 levels that may lead to recommendations regarding routine screening of lung cancer survivors post-operatively for nocturnal O2 therapy. Additional research is needed prior to dissemination and translation into practice.

Support (If Any): This study was supported by the NIH-NINDS R15NR013779.

SLEEP QUALITY AND NOCTURNAL SYMPTOMS IN A CANADIAN COPD COHORT
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Introduction: Small studies have suggested that patients with chronic obstructive pulmonary disease (COPD) have poor sleep quality. Our aim was to examine the prevalence of subjective sleep related complaints including insomnia, obstructive sleep apnea, and restless leg syndrome in a large community based cohort.

Methods: We analyzed cross-sectional data on sleep questionnaire responses from the Canadian Cohort Obstructive Lung Disease (CANCOLD) study, a population-based, prospective longitudinal cohort study across Canada. The cohort comprises a COPD group (classified by pulmonary function test in terms of severity) and two matched non-COPD (never smokers and ever-smokers) groups. Sleep related symptoms were assessed using questionnaires including Pittsburgh Sleep Quality Index (PSQI). PSQI consists of seven elements of sleep quality, and a total score of PSQI > 5 indicates poor sleep quality. Data were compared between groups using Wilcoxon-Mann-Whitney test.

Results: Of the 1117 subjects, 262 were healthy controls, 321 were smokers without COPD, and 534 had COPD (297, 210, and 27 had mild (GOLD 1), moderate (GOLD 2), and severe (GOLD 3 and 4) disease respectively). The median PSQI score was 4 across all groups; however, a higher percentage (40.7%) of patients with severe COPD had poor sleep compared to the other groups (33.7–37.4%). Also, a significantly higher percentage of patients with severe COPD complained of nocturnal breathing discomfort (22.2%) compared to normal controls (p < 0.05).

Conclusion: Compared to normal controls and smokers, subjects with mild to moderate COPD have similar subjective sleep quality. Patients with severe COPD have a tendency towards poor sleep quality and a high prevalence of nocturnal breathing related symptoms.

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ASSOCIATION OF SLEEP DURATION AND SOCIOECONOMIC FACTORS WITH HEADACHE/MIGRAINE: ANALYSIS OF THE NATIONAL HEALTH INTERVIEW SURVEY DATA- 1997-2013

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Introduction: We assessed associations of sleep duration and sociodemographic factors with severe headaches/migraine.

Methods: National Health Interview Survey (NHIS) data collected from 1997–2013 was utilized. NHIS applied a multistage area probability sampling design. Descriptive statistics were used to characterize the sample, and multivariate logistic regression model was used to test associations of sleep duration and socioeconomic factors with severe headaches/migraine.

Results: Of 515,456 adults surveyed, the mean (± SEM) age was 54.3 ± 0.016 ranging from 18 to 85 years; the mean body mass index (BMI) in kg/m2 was 26.8 ± 0.007. A greater proportion of women reported headaches compared to men (20.1% vs 9.5%, p < 0.001). Individuals with headaches were younger (42.2 ± 0.05 vs. 48.1 ± 0.02, p < 0.01) and had higher BMI (27.3 ± 0.02 vs. 26.7 ± 0.01, p < 0.01). Headaches were more common among short sleepers, <7 hours (21.5%) and long sleepers, ≥ 8 hours (15.7%), compared to those averaging 7–8 hours (12%), p < 0.01. Headaches were more common among blacks, compared to whites and Asians (16.5%, 15.4% and 10.9%, respectively, p < 0.01). Headaches were reported by individuals who were separated (23.1%), divorced (18.3%), never married individuals (16.8%) married (14.6%) or 9 widowed (6%), p < 0.01. After adjusting for age, BMI and sleep duration, the odds ratio (OR) for headaches for married was 1.126 (95% CI = 1.093–1.159), p < 0.01; for widowed: OR was 1.28 (95% CI = 1.207–1.36), p < 0.01; for divorced: OR was 1.57 (95% CI = 1.52–1.63), p < 0.01 and for separated: OR was 1.85 (95% CI = 1.75–1.95), p < 0.01, using never married as a referent. Headaches were more common among individuals below (23%), compared to those above (14.8%) poverty level, p < 0.01.

Conclusion: Both short and long sleep durations were associated with higher frequency of headaches. Female sex, increasing BMI and younger age were also associated with increased headaches. Compared to individuals who were never married, those of other marital status had increased odds of having headaches. Poverty level was significantly associated with increased headaches.

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DO WOMEN WITH CHRONIC MIGRAINE HAVE PARADOXICAL INSOMNIA? A PRELIMINARY CONTROLLED INVESTIGATION

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Introduction: Sleep disturbance commonly occurs during the course of chronic migraine with up to 85% reporting insomnia symptoms. However, the majority of the existing literature is limited by primarily subjective measures of sleep. To examine the possibility of paradoxical insomnia, we conducted preliminary analyses between women with chronic migraine (CM) and healthy controls (HC) on self-report measures and polysomnography (PSG).

Methods: Fifteen women with CM (mean age = 33 years) and 11 HC women (mean age = 30 years) completed an overnight laboratory PSG with a fixed 8-hour time in bed and several headache and sleep-related measures, including sleep diaries. Difference scores were calculated for sleep parameters by subtracting PSG from sleep diary data corresponding to the PSG night. CM and HC were compared using parametric (t-test) and non-parametric tests (Mann-Whitney) on PSG, sleep diaries, difference scores, and other measures of insomnia symptoms.

Results: No significant differences were found between individuals with CM and HC on PSG or sleep diary measures of sleep parameters. However, a Mann-Whitney test revealed a significant difference (p < 0.05) between CM and HC on total sleep time (TST) difference score (diaries-PSG), with CM underestimating TST (median = −14.5 minutes) and HC overestimating TST (median = +10 minutes). Compared to HC, CM also reported significantly higher scores (p < 0.05) on the Insomnia Severity Index, Epworth Sleepiness Scale, Fatigue Severity Scale, Pre-Sleep Arousal Scale, and Migraine Disability Assessment.

Conclusion: These preliminary results indicate a relative difference between women with CM and HC on the accuracy of sleep-diary estimated TST compared to PSG-derived TST, despite similar sleep parameters. On self-report measures, women with CM report global insomnia symptoms and daytime dysfunction that are consistent with an insomnia disorder. The subjective/objective discrepancy raises the possibility that paradoxical insomnia may be more prevalent in women with CM. Further data collection is underway to examine this hypothesis.

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SHORT SLEEP DURATION MODIFIES THE ASSOCIATION BETWEEN STROKE AND IMPAIRED EXECUTIVE AND MEMORY FUNCTIONS

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Introduction: Short sleep duration has been associated with increased risk of neurocognitive, cardiovascular, and cerebrovascular morbidity and mortality. It is unknown, however, whether short sleep duration plays a role in increasing the risk of neurocognitive impairment in individuals with a history of cerebrovascular disease.

Methods: We addressed this question in the Penn State Adult Cohort, 1,741 men and women studied in the sleep laboratory. Stroke was defined as a lifetime history of stroke upon clinical history and physical examination. Polysomnographic short sleep duration was de-
fined as < 6 hours of sleep. Neurocognitive scores were calculated on processing speed, executive attention, verbal fluency, and short-term memory. MANCOVA was used to examine the effect of stroke, short sleep duration, and their interaction on neurocognitive functioning, while controlling for sex, age, race, obesity, sleep apnea, diabetes, hypertension, smoking, and depression.

Results: Stroke survivors showed significantly impaired functions on all neurocognitive domains (all p < 0.05), among which the impact of stroke on executive attention and short-term memory was significantly stronger in those with short sleep duration. Specifically, executive attention and short-term memory scores in stroke survivors with short sleep duration were 52.3 seconds and 2.1 points higher, respectively, as compared to controls with short sleep duration (both p < 0.01). In contrast, in those with normal sleep duration, stroke was not significantly related to executive attention (52.2 ± 10.5 vs. 44.1 ± 1.4, p = 0.44) or short-term memory deficits (5.3 ± 0.9 vs. 5.2 ± 0.1, p = 0.89).

Conclusion: Overall, stroke survivors showed impaired neurocognitive functioning. However, the impact of stroke on executive attention and short-term memory was more pronounced in those with short sleep duration, while in stroke survivors with normal sleep duration these specific cognitive functions appeared to be preserved. These findings expand on the known association of sleep with neurocognitive memory consolidation by highlighting the potential role of treating sleep in stroke survivors.

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0873 USING MACHINE LEARNING TO DETERMINE EFFECTS OF SLEEP DURATION AND PHYSICAL ACTIVITY ON STROKE RISK: ANALYSIS OF THE NATIONAL HEALTH INTERVIEW SURVEY

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Introduction: Big data and complex system analyses provide unique opportunities to quantify dynamic omnidirectional interactions among multiple factors that impact diseases and health outcomes. Applying this type of analysis to sleep data is crucial, as sleep is linked to a host of chronic medical conditions.

Methods: Analysis was based on the 2004–2013 National Health Interview Survey (N = 231,111). We employed a machine-learning Bayesian Belief Network (BBN) to model the probabilistic relationships (independent and additive) of sleep duration and physical activity to stroke risk. Factors considered included demographic, behavioral, health/medical, and psychosocial as well as sleep duration (short, average, and long), and physical activity (leisurely walking/bicycling, slow swimming/dancing, and simple gardening activities).

Results: Of the sample, 48.1% were ≤ 45 years; 77.4% were White; 15.9%, Black/African American; and 45.1% reported less than $35K annually. Overall, the model had a precision index of 95.84%. Average sleepers (7–8 hours) were 25% (2.3% to 3%) less likely to experience a stroke. Respectively, long sleepers (> 8 hours) were 146% (3% to 7.5%) and short sleepers (< 7 hours) were 25% (3% to 3.7%) more likely to report a stroke. A model-based adaptive method evidenced that combined effect of health status, hypertension, heart condition, income, and alcohol consumption increased the likelihood from 3% to 90%. Healthy sleep (7–8 hours) and vigorous exercise (30–60 minutes) three to six times per week significantly decreased stroke risk. Using the observational inference technique, we developed idiosyncratic protective behaviors (i.e. minutes and frequency of moderate or vigorous exercise per week and short, average or long sleep) that reduced stroke risk.

Conclusion: Utilization of BBN analysis is important, as it provides a more dynamic risk stratification system. Our findings revealed healthy sleep and exercise routines reduced stroke risk based on systematic iterations using multiple demographic, behavioral, health/medical, and psychosocial factors.

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0874 REDUCTION IN UNREALISTIC SLEEP EXPECTATIONS MEDIATES THE EFFECT OF COGNITIVE BEHAVIOR THERAPY FOR INSOMNIA IN PATIENTS WITH CANCER

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Introduction: Insomnia is a prevalent and pernicious consequence of a cancer diagnosis and treatment. The presence and strength of dysfunctional sleep beliefs is related to the development, maintenance, and remission of insomnia. Previously, we demonstrated that Mindfulness-based Cancer Recovery (MBCR) was not inferior to Cognitive Behavior Therapy for Insomnia (CBT-I); however, the groups had differential effects on overall dysfunctional sleep beliefs. The objective of the present study was to examine whether changes in dysfunctional sleep beliefs mediate treatment outcomes of CBT-I relative to MBCR.

Methods: Participants were 72 adult post-treatment cancer patients who met criteria for insomnia disorder (MBCR n = 40; CBT-I n = 32). Mediation analyses were used to determine the indirect effects of total dysfunctional sleep beliefs about sleep and the 4 subscales (i.e. unrealistic sleep expectations, worry about sleep, beliefs about the consequences of poor sleep, use of sleeping medication) in the relationship between treatment and insomnia severity adjusting for baseline scores. Bootstrap was used to obtain biased corrected 95% confidence intervals for the indirect effects. Separate models were generated for each candidate mediator.

Results: CBT-I had significantly greater pre-post reductions in unrealistic sleep expectations than MBCR (B = −1.30 SE = 0.47 p = 0.008) and this predicted improved insomnia symptoms (B = 0.58 SE = 0.24 p = 0.019). Mediation analyses showed that changing unrealistic sleep expectations mediated the decrease in insomnia severity in CBT-I (ab = −0.76 SE = 0.51, 95% CI = −1.92: −0.41). The proportion of variance in change in insomnia severity predicted by the indirect effect of modified sleep expectations was large (R2 = 0.20). Total dysfunctional sleep beliefs and the remaining subscales failed to add significantly beyond the contribution of expectation modification.

Conclusion: These results suggest that sleep expectations may be a specific mechanism of CBT-I (relative to MBCR) in improving insomnia severity.

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0875
NURSE-DELIVERED INSOMNIA TREATMENT IN LUNG CANCER SURVIVORS: PILOT STUDY TO IMPROVE SLEEP MOOD AND QUALITY OF LIFE
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Introduction: Sleep disturbances are frequently reported by patients receiving treatment for lung cancer and in lung cancer survivors. Improving sleep in this population has the potential to reduce daytime sleepiness and improve mood and quality of life. Cognitive behavioral therapy (CBT-I) is the standard treatment for insomnia; however the length of treatment and the insufficient number of psychologists trained to deliver CBT-I make this unrealistic. Nurses are uniquely positioned to deliver a modified version of CBT-I, i.e., Brief Behavioral Therapy for Insomnia (BBTI). This study aims to determine preliminary efficacy of BBTI delivered by baccalaureate-prepared registered nurses via group education and telephone therapy for lung cancer survivors with self-reported insomnia.

Methods: A prospective RCT design was used. Eligible participants were recruited from a thoracic clinic in a comprehensive cancer center if: > 6-weeks post-operative for stage I/II non-small cell lung cancer and Insomnia Severity Index > 7. Participants positively pre-screened for sleep apnea became ineligible and were referred for definitive diagnosis. Quality of life, fatigue, anxiety, depression, sleep diaries and actigraphy were assessed at baseline and repeated post-intervention. Participants were randomized into two group interventions: BBTI (experimental) or healthy eating (attention control), followed by therapy telephone calls one and two-weeks after group interventions.

Results: To date, 20 were recruited; 18 completed baseline assessments; 2 were referred for apnea treatment, 6 have completed treatment. Preliminary results of efficacy revealed improvements in all self-report sleep measures in the experimental group and no improvement in attention control. Interestingly, neither group had an improvement in daytime sleepiness scores.

Conclusion: This pilot study demonstrated preliminary efficacy of BBTI with group education and brief telephone therapy delivered by baccalaureate-prepared registered nurses. Further research into the dissemination and translation into practice is warranted.

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0876
EXCESSIVE DAYTIME SLEEPINESS AND NEUROCOGNITIVE PERFORMANCE IN PEDIATRIC PATIENTS WITH CRANIOPHARYNGIOMA
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Introduction: Craniohypophysealgioma is a brain tumor commonly arising in the sellar/suprasellar region. The tumor and its treatment impact anatomical structures associated with excessive daytime sleepiness (EDS) and impaired neurocognitive performance. We sought to extend upon our previously presented work to include more participants and to perform a more refined analysis of neurocognitive performance in children with craniohypophysealgioma.

Methods:Thirty-eight patients with craniohypophysealgioma (ages 6–16 years; M = 10.1 ± 3.1 years) received neurocognitive assessments (including Wechsler Intelligence Scale for Children-IV (WISC-IV), overnight polysomnography, and multiple sleep latency testing (MSLT) after surgery and prior to proton therapy. Wilcoxon-rank sum tests were conducted to examine differences in neurocognitive performance between patients with mean sleep onset latency (SOL) of > 10 minutes versus ≤ 10 minutes (EDS) and those with < 2 versus ≥ 2 sleep-onset REMs (SOREMs) on MSLT.

Results: 66% of patients had mean SOL of ≤ 10 minutes and 34% had ≥ 2 SOREMs. Patients with ≥ 2 SOREMs demonstrated significantly worse performance on WISC-IV subtests, including similarities, vocabulary, coding, and symbol search (Mean scaled score differences = −2.4 to −3.5, p's < 0.05). Having ≥ 2 SOREMs was also associated with lower Verbal Comprehension, Working Memory, Processing Speed, and Full Scale IQ index scores (Mean standard score differences = −9.6 to −19.4, p's < 0.05). There were no statistically significant differences when examining SOL (p > 0.05); however, the poorer performance in the EDS group was clinically significant for perceptual reasoning (Cohen's d = −0.67) and processing speed (d = −0.73).

Conclusion: More than half of children receiving treatment for craniohypophysealgioma present with EDS; however, SOREM appears to be the more important factor to consider regarding neurocognitive performance prior to initiating proton therapy. This study highlights the importance of an ongoing assessment of sleep and cognitive functioning, as well as the need to investigate interventions to address sleepiness within this population.

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0877
PARENT-PROXY AND SELF-REPORTED SLEEPINESS, FATIGUE, AND QUALITY OF LIFE IN SURVIVORS OF CHILDHOOD HEMATOPOIETIC STEM CELL TRANSPLANT
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Introduction: Psychosocial and quality of life (QOL) outcomes of hematopoietic stem cell transplant (HSCT) survivors are well-documented, and long-term QOL outcomes have recently been examined. Childhood cancer is associated with greater parent- and self-reported fatigue and sleepiness when compared to healthy peers. Little is known about these factors in childhood HSCT survivors and their relationship with the QOL outcomes of survivors. The aim of this study is to examine parent-proxy and self-reported sleepiness as a predictor of fatigue and QOL in childhood HSCT survivors.

Methods: Seventy-six HSCT survivors (age 8–39 years; M = 17.84 ± 6.04 years) were assessed 5–14 years post-transplant (M = 7.8 ± 1.87 years). Parent-proxy report was obtained for child and adolescent participants. Two sample t-tests were conducted to compare the presence of survivor sleepiness (Epworth Sleepiness Scale ≥ 10) and non-sleepiness across fatigue (PedsQL™ Multidimensional Fatigue Scale) and QOL (Ped-sQL™ Generic Core Scale) domains.

Results: Survivor sleepiness was reported by approximately 21–28% of parents and survivors. There was also significant parent-proxy and self-reported fatigue (Range = 19.41–50.32). Subjectively reported sleepiness was associated with greater total, cognitive, general, and sleep/rest fatigue (p's < 0.01). Survivor-endorsed sleepiness was associated with poorer QOL across all domains than survivors without significant sleepiness, with mean differences ranging from 14.01 to 19.66.
(p’s < 0.01). Similarly, parent-proxy sleepiness was associated with poorer survivor QOL across most domains (Mean difference = 14.83 to 22.42, p’s < 0.05).

Conclusion: This study is unique in its examination of sleepiness, fatigue, and QOL in long-term survivors of pediatric HSCT. Survivors with subjective sleepiness exhibited substantial fatigue and QOL impairments when compared to survivors without significant sleepiness. The current study highlights the importance of an ongoing assessment of clinical, psychosocial, and QOL outcomes in childhood HSCT survivors, as well as the need to investigate potential patient-centered interventions aimed at optimizing functional outcomes.

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0878
CIRCADIAN ACTIVITY RHYTHMS ARE ASSOCIATED WITH FATIGUE IN PRE-SURGERY GYNECOLOGIC CANCER PATIENTS
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Introduction: Fatigue is a common and distressing symptom of gynecologic cancer. However, little is known about why fatigue is high prior to diagnosis. Previous studies have examined psychosocial and demographic correlates of fatigue in gynecologic cancer patients; however, to our knowledge no studies have examined circadian activity rhythms as contributors to fatigue prior to surgery for gynecologic cancer.

Methods: Thirty-five patients were recruited, wore actigraphs for 72 hours, and completed the Fatigue Symptom Inventory to assess fatigue severity prior to surgery for gynecologic cancer. Circadian activity rhythms were modeled for each participant using a five-parameter extended cosine model to assess the amplitude and rhythmicity of each participant’s activity. Univariate associations were examined between fatigue and circadian parameters as well as demographic factors; multivariate analyses were then conducted to determine whether circadian parameters contributed significant variance to fatigue above and beyond that contributed by demographic factors.

Results: Sixty-nine percent of participants reported clinically-significant fatigue severity (≥ 3 on a 0–10 scale). The amplitude and rhythmicity of participants’ activity rhythms were associated with fatigue severity (p ≤ 0.04), such that lower activity levels and less rhythmic activity were associated with greater fatigue. There was a trend towards an association between age and fatigue (p = 0.07), such that younger participants reported greater fatigue; marital status, education, household income, medical comorbidities, and race were not associated with fatigue (p’s ≥ 0.45). In hierarchical linear regression analyses amplitude and rhythmicity accounted for significant variability in fatigue above and beyond that accounted for by age (ΔR² = 0.27, p = 0.01).

Conclusion: This pilot study is among the first to examine associations between circadian activity parameters and fatigue in pre-surgery cancer patients. Lower activity levels and less rhythmic activity were associated with worse fatigue. Future studies should examine genetic and immunologic parameters that may be contributing to circadian disruption in this population.

0879
CLINICAL AND DEMOGRAPHIC FACTORS ASSOCIATED WITH SLEEP DURATION IN US MILITARY VETERANS RETURNING FROM IRAQ AND AFGHANISTAN
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Introduction: The pattern of sleep duration among the US military veterans returning from Iraq and Afghanistan have not been fully investigated. The objective of this study was to determine the association between clinical and demographic factors with sleep duration in post-deployment US military veterans returning from Iraq and Afghanistan.

Methods: We used data from three years (2011, 2012 and 2013) of the National Health Interview Survey (NHIS) obtained from the website of Integrated Health Interview Series of the U.S. National Health Interview Survey (Minnesota Population Center). Subjects were 18 years and older who served on active-duty in US Armed Forces in September 2001 or later. We assessed the age, gender, education, employment status, sleep duration, alcohol and tobacco use, hypertension and symptoms of depression and anxiety. The primary outcome was sleep duration. Sleep duration in whole numbers was ascertained by the answer to the question: “On average, how many hours of sleep do you get in a 24-hour period?” Sleep duration was divided into 2 groups: 7–8 hours and less than 7 hours or greater than 8 hours of sleep. Sleep duration of 7 and 8 hours is considered normal. We compared the characteristics of the subgroups of subjects using the chi-square test for categorical variables and the Student’s t-test for continuous variables.

Results: A total of 1073 subjects were identified who served on active duty in US Armed Forces in September 2001 or later. Mean (SD) age was 34.7 (10.3) years. 78.6% were male. Subjects with employment were more likely to get 7–8 hours of sleep compared to subjects without employment (p-value < 0.0001). Unemployment, high school to associate degree vs. bachelor or higher degree, current alcohol use, smoking status, and hypertension were associated with sleep duration other than 7–8 hours (p-value < 0.0001). Functional limitation from depression, anxiety or emotional problem, frequency of feeling worried, nervous, or anxious, and frequency of feeling depressed were more frequent in subjects with sleep duration other than 7–8 hours (p-value < 0.0001).

Conclusion: Individuals with unemployment, hypertension, current tobacco and alcohol use, and self-reported symptoms of depression and anxiety are associated with sleep duration other than 7–8 hours. Future prospective studies are needed to better understand factors which affect sleep duration in returning veterans.

0880
EXERCISE AND ABSENTEEISM AMONG INDIVIDUALS WITH CHRONIC FATIGUE SYNDROME: ANALYSIS OF THE NATIONAL HEALTH INTERVIEW SURVEY
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Introduction: Individuals with chronic fatigue syndrome (CFS) frequently show abnormal and unrefreshing sleep patterns, in addition to chronic malaise, depressed mood, body pain, sore throat, and lifestyle restrictions. Using data from the National Health Interview Survey (NHIS), we hypothesized that among participants reporting CFS, higher frequency of moderate exercise would be associated with fewer missed workdays due to illness.
Methods: NHIS is a cross-sectional household interview survey, using a multistage area probability design. Data from participants in the 2008 NHIS emulated from face-to-face interviews with trained interviewers from the U.S. Census Bureau. Respondents provided sociodemographic and physician-diagnosed chronic conditions. Our analysis focused on those responding to the questions: “Have you ever had... chronic fatigue syndrome”, and “how often per week do you do light or moderate leisure-time physical activities?” Student’s T-test was used for mean comparisons, and ANOVA assessed interaction effects on continuous variables. Analyses were performed using SAS 9.3.

Results: A total of 21,733 individuals provided valid data. The male/female ratio was 0.38:1. Of the sample, 78% were white; 16%, black; and 4%, Asian. The average age for respondents with CFS was > those without (55.0 ± 15.4 years vs. 48.0 ± 18.1 years, p < 0.0001). The prevalence of CFS was 2.7%. Among respondents with CFS, those reporting frequent exercise (≥ 2X moderate exercise weekly) had lower sleep duration (7.0 ± 1.7 hours) than those who did not (7.4 ± 1.9 hours); NS. Results of ANOVA showed that among respondents with CFS, those with higher exercise frequency (≥ 2X weekly) had lower average number of missed workdays (6 days), compared to those with lower exercise frequency (< 2X weekly [15 days] [F = 11.56, p < 0.001].

Conclusion: Results support our hypothesis that among individuals with CFS those who exercised more frequently had lower rates of missed workdays due to illness, compared to those who exercised less. Decreased exercise was linked to absenteeism during the year they were assessed.

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0881
EFFECTS OF MILNACIPRAN ON SLEEP AND PAIN IN SUBJECTS WITH FIBROMYALGIA
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Introduction: Fibromyalgia (FM) is characterized by widespread focal pain, fatigue and non-restorative sleep. Given the relationship between reduced or fragmented sleep and pain severity, we were interested in evaluating the effects of milnacipran, a selective serotonin-norepinephrine receptor inhibitor (SNRI) in FM subjects experiencing disturbed sleep.

Methods: This was a randomized, double-blind, placebo-controlled, 2-way crossover polysomnography study. Following the diagnosis of FM and confirmation of sleep difficulty based on subjective history and daily diaries, 19 subjects (2 males, 17 females), age 28–72 years were randomized to either a milnacipran-placebo or placebo-milnacipran sequence. Subjective assessments including the brief pain inventory (BPI) and overnight polysomnography were measured at baseline and at the end of each 5-week treatment period. Subjective sleep quality was determined using a numerical rating scale on the daily diary, with ratings from 0 (very poor) to 10 (excellent). A responder analysis was implemented for subjects with 25% reduction in BPI pain interference with daily activities compared to baseline.

Results: Overall, subjects did not show improvement in objective sleep parameters. However, 10 subjects showed a significant reduction in pain on milnacipran compared to placebo [Paired difference (95% CI): –1.44 (–2.83, –0.05); t (p-value): –2.350 (0.043)]. The reduction in pain parameter was accompanied by a significant improvement in subjective sleep quality [Paired difference (95% CI): 0.64 (0.04, 1.24); t (p-value): 2.396 (0.040)].

Conclusion: Contrary to our original hypothesis that a direct positive effect on sleep continuity and architecture would be associated with clinical improvement, it became apparent that milnacipran has minimal sedative effects and may be stimulating. The results of this study confirm the effectiveness of milnacipran in reducing pain. Thus, rather than reducing pain by improving sleep, sleep improved when pain was reduced.

Support (If Any): The study was supported by Forest Research Institute.

0882
MEASUREMENT, CLASSIFICATION AND EVALUATION OF SLEEP DISTURBANCE IN PSORIASIS: A SYSTEMATIC REVIEW
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Introduction: Psoriasis, whilst impacting the skin primarily, results in high levels of psychological and physical morbidity and significant reductions in quality of life. Recent evidence suggests that sleep disturbance may be a salient issue for psoriasis patients, however, as of yet no effort has been made to conduct a systematic examination of this literature.

Methods: A systematic review was conducted to assess the evidence for sleep disruption in psoriasis. PubMed, SCOPUS and Web of Science databases were examined using broad search terms including “sleep” or “circadian rhythm” and “psoriasis” to provide maximum coverage of potential articles.

Results: The searches yielded 29 viable articles that assessed sleep either as a primary or secondary outcome in psoriasis samples. Prevalence rates for sleep disturbance in psoriasis varied, from 56.6% to 85.7%. While some studies employed validated measures of sleep quality/disruption, 16/29 (55.2%) used proxy or non-validated measures of sleep, such as Health-Related Quality of Life questionnaires or single questions pertaining to sleep. Additionally, 20/29 (68.9%) of studies did not focus primarily on sleep, and failed to take into account symptoms of psoriasis and comorbid conditions known to have associations with sleep disturbance.

Conclusion: Sleep disruption appears to be experienced commonly by psoriasis patients, however, the exact nature and prevalence remains unclear due to variation in sleep measurement and lack of controlling for confounding variables. Thus, there is a requirement for a thorough enquiry of sleep in psoriasis to identify, address and understand the nature of sleep problems and possible contributory factors.

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0883
SLEEP-RELATED INFLUENCES ON BRAIN STRUCTURAL CHANGES IN FIBROMYALGIA SYNDROME PATIENTS
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Introduction: Fibromyalgia (FMS) is a complex clinical syndrome that includes many symptoms beyond chronic pain. Sleep disturbance
is one of the most common and relevant symptoms in FMS. We aimed to investigate whether the core FMS symptoms and clinical features, including pain, sleep quality, sleepiness, psychological distress, health status, and medication intake affect brain morphology to determine if brain changes in FMS are “symptom-related” more than “diagnosis-related.”

Methods: We performed voxel-based morphometry analyses on structural magnetic resonance images from 46 premenopausal women (23 FMS patients; 23 age-matched healthy participants). We determined total and local brain volume differences between groups, and used multiple regression models to assess the associations between brain volumes and FMS clinical characteristics.

Results: Sleepiness, anxiety, and psychological distress, as well as analgesic consumption, accounted for FMS patients’ smaller total gray matter volume (GMV). Local decrements of GMV in the medial and superior orbitofrontal gyri, and a local increase of GMV in the temporal pole were observed in the FMS group. For both groups, local decrements of GMV in the medial orbitofrontal cortex were associated with higher psychological distress, and local increases of GMV were positively related to pain intensity (superior frontal gyrus), psychological distress (cerebellum), anxiety (medial orbitofrontal cortex), and sleepiness (frontal superior medial cortex).

Conclusion: Findings suggest that total and local GMV changes in FMS go beyond traditional “pain matrix” alterations. In particular, subjective sleep quality does not appear to be related to brain structural changes; however, subsequent daytime sleepiness has a role explaining GMV increments in frontal areas. These areas have been related to the ability to overcome sleepiness in task execution. In summary, we demonstrated that brain morphology is altered not only by pain, but also by clinical characteristics such as sleepiness, anxiety, psychological distress, and analgesic consumption.

Support (If Any): CDP was supported by a FPU grant from the Spanish Ministry of Education (AP 2007-02965) and is currently supported by the UGR Postdoctoral Fellowship program (2013 University of Granada Research Plan). Research by GBC is funded by a Spanish Ministry of Economy and Competitiveness grant (State Secretariat for Research, Development and Innovation Secretory, EDU2010–21215). Research by AC is funded by a Spanish Ministry of Economy and Competitiveness grant (State Secretariat for Research, Development and Innovation Secretory, PSI2012-39292).

0884

THE RELATIONSHIP BETWEEN SLEEP DURATION AND OBESITY DEPENDS ON STATE OF RESIDENCE: DATA FROM 50 STATES AND THE DISTRICT OF COLUMBIA, BRFSS 2013

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Introduction: Many studies have shown that short sleep duration is associated with obesity at the population level. Further, studies have shown geographic factors associated with both obesity and sleep. Thus, the relationship between sleep duration and obesity may vary geographically.

Methods: Data from the 2013 BRFSS was used (N = 484,401 with sleep duration data). The BRFSS is a state-based telephone survey conducted by the CDC. Data from 50 states and the District of Columbia were included. Sleep duration was assessed as habitual sleep in a typical 24 hours and was coded as short (6 h or less), normal (7–8 h, reference), or long (9 h or more). Obesity (BMI ≥ 30) was based on self-reported height and weight. Covariates included age, sex, education, access to insurance, smoking, and race/ethnicity. Population-weighted multinomial logistic regression analyses examined the relationship between race/ethnicity and sleep duration in the complete sample, and stratified by state. Holm-Bonferroni was used to adjust for Type-1 error rate.

Results: Overall, short sleep was associated with obesity (OR = 1.35; 95% CI [1.31–1.39], p < 0.0001), as was long sleep duration (OR = 1.10; 95% CI [1.05–1.16], p = 0002). Short sleep was associated with obesity in 41 states, in order from greatest to weakest association: MN (OR = 1.73; 95% CI [1.48,2.03]; p < 0.0001), MA, SD, RI, ME, ID, CO, NC, WA, NM, TX, IN, GA, KS, WY, AR, FL, TN, KY, CT, ND, VT, PA, NE, IA, VA, OH, NJ, AL, UT, MD, SC, IL, MT, WV, MS, NH, MI, OK, CA, and NY (OR = 1.24; 95% CI (1.07–1.44); p = 0.004). Note that no significant relationships were found in AK, AZ, DC, DE, HI, LA, MO, NV, OR, or WI. Long sleep duration was not associated with obesity in any state after Type-I error adjustment and only in NC, IN, and NE (all OR = 1.3; p < 0.05) before adjustment.

Conclusion: Regional differences in social and environmental factors may play a role in the relationship between sleep duration and obesity.

Support (If Any): K23HL110216, R21ES022931

0885

SLEEP, OBESITY AND THE PHYSICAL AND PSYCHOSOCIAL WELLBEING OF YOUNG ADULTS IN THE UNITED STATES

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Introduction: Previous research has shown that short sleep duration and obesity influence the physical and psychosocial wellbeing of children and adolescents. However, much of this research is cross-sectional and focused on either sleep or obesity in isolation, without examining whether sleep duration and obesity interact in their associations with health outcomes. In this investigation, we (1) extend these findings to young adults, (2) assess how cumulative exposures to short sleep duration and obesity affect wellbeing, and (3) evaluate interactions between short sleep and obesity.

Methods: We base this investigation on four waves of data from the National Longitudinal Study of Adolescent to Adult Health (n = 14,800). We use standard methods of measuring short sleep and obesity throughout adolescence (waves 1–3). Measures of physical and psychosocial wellbeing in wave 4 include self-reported health, physical limitations, and physician-diagnosed conditions. Our analyses employ logistic regression models to assess how cumulative exposures to short sleep and obesity associate with wellbeing outcomes in young adulthood.

Results: Adjusted for age and gender, obesity and short sleep duration are independently associated with physical and psychosocial wellbeing. For example, the odds of reporting fair or poor health (vs. good, very good or excellent health) increase by 45% with each instance (wave) of obesity (p < 0.001) and by 16% with each instance of short sleep duration (p = 0.08). Significant interaction effects between sleep and obesity were not observed for self-rated health or other outcomes, with the exception of hypertension (p = 0.04). In further explorations, we will employ multiple imputation analyses and restricted-use data, which will substantially increase statistical power.

Conclusion: Consistent with research on children and adolescents, we found that prolonged exposure to both short sleep duration and obesity are associated with poorer wellbeing among young adults in the U.S. These preliminary findings demonstrate the importance of considering cumulative exposures to these conditions.
Support (If Any): We acknowledge research support from the National Institute of Diabetes and Digestive and Kidney Diseases (grant R21DK08941).

0886
CHANGE IN HEMODYNAMIC FUNCTION FOLLOWING NON-CPAP TREATMENT
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Introduction: Obstructive sleep apnea (OSA) has been associated with impaired cardiac function due to endothelial dysfunction, increased intrathoracic pressure, and systemic inflammation. Continuous positive airway pressure (CPAP) is a documented therapy that may improve cardiac function in patients with OSA. Untreated OSA is associated with atherosclerosis progression which may lead to further hemodynamic impairment including decreased stroke volume (SV), cardiac output (CO), and ejection fraction (EF). The goal of our study was to investigate the effect of OSA on cardiac function in patients not receiving OSA treatment.

Methods: Patients undergoing cardiac rehabilitation were tested initially for OSA and cardiac function. Cardiac assessment was performed using thoracic bioimpedance at rest. Based on one night in-home apnea screening (ApneaLink), patients were divided into two groups; one group of patients with OSA and treatment recommended and another group without OSA. Two years after, 27 of the 70 patients volunteered for re-testing.

Results: Although not statistically different, the OSA group showed a lower SV (74.12 ± 4.3 vs 83.7 ± 13.7 ml/beat), CO (4.6 ± 1.4 vs 5.3 ± 1.1 L/min) and EF (60.6 ± 15.2 vs 62.5 ± 9.6%). Systemic vascular resistance was elevated in OSA patients when compared to the non-OSA group (1637.6 ± 515.2 vs 1356.4 ± 239.1). Backward regression analysis determined that baseline saturation and number of desaturations were the strongest variables for changes in ejection fraction (R² = 0.67, p < 0.001). Same two variables best predicted contractility of the heart after two years of non-treatment (R² = 0.68, p < 0.001).

Conclusion: Untreated OSA may impact hemodynamic function. This is more important in patients already suffering from cardiac dysfunction where CPAP treatment could be a viable addition to their cardiac management. Future studies should examine these associations in a larger and more balanced group distribution.

0887
THE EFFECT OF UNTREATED OBSTRUCTIVE SLEEP APNEA ON CARDIOVASCULAR HEALTH
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Introduction: Obstructive sleep apnea (OSA) is frequently observed in patients with cardiovascular disease. Treatment for OSA is associated with acute decreases in blood pressure, sympathetic activation, and incidents of new cardiovascular events. The purpose of this study was to evaluate cardiovascular health of individuals who screened positive for OSA and did not follow up with treatment.

Methods: Cardiac-function was tested using non-invasive bioimpedance technology. Patients were screened for OSA with a one night at-home apnea detection device (ApneaLink). Results were compared to data collected 2-years prior. Pertinent electronic medical history was acquired in order to determine re-hospitalizations, medical complaints, and office visits. Patients were divided into 2 groups; those who received treatment and those who did not.

Results: Two years after the initial testing, 21 patients were re-evaluated for OSA. Of those, 3 have received treatment for OSA and 18 did not. Although not significant, the untreated group showed aggravations of AHI (11.4 ± 8.6 to 13.1 ± 8.6), obstructive events (16.8 ± 22.8 to 22.4 ± 28.8), hypopneas (58.2 ± 38.7 to 64.6 ± 50.3) and snoring events (627.0 ± 593.1 to 1281.6 ± 1528.1). The same sleep variables were lower after two years in patients receiving treatment, albeit not statistically significant. Untreated patients showed a trend towards increases in systolic blood pressure (SBP) over 2 years (122.9 ± 15.7 vs. 126.0 ± 13.1 mmHg) and higher number of cardiac appointments than those receiving treatment (4.4 ± 2.5 vs 3.0 ± 1.1). Treated patients displayed a non-significant decrease in systolic blood pressure (122.0 ± 19.8 vs. 120.0 ± 0.1 mmHg).

Conclusion: Worsening of sleep parameters could impact the cardiovascular health as seen by the increase in SBP and high numbers of cardiac appointments. A larger sample size should be further used to detect more robust differences.

0888
PATIENTS WITH SUSPECTED OBSTRUCTIVE SLEEP APNEA WHO TEST NEGATIVE: HOW DO THEY DIFFER FROM OTHER PATIENTS?
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Introduction: At JAH Veterans Administration Hospital, patients are referred to the sleep-lab for obstructive sleep apnea (OSA) only if they are suspected of having OSA. If the suspicion of OSA is considered a “test,” then patients with apnea-hypopnea index (AHI) scores < 5 are considered false positive (FP) for OSA. While the prevalence of these types of patients is low, it’s important to understand how they differ from confirmed OSA patients and the general population of patients without suspected OSA.

Methods: One-hundred thirty-nine FP cases were matched 4:1 to 556 random controls and 556 confirmed OSA controls for a JAHVA visit within one year of a case sleep-lab visit from 2003–2007. Logistic regression, adjusting for age, sex, and BMI identified the ICD-9 diagnostic codes most strongly associated with being FP for OSA, compared with random controls and confirmed OSA controls.

Results: FP cases were significantly younger and more likely to be female than either random or OSA controls. After adjusting for age and sex, they had lower BMI than OSA patients (30.3 versus 34.3; p < 0.001). They were more likely to have diagnoses of respiratory abnormalities (OR: 10.34; 95% CI: 4.29–24.94), shortness of breath (OR: 5.13; 95% CI: 2.57–10.23), malignant neoplasm of bronchus/lung (OR: 4.59; 95% CI: 1.41–14.96), periodontal disease (OR: 4.63; 95% CI: 2.11–10.15), and tooth loss (OR: 3.42; 95% CI: 1.58–7.43) than random controls. FP patients were also more likely to have shortness of breath (OR: 3.30; 95% CI: 1.74–6.24), acute respiratory infections (OR: 2.90; 95% CI: 1.45–5.77), diseases of the respiratory system (OR: 11.74; 95% CI: 2.07–66.62), and malignant neoplasm of bronchus/lung (OR: 10.53; 95% CI: 2.25–49.30) than OSA controls.

Conclusion: Among veterans, patients with a suspicion of OSA but AHI < 5 may require further pulmonary testing and diagnosis. It’s possible that poor dental health may be a correlate of diagnoses mistaken for OSA.
B. Clinical Sleep Science

0889

SLEEP STUDY IN EHLER DANLOS SYNDROME
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Introduction: Ehlers-Danlos syndrome (EDS) is a heterogeneous group of heritable connective tissue disorders, characterized by articular (joint) hypermobility, skin extensibility and tissue fragility. Sleep problems are commonly reported in EDS. The purpose of this research is to study the sleep pattern in EDS patients.

Methods: 139 patients with EDS referred to our clinic from January to November had polysonography using standard technique. Epworth Sleep Scale, N1, N2, N3, REM stages, Apnea/hypopnea index (AHI), SpO2, Sleep HR bpm, PLMS index and Total sleep efficiency (TSE) are recorded.

Results: Out of 139 patients (n = 139), 96% are females (n = 133; age 31.88 ± 11.36), 4% are males (n = 6; age 23.83 ± 9.19), Epworth scale (10.78 ± 4.95), N1 (6.86% ± 4.91%), N2 (50.76% ± 14.37%), N3 (26.34% ± 13.08%), REM (17.41 ± 8.58), AHI (1.48 ± 3.25), SpO2 (90.03 ± 8.75) Sleep HR bpm (70.59 ± 10.37 bpm), PLMS index (4.12 ± 9.91) TSE (%) (74.37 ± 13.29%). Out of 139 patients, 77 patients had Epworth Scale > 10; 96 patients had N1 < 8% and 43 patients had N1 > 8%; 91 patients had N2 > 45% and 48 patients had N2 < 45%; 92 patients had N3 < 22% and 47 patients had N3 > 22%; 23 patients had REM > 23% and 116 patients had REM < 23%; 10 patients had AHI > 5 and 129 patients had AHI < 5; 20 patients had SpO2 < 86% TSE. Snoring is observed in 121 patients (21 patients had REM > 23% and 116 patients had REM < 23%; 10 patients had AHI > 5 and 129 patients had AHI < 5; 20 patients had SpO2 < 86% TSE). Sleep apnea and decreased SpO2 is observed in few patients.

0890

BRIEF BEHAVIORAL TREATMENT FOR INSOMNIA IN PEOPLE LIVING WITH HIV
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Introduction: About 73% of persons living with HIV (PLWH) experience insomnia. The purpose of this study was to test the feasibility, acceptability, and initial efficacy of Brief Behavioral Treatment for Insomnia (BBTI) intervention.

Methods: The initial design was wait-list control, but this was changed to a one-group pilot due to difficulty retaining participants on the wait-list. Eligibility criteria: aged 18 years or older; diagnosed with HIV infection, meeting Research Diagnostic Criteria for Insomnia; no cognitive impairment or substance dependence. Participants completed baseline and post-intervention assessments. BBTI involved 4 weekly 30–45 minute sessions, alternating between in-person and telephone.

Results: The sample (N = 22) was 77.3% biologically male, 68.2% white/Caucasian, with mean age 44.7 ± 8.8 years. Nine subjects were lost or withdrew during the wait-list period. Thirteen subjects started BBTI, and 11 completed the program. Mean attendance was 3.5 ± 0.8 sessions. The most common sleep problems were poor sleep hygiene (n = 12) and difficulty initiating sleep (n = 9). The most common treatment recommendations were regular sleep scheduling (n = 12), reduction of caffeine (n = 6), and stimulant control (television/computer use in the sleep setting, n = 6). Subjects significantly improved on the Pittsburgh Sleep Quality Index (pre = 9.8 ± 4.4, post = 6.6 ± 3.8, paired t-test p = 0.03); Insomnia Severity Index (pre = 16.0 ± 6.5, post = 6.6 ± 6.8, p = 0.01); PROMIS Sleep-related Impairment (pre = 21.1 ± 7.6, post = 16.0 ± 6.4, p = 0.03); and Sleep Disturbance Questionnaire (pre = 27.0 ± 10.9, post = 17.2 ± 12.5, p = 0.01), but not PROMIS Fatigue.

Conclusion: The study supports the feasibility of the BBTI intervention, but did not support not the use of a wait-list control approach in this population. Initial findings support of the efficacy of BBTI for improving sleep in PLWH.

Support (If Any): P30 NR 011400 (Center for Research on the Management of Sleep Disturbance).

0891

THE IMMUNOLOGICAL RESPONSE OF OBSSECTIVE SLEEP APNEA (OSA) IN ADULT PATIENTS
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Introduction: OSA has been associated with chronic inflammation and heart disease. The pathophysiological characteristics of OSA, such as hypoxemia, influence immune responses, but little is known about how the clinical disease will impact the different immune parameters.

Methods: Four hundred patients examined at Ayass Lung Clinic & Sleep Center in 2013 participated in the study. We analyzed immunoglobulin levels in association with OSA and other biomarkers. OSA was diagnosed with the polysomnography. Demographic, clinical, laboratory and sleep study information were obtained from medical records. Logistic regression models were employed to determine the association between immunological factors and OSA.

Results: One third (31%) of the patient population suffered from OSA, half (51%) were > 65 years of age, 56% female and three-fourth were White. In our study sample, the prevalence of IgA levels higher than 453 and B2IgA levels more than 12 were 82% and 39% respectively, while in OSA patients the levels were 89% and 30% respectively. Univariate analysis showed that those with a level of IgA > 453 have twice the odds of having OSA, and B2IgA > 12 were 40% less likely to be associated with OSA (p = 0.02) compared to control groups. Multivariate logistic regression analysis, after controlling for age, gender, ethnicity, obesity, asthma, hypertension and lupus were: IgA > 453 (OR 2.13; 95% CI, 1.06–4.26; p < 0.05), and B2IgA > 12 (OR 0.57; 95% CI, 0.34–0.96; P < 0.04). The negative association of disease with B2IgA can be an indication for the therapeutic role of B2IgA.

Conclusion: Clinical OSA positively impacted the IgA levels, and impaired or attenuated B2IgA levels after controlling for comorbid conditions. Understanding the immunological response of OSA will shed light on the possibility of different ways to help these patients. We hope that these cellular findings can be utilized for development of diagnostic/therapeutic biomarkers for early detection, prevention, and treatment. Future prospective studies are vital to unravel the immune response modulation in OSA patients with comorbid conditions.

0892

IMPROVEMENT IN SLEEP DISTURBANCES PREDICTS CHRONIC PAIN TREATMENT OUTCOMES
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Introduction: A large body of evidence demonstrates that sleep disturbances and pain are closely related. Sleep predicts next day pain ratings
and initial findings suggest that sleep treatments result in modest but significant improvements in pain and pain function. The goal of these analyses was to determine if improvement in sleep over the course of chronic pain treatment predicts improvement in pain outcomes, controlling for changes in depression and anxiety.

Methods: We report a secondary data analysis of the Stepped Care to Optimize Pain Effectiveness (SCOPE) trial, a 12-month randomized controlled trial measuring the effectiveness of a collaborative care intervention for Veterans with chronic musculoskeletal pain. Participants were 250 Veterans from 5 primary care clinics in a VA medical center. Measures of pain, sleep, depression and anxiety were collected at baseline, 3 months, and 12 months, including PROMIS scales, SF-36, and the Brief Pain Inventory. Structural equation modeling was used to examine relationships among sleep, pain, and mental health symptoms over time.

Results: We found that changes in sleep complaints at 3 months significantly predicted changes in pain at 12 months (standardized coefficient = 0.29, p < 0.001) after controlling for demographic covariates and changes in depression and anxiety symptoms. Changes in mental health symptoms did not significantly predict pain outcomes. We also found differential relations of lower order sleep dimensions with pain outcomes. Insomnia significantly predicted pain outcomes (standardized coefficient = 0.17, p < 0.05), whereas lassitude did not.

Conclusion: Although patients with chronic pain identify sleep problems as an important treatment target, most chronic pain treatment programs do not directly address sleep disturbances. This work joins a growing body of evidence highlighting the importance of directly targeting sleep problems in patients with chronic pain to improve both sleep and pain outcomes.

Support (If Any): This material is the result of work supported with VA resources and facilities

0893
CONTRIBUTION OF THE SLEEP MEDICINE CONSULTATION TO INPATIENT MANAGEMENT IN A PUBLIC ACADEMIC HOSPITAL
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Introduction: Patients with sleep breathing disorders (SBD) have high hospitalization rates due to respiratory failure and associated cardiovascular (CV) morbidities. The sleep medicine center at Olive View-UCLA Medical Center, a Los Angeles County academic hospital established an inpatient consultation service in July 2012. We examined the initial 13 month experience to assess the contribution to patient management during the hospital stay.

Methods: We developed a database from hospital registration, medical and sleep laboratory records. Inpatient resident teams requested formal consultations that were completed by a sleep fellow and supervising ABMS-certified specialist. Inpatient sleep testing (IPST) was performed with Stardust II (Philips) or Nocturnal T3 (Carefusion) devices. Data was compiled regarding reasons for consultation, consultation diagnoses, IPST results, and effect on management during the hospital stay.

Results: Data reported as # (%) or mean ± SD. During July 2012–July 2013, there were 97 consultations for 94 patients: 55 (59%) men; aged 52.5 ± 12.6 yr; BMI 40.4 ± 10.5. SBD had been previously diagnosed in 23 (25%) with 18 (19%) prescribed PAP. Reasons for admission included: CV 41 (42%); respiratory 30 (31%); other 26 (27%). Average length of stay was 9 ± 10 days with 25 (26%) ICU and 18 (19%) step-down unit admissions. Reasons for consultation: suspected obstructive sleep apnea (OSAS) or obesity hypoventilation syndrome (OHS) 79 (81%); history of OSAS or OHS 17 (18%); other 1 (1%). Average time from admission to consultation was 4.7 ± 6.3 days. IPST was ordered for 77 (79%) consultations: 64 (83%) completed; 13 (17%) not completed because patients refused (5 (7%)) or were discharged (8 (10%)). Consultation diagnoses included: OSAS 61 (63%) (first diagnosis 38 (39%), with OHS 18 (19%)); OSAS suspected, not documented 22 (23%); SBD unlikely 9 (9%); other 5 (5%). The consultation resulted in 44 (45%) new PAP prescriptions, 46 (47%) in-hospital autoCPAP titrations (6.5 ± 7.2 days after admission) and 37 (38%) new PAP users at time of discharge.

Conclusion: Sleep medicine consultations contributed to in-hospital management by providing SBD diagnoses and expediting primary and adjunctive treatment.

Support (If Any): ASMF Humanitarian Award

0894
ANXIETY: A CORRELATE OF PERSISTENT SLEEP DISTURBANCE IN INDIVIDUALS RECOVERING FROM ALCOHOL DEPENDENCE
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Introduction: Alcohol dependence is often accompanied by a range of co-morbidities, including but not limited to sleep disturbances and anxiety. Sleep disturbances are common among individuals who are alcohol-dependent and are often associated with relapse.

Methods: In a cohort of research participants enrolled on an inpatient alcohol treatment protocol, 90.1% of individuals reported having baseline sleep disturbances. In this sub-analysis, those with ongoing sleep disturbances (OSD) after the first month of admission were compared to those whose sleep disturbances resolved (SDR). Sleep quality was determined using the Pittsburgh Sleep Quality Index (PSQI) on days 2 and 28 of inpatient treatment, twice-daily diaries, and continuous actigraphy (Actiwatch 2, Respironics). Visual analog-based self-reports, measuring sleep duration and quality and several mood variables, and the Comprehensive Psychopathological Rating Scale (CPRS), measuring anxiety and depression, were administered weekly. Linear mixed models were used to compare variables between groups over time.

Results: The sample (n = 75) is mostly male (66.7%) and African-American (45.5%) with a mean age of 43.66 (± 9.28) years. Participants were classified as SDR if PSQI score at day 28 was ≤ 5 (n = 34), and as OSD if PSQI on day 28 was > 5 (n = 42). Although anxiety levels decreased in both groups over time, OSD group reported 153% higher anxiety levels at one month when compared to SDR group (5.53 vs. 2.19, p = 0.004). Self-reported levels of mental exhaustion, physical exhaustion, and tiredness decreased while sleep quality improved in both groups over time; however, self-reported sleep quality was 20% higher in the SDR group at one month (7.03 vs. 5.85, p = 0.0002).

Conclusion: Understanding sub-groups of inpatients undergoing alcoholism treatment could allow for interventions targeting individuals at highest risk for sustained sleep disturbances and possibly relapse. Individuals recovering from alcohol dependence with higher self-reported anxiety levels may benefit from interventions designed to improve both sleep and anxiety.

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SLEEP INDICES AND PATTERNS IN POSTURAL ORTHOSTATIC TACHYCARDIA SYNDROME (POTS)
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Introduction: POTS affects primarily young women. Pots patients have a wide variety of symptoms. Poor sleep is one of the symptom found in the POTS patients. The purpose of this research is to study the sleep indices and sleep stages in the POTS patients.

Methods: 51 patients with POTS were referred to our clinic from January to November. Standard Polysomnography was performed in all the patients. Epworth Sleep Scale, N1, N2, N3, REM stages, Apnea/hypopnea index (AHI), SpO2 Sleep HR bpm, PLMS index and Total sleep efficiency (TSE) are recorded.

Results: Out of 51 patients, 96% are females (n = 45; age 29.20 ± 9.26), 4% are males (n = 6; age 28.50 ± 13.64); Epworth scale (10.21 ± 5.19); N1 (8.94% ± 5.68%); N2 (56.74% ± 10.69%); N3 (19.63% ± 9.718%), REM (15.60 ± 6.34), AHI (1.59 ± 3.18), Spo2 (Spo2 = 86.66 ± 14.06) Sleep HR bpm (72.57 ± 7.94 bpm) PLMS index (3.32 ± 7.53) TSE% (69.14% ± 15.50%). Out of 51 patients, 21 patients had > 10 Epworth scale; 24 patients had N1 < 8% and 27 patients had N1 > 8%; 4 patients had N2 < 45% and 47 patients had N2 > 45%; 23 patients had N3 < 22% and 28 patients had N3 > 22%; 7 patients had REM > 23% and 44 patients had REM < 23%; 6 patients had AHI > 5 and 45 patients had AHI < 5; 45 patients had < 5 PLMS index and 6 patients had > 5 PLMS index; 6 patients had > 85% TSE and 45 had < 85% TSE. Snoring is observed in 48 patients (11 patients had Severe snoring BMI 30.11 ± 5.20; 18 patients had moderate snoring BMI 27.46 ± 6.22; 19 Patients had mild snoring 20.37 ± 4.62).

Conclusion: 1. Patients with POTS have increased N1, N2, N3, daytime sleepiness, Sleep apnea, Periodic limb movements, Snoring, decreased REM sleep stages and decreased Total sleep efficiency. 2. Average Sleep heart rate is normal in all the patients.
0896
MEDIATION AND MODERATION OF THE
RELATIONSHIP BETWEEN COMBAT EXPERIENCES
AND POST-TRAUMATIC STRESS DISORDER IN
ACTIVE-DUTY OEF MILITARY PERSONNEL

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Introduction: Sleep problems, personality traits, and childhood trauma have all been associated with the development of Post-Traumatic Stress Disorder (PTSD) in military populations, especially in relation to combat experiences. The present study assesses sleep problems and predisposing variables as potential mediators and moderators of the relationship between combat exposure and PTSD. We hypothesize that increased combat experiences will predict PTSD, that sleep disturbances will partially mediate this relationship, and that neuroticism and adverse childhood experience (ACEs) will moderate the relationship.

Methods: 972 active duty Navy and Marine members serving in Afghanistan were given surveys to complete. Participants were measures on scales of PTSD, depression, combat exposure, sleep problems, neuroticism, and childhood trauma. Screening diagnosis of PTSD was measured using the PCL scale with a cutoff score of 25. Mediation and moderation models were developed and tested using a series of logistic regression analyses.

Results: Combat experiences were a significant predictor of PTSD, even when adjusting for all other covariates (p < 0.01). When adjusting for nightmares, the path coefficient between combat and PTSD dropped from 0.218 to 0.160, indicating a partial mediation accounting for 36.3% of the direct effect. Insomnia and sleep-related irritability were not significant mediators of the Combat-PTSD relationship. Neuroticism acted as an independent predictor of PTSD (p < 0.01), but did not moderate the Combat-PTSD relationship. ACEs did not have a significant predictive or moderating effect in the model.

Conclusion: This survey data indicates that difficulty sleeping, particular nightmares, may partially explain how traumatic combat experiences lead to the development of PTSD. This study highlights the importance of sleep in the military, especially after combat exposure. A renewed focus on sleep hygiene and coping mechanisms for those with high neuroticism could help with early prevention and treatment of PTSD in active duty populations.

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0897
THE INFLUENCE OF CHILDHOOD SEXUAL AND PHYSICAL ABUSE ON SELF-REPORTED SLEEP QUALITY IN ADULTHOOD

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Introduction: It is well known that depression is associated with poor subjective sleep quality. Childhood sexual and physical abuse are established risk factors for depression in adulthood. However, the link between childhood abuse and sleep in adulthood has not been thoroughly investigated to date

Methods: Subjective sleep quality was assessed using a 5 point scale in two population-based twin studies conducted at the Queensland Institute of Medical Research in Brisbane, Australia. In addition, multiple phone interviews were conducted by trained interviewers across several studies to assess symptoms of depression according to the DSM-IV criteria. Questions about sexual and physical abuse were also asked. Regression models were used to assess the effects of childhood abuse and depression on sleep quality. A total of 1,821 individuals were included in the analysis

Results: After adjusting for the effects of age, gender, BMI and depression, both childhood sexual and physical abuse were associated with poor sleep quality in adulthood (p = 0.008)

Conclusion: Childhood abuse is a risk factor for poor self-reported sleep quality in adulthood. Our analyses suggest that the effects of abuse on sleep are at least partially independent of the effects of depression on sleep quality

Support (If Any): Support was provided by grants from the National Health and Medical Research Council of Australia and the National Institutes of Health
Introduction: Emerging evidence suggests that day-to-day variability in sleep duration has a stronger association with mental health than does mean sleep duration. These data may be especially relevant in the context of psychological stress and its downstream associations with sleep and mental health, which is the focus of the present report.

Methods: Participants were 262 women (42–52 years of age) enrolled in the Study of Women’s Health Across the Nation (SWAN) and the SWAN Sleep Study. Upsetting life events were assessed annually for up to 9 years and trajectory analyses were used to identify three distinct groups: low, moderate, and high chronic stress. Sleep was assessed by actigraphy for 7–35 days at year 9. Depression and anxiety symptoms were assessed at years 9 and 12. Multivariable analyses tested the hypothesis that women with high chronic stress would have increased variability in sleep duration at year 9, and greater depression and anxiety symptoms at year 12. Analyses adjusted for sociodemographics, health characteristics, acute life events, and depression and anxiety symptoms at year 9.

Results: Women with high chronic stress had more variability in sleep duration in year 9 ($\beta = 0.17$, $p = 0.03$) and greater symptoms of depression and anxiety in year 12 ($\beta = 0.22$, $p = 0.001$) compared to women with low or moderate chronic stress. Furthermore, variability in sleep duration mediated the relationship between chronic stress group and later mental health (ES = 0.06, 95% CI: 0.0019, 0.1857). Chronic stress group was not associated with mean sleep duration in year 9 ($p > 0.05$).

Conclusion: High chronic stress in midlife women is prospectively associated with increased variability in sleep duration and increased depression and anxiety symptoms. The results are consistent with models linking variability in sleep duration—indicating poor sleep regulation—to impaired mental health.

Support (If Any): The Study of Women’s Health Across the Nation (SWAN) has grant support from the National Institutes of Health (NIH), Department of Health and Human Services, through the National Institute on Aging, the National Institute of Nursing Research and the NIH Office of Research on Women’s Health (Grants U01NR004061, U01AG012505, U01AG012535, U01AG012531, U01AG012539, U01AG012546, U01AG012553, U01AG012554, U01AG012495). Funding for the SWAN Sleep Study is from the National Institute on Aging (Grants AG019360, AG019361, AG019362, AG019363). In addition, support for M. Hall was provided by HL104607 and support for M. Casement was provided by MH103511.

B. Clinical Sleep Science

ASSOCIATIONS BETWEEN DEPRESSION AND HYPERSONMIA IN THE WISCONSIN SLEEP COHORT STUDY

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Introduction: Hypersomnia is commonly comorbid with depression, and is associated with treatment resistance, symptomatic relapse, and functional impairment. Prior investigations have variably demonstrated objective measures of hypersomnia in mood-disordered patients. This investigation used data from the Wisconsin Sleep Cohort Study to examine cross-sectional associations of depression with habitual sleep duration, daytime sleepiness, and objective sleep propensity.

Methods: To examine relationships between depression and hypersomnia in a population-based sample of middle-aged and older adults, we examined the association between presence of depression (defined as modified Zung Self-Rating Depression Scale ≥ 50 or use of antidepressant medications) with three hypersomnia domains: subjective excessive daytime sleepiness (EDS) [Epworth Sleepiness Scale ≥ 11], objective, actigraphic assessment in a large, population-based sample. We also considered whether sex moderates these relationships.

Methods: 418 participants (age 35–85, mean 57.04, SD = 11.47) in the Midlife in the United States (MIDUS) Biomarker project completed questionnaires, medical evaluations, and one week of wrist-worn actigraphy. Depression was determined by the Center of Epidemiological Studies-Depression scale (CES-D), yielding a continuous depression score. Traditional cosinor analysis was used to calculate rest-activity statistics, including mesor (mean activity level), amplitude (height of rhythm), and acrophase (time of day that rhythm peaks). Furthermore, we used Actiware-derived sleep onset latency (SOL), wake after sleep onset (WASO), sleep efficiency (SE), and total sleep time (TST).

Results: Multiple regression analyses revealed main effects of CES-D predicting longer SOL ($p < 0.01$), lower SE ($p < 0.05$), and later acrophase ($p < 0.05$). Men demonstrated longer SOL ($p < 0.001$), longer WASO ($p < 0.01$), lower SE ($p < 0.001$), and lower TST ($p < 0.01$) than women. Sex moderated the relationship between CES-D and SOL, TST, mesor, and amplitude. Sex-stratified models revealed that higher CES-D scores were associated with greater SOL ($p < 0.001$) and less TST ($p < 0.10$) for women only, while higher CES-D scores were associated with lower mesor ($p < 0.01$) and lower amplitude ($p < 0.01$) for men only.

Conclusion: Depression negatively impacted sleep continuity and rest-activity rhythms in this population-based sample; however, the impact of depression differed by sex. Depressed women exhibited more difficulty with sleep continuity, whereas depressed men demonstrated more rest-activity rhythm dysregulation. Although depression can be disruptive for both men and women, the type of disruption may differ between the sexes.

Support (If Any): The MIDUS I study (Midlife in the U.S.) was supported by the John D. and Catherine T. MacArthur Foundation Research Network on Successful Midlife Development. The MIDUS II research was supported by a grant from the National Institute on Aging (P01-AG020166) to conduct a longitudinal follow-up of the MIDUS I investigation. The research was further supported by the following grants: 1UL1RR025011 from the Clinical and Translational Science Award (CTSA) program of the National Center for Research Resources, National Institutes of Health; 1R01MH095778 for the National Institute of Mental Health.
HIGH MOOD TRIGGERED BY SLEEP LOSS: HETEROGENEITY WITHIN BIPOLAR DISORDER

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Introduction: Sleep deprivation is a commonly reported trigger of manic symptoms in individuals with bipolar disorder but prospective studies within this population find inconsistent evidence that sleep loss is associated with increased positive mood. We propose that these inconsistencies are due to heterogeneity in the response to sleep loss, as is also noted within healthy populations. In these analyses, we examined whether clinical variables such as bipolar diagnosis are associated with response to sleep loss.

Methods: 2571 individuals with bipolar disorder (64.7% BD-I, 31.7% BD-II) participated in a retrospective interview that included questions on triggers of high and low mood. DSM-IV diagnosis of bipolar I disorder (BD-I) or bipolar II disorder (BD-II) was derived from case notes and interview data.

Results: Twenty-two per cent of individuals reported sleep loss as a trigger of high mood. Females were more likely than males to report episodes of high mood triggered by sleep loss (OR = 1.42, 95% CI = 1.15–1.76). However, even when controlling for gender, individuals with BD-I were 2.89 times more likely to report episodes of high mood triggered by sleep loss (95% CI, 2.72–3.69) compared to those with BD-II.

Conclusion: Females and individuals with BD-I were more likely to report episodes of high mood triggered by sleep loss. This variability may explain the mixed findings in literature examining sleep loss and mood disturbance within BD, which do not differentiate according to sensitivity and typically include heterogeneous samples. Future research should explore whether self-reports of sleep loss triggering can be validated in prospective studies of sleep and mood change.

Support (If Any): ASFA (Association des Sociétés Françaises d’Autoroute)
0904

OVERLAP OF GENETIC VARIANTS FOR SCHIZOPHRENIA AND SLEEP TRAITS IN HEALTHY INDIVIDUALS

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Introduction: Disturbances in sleep, including fragmentation and alterations in sleep-wake cycle and spindle generation, are common in schizophrenia. The possibility of common sleep and schizophrenia genetic mechanisms was suggested by a recent study reporting an association between schizophrenia with multiple variants within the dopamine D2 receptor gene (DRD2), that also associated with sleep duration in the CARe Consortium. We hypothesized that the shared genetic basis for schizophrenia and sleep traits could be further elucidated by examination of schizophrenia genetic risk scores in sleep traits and by quantitative analysis of EEG (fragmentation, stage duration, alpha/sigma band activity, and spindle distribution).

Methods: Phenotype and genotype data were analyzed from 1,860–18,026 European-Americans from community-based cohorts (depending on phenotype). Habitual weekday sleep duration was based on questionnaire. EEG data were extracted from centrally derived leads and analyzed using spectral analysis with spindle detection underway. Traits were analyzed in a linear regression framework using an additive genetic model adjusted for age, sex, BMI, and 10 population principal components and meta-analyzed using an inverse-variance approach. A weighted genetic risk score of 12 of 108 genome-wide significant schizophrenia risk SNPs was calculated using GTX.

Results: Longer sleep duration was associated with a schizophrenia genetic risk score with and without inclusion of the top DRD2 variant (beta (se) 0.86 (0.24) min per allele, p = 2.4x10-4; beta (se) 0.54 (0.25) min per allele, p = 0.03; n = 18,026). A nearly significant association was also seen with longer time spent in Stage 2, despite a smaller sample size (p = 0.07; n = 3,250).

Conclusion: A schizophrenia genetic risk score including DRD2 was strongly associated with longer sleep duration in healthy populations, suggesting shared underlying mechanisms. Analyses of quantitative EEG are ongoing, including multiple cohorts with denser genotyping. These studies offer an unprecedented opportunity to gain insights into shared sleep and schizophrenia genetic architecture.

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0905

CHARACTERIZING SLEEP SPINDLE ABNORMALITIES IN SCHIZOPHRENIA AS A NOVEL TARGET FOR IMPROVING COGNITION

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Introduction: Sleep spindles play a critical role in memory consolidation. Schizophrenia patients have a dramatic reduction in sleep spindles that correlates with impaired sleep-dependent memory consolidation and poorer performance on cognitive measures more generally. Our recent findings of spindle deficits in first-degree relatives and that eszopiclone increases sleep spindles in schizophrenia suggest that sleep spindle deficits are markers of genetic vulnerability to schizophrenia and are treatable. This motivates us to further characterize the nature of the spindle deficit in schizophrenia and its relation to memory consolidation. Specifically, using high density EEG and anatomical MRI, we are identifying the sources and characteristics of spindles that mediate memory consolidation in health, and how these differ in schizophrenia.

Methods: Schizophrenia patients and demographically-matched healthy controls spent two overnights at MGH with polysomnography. They were trained on a finger-tapping motor sequence task before bedtime on the second night and tested the following morning. Sleep spindles were identified using a wavelet spindle detector. We computed current source estimates of sleep spindles anatomically constrained by structural MRI. In source space, we applied a continuous Morlet wavelet transform to derive the time-frequency distribution of spindles in different cortical regions.

Results: Relative to healthy controls, patients had reduced spindle density across multiple electrode sites. Source localization identified fast (> 13 Hz) spindles in parietal regions and slow (< 13 Hz) spindles in frontal regions. We are examining changes in the time-frequency characteristics and spatial distribution of spindles as a result of learning (comparison of the learning and non-learning nights), and how these differ by group.

Conclusion: We replicate our findings of a spindle deficit in schizophrenia, and discriminate between fast and slow spindle cortical sources. We are refining these methods to determine the types of spindles that contribute to memory consolidation and are abnormal in schizophrenia.

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0906

NIGHTTIME AND DAYTIME SLEEP IN FIRST EPISODE PSYCHOSIS

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Introduction: Disturbed nighttime sleep and increased daytime sleep are common in individuals with psychosis. Previous research on habit-
ual sleep in individuals with psychosis has focused on middle-aged and older adults. The purpose of this study was to examine characteristics and clinical correlates of sleep among individuals with first-episode psychosis.

**Methods:** Forty young adults (10 female, mean age 22.7 years, range 17–33) with first-episode psychosis (16 affective-spectrum, 24 schizophrenia-spectrum, 26 taking antipsychotics) were assessed for psychotic symptoms and reported their activities for the last 4 am–4 am period, from which measures of sleep were derived. Age/sex matched normative values for total sleep time were taken from the American Time Use Survey.

**Results:** Mean bedtime was 00:04 (SD: 229.94 minutes) and mean wake time was 10:11 (SD: 212.92 minutes). Total sleep time over 24 hours (TST) was 637.68 minutes (SD: 173.19), reflecting 102.8 minutes (SD: 173.7) more sleep than age/sex norms. Day sleep (08:00–20:00) was 181.18 minutes (SD: 154.34). Antipsychotic use was associated with a trend toward longer TST, p < 0.07, d = 0.67, apparently driven by later wake time, p < 0.05, d = 0.75. After controlling for antipsychotic use and main effects, the interaction of diagnosis and positive symptoms (e.g., delusions, hallucinations) significantly predicted day sleep, p < 0.05, R² = 0.21. Positive symptoms were associated with more day sleep among individuals with schizophrenia-spectrum disorders (b = 11.81, p < 0.05), while there was an opposite trend in individuals with affective-spectrum disorders with psychosis (b = −15.12, p < 0.1).

**Conclusion:** To our knowledge, this is the first study of habitual sleep and its clinical correlates in first-episode psychosis. Individuals with first-episodes psychosis slept longer than normal, including an average of 3 hours of day sleep, which was associated with psychotic symptoms rather than antipsychotic medication. This may reflect circadian abnormalities among individuals with schizophrenia-spectrum disorders.

**Support (If Any):** The Institute for Mental Health Research and the Arizona Center for the Biology of Complex Diseases.

**0907**

**A REM SLEEP QUANTITATIVE EEG STUDY IN NEUROTYPICAL AND AUTISTIC CHILDREN**

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**Introduction:** Autism is a neurodevelopmental disorder characterized by atypical connectivity between brain regions. We have shown that this translates into atypical quantified EEG activity (QEEG) during sleep in adults with autism, including localized spectral power differences as well as atypical intra- and interhemispheric coherence patterns. The purpose of this study was to analyze QEEG in children with high-functioning autism (HFA) and typically developing (TD) children during REM sleep and test associations between these measures and clinical scales.

**Methods:** 11 HFA children (10.5 ± 1.2 years) and 13 TD children (10.2 ± 2.0 years) were recorded for 2 consecutive nights in a sleep laboratory using a 22-electrode montage. All participants had a normal IQ and none were taking medication. Spectral power was calculated for Delta, Theta, Alpha, Sigma and Beta activity and coherence values were calculated for inter- and intrahemispheric pairs of electrodes on artifact-free samples of REM sleep taken from the second night. Group differences on EEG coherence were assessed with repeated-measured ANOVA on each electrode pair for all frequency bands and correlations were calculated with Pearson’s r.

**Results:** We found no group differences for any frequency band and any recording sites. Compared to TD children, the HFA group had significantly greater coherence values in frontal interhemispheric pairs of electrodes (FP1-FP2; F3-F4), between short distance frontal electrode pairs (FP1-F7; FP1-F3; F3-F7; FP2-F8; FP2-F4; F4-F8) and between frontal-related distant pairs (F7-C3; F3-T7; F4-C4; F8-C4; F4-T8). Enhanced coherence values in frontal electrodes pairs positively correlated with scores of internalizing behaviors in the HFA group.

**Conclusion:** HFA children displayed typical amounts of EEG voltage over all cortical areas but atypical connectivity patterns between these areas, namely enhanced connectivity among local frontal areas. The absence of atypical connectivity involving the occipital area diverges from adult data during REM sleep. These results point toward a developmental pattern of atypical brain organization in autism and suggest that this pattern shares a common substrate with clinical status.

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**0908**

**TO USE THE SUBCATEGORIZATION OF SLEEP MARKERS AND DEPRESSION IN OUTPATIENT ADOLESCENT YOUTH**

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**Introduction:** Major Depressive Disorder (MDD) is a common health problem characterized by low mood, sadness and irritability. Sleep disturbances are a central feature of depression and adolescence is a period of rapid change in sleep physiology. The aim of this study is to evaluate the categorization of sleep change in three of sleep elements: REM changes; Slow wave sleep changes and fragmentation of sleep. We evaluated this as a tool to detect depression. The objective is to assess features of sleep macroarchitecture as markers for evaluating and detecting adolescent depression.

**Methods:** Adolescents completed a two-week protocol that included a formal psychiatric interview, standardized scales, polysomnographic (PSG) assessment, actigraphy, salivary melatonin sampling, and holter monitoring.

**Results:** Depressed adolescents (n = 22) differed from controls (n = 20) on features of sleep macroarchitecture measured by PSG. 59% of the depressed subjects had more than one PSG marker from each category as compared to control (N = 20). This indicates that subjects who were depressed on clinical assessments using the standardized scales and evaluations had changes in sleep suggestive of depression.

**Conclusion:** The categorization of sleep change in three categories of sleep components (see above) can be a useful tool to detect depression. The results suggest that the individual markers of depression in children and adolescents may not be as effective as the categorization of sleep changes into three categories and using this general approach.

**0909**

**SLEEP COMPLAINTS IN DEPRESSED YOUTH AS A MARKER OF THE SEVERITY OF THE ILLNESS**

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**Introduction:** Affective disorders are prevalent forms of mental illness. In children the presence of insomnia and hypersomnia has been reported. The presence of sleep complaints in Brazilian depressed chil-
dren has been an ongoing discussion. They may cause a significant and potentially lifetime burden for the developing child. The aim of this study was to examine the severity of the illness in depressive youth with sleep complaints.

**Methods:** Our sample was composed of 142 youths with current major depressive disorder to an outpatient Brazilian clinic. Depressive psychopathology was ascertained by face-to-face clinical interview and by the Diagnostic Interview for Children and Adolescent DSM IV version. The Children's Depression Rating Scale (CDRS) was applied with 16-item measure to determine the severity of depression. We obtained the score 1 to 4 from the presence of sleep complaints. We performed t-test and one-way ANOVA to compare CDRS T-score across youth with 1 up to 4 sleep complaints with a significance level set at 5%.

**Results:** All subjects in this sample had sleep complaints (mean of age = 11 ± 8.1; 54.9% boys). The mean of CDRS T-score was 78.7 ± 7.1, and the most frequent complaint was initial insomnia (88.7%), followed by night awakenings (54.2%), early awakening and hypersomnia (34.5% and 31%, respectively). Youth with 3 or more sleep complaints had significantly higher CDRS T-score [F(3, 138) = 5.7, p = 0.001]. This is especially the case in adolescent boys [F(3, 138) = 3.1, p = 0.027].

Also, the severity of depression is associated to the number of sleep complaints (p = 0.022), particularly in patients without family history of affective disorder (p = 0.010).

**Conclusion:** We found that the severity of depression was increased by the number of sleep complaints. The sleep complaints associated with depression might be clinically important in youth without family history of affective disorder.

**0910**

**CIRCADIAN SYNCHRONY AND AFFECTIVE SYNDROMES EMERGING DURING YOUTH**

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**Introduction:** Disruptions in the synchrony of circadian rhythms have been hypothesized to play a role in the pathophysiology of affective disorders. In depressed adults with a delayed circadian profile, greater depression severity has been found to correlate with variations in the phase angles between sleep schedule, dim light melatonin onset (DLMO), and core body temperature nadir (CTBmin). Considering the marked phase delay often characteristic of mood disturbances during youth, this study investigated how the phase relationship between circadian rhythms relate to the clinical profile of young persons with emerging affective syndromes.

**Methods:** One hundred and one young persons [62.4% females; 14 to 34 years, mean (SD) = 20.9 (0.43) years] seeking professional help primarily for significant symptoms of anxiety, depression or bipolar disorder were recruited from specialised early intervention services. A research psychologist administered the Brief Psychiatric Rating Scale (BPRS) and the Social and Occupational Functioning Assessment Scale (SOFAS). Participants completed 5 to 21 days of actigraphy monitoring and a semi-constant routine protocol during which saliva samples were collected every 30-minute from 6-hour prior to habitual sleep time (HST) until 2-hours after HST, and CBT was recorded across the night with an ingestible sensor.

**Results:** Negative phase angles between habitual sleep midpoint and CTBmin, and between HST and DLMO were found in respectively 51.0% and 25.8% of the sample. Higher mania symptoms on the BPRS correlated with later DLMO (r = 0.30, p = 0.017) and with shorter CBTmin-DLMO phase angle (r = –0.46, p = 0.014). Lower SOFAS scores correlated with later DLMO (r = –0.30, p = 0.019) and with shorter HST-DLMO phase angle (r = 0.27, p = 0.040).

**Conclusion:** Unusual phase angles between sleep, melatonin and temperature rhythms were found in several young persons with emerging affective syndromes. During youth, shorter phase angles in conjunction with later melatonin rhythms may be associated with more severe mania symptoms and lower socio-occupational functioning.

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B. Clinical Sleep Science

0912

ANXIETY SYMPTOMS PREDICT SHORT SLEEP DURATION, BUT ONLY IN INDIVIDUALS WHO ARE NOT “NATURAL” SHORT SLEEPERS

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Introduction: Sleep duration may be, at least in part, mediated by anxiety. This may not apply, though, for individuals who are “natural” short sleepers.

Methods: Data from the Sleep and Healthy Activity, Diet, Environment, and Socialization (SHADES) study was used. SHADES is a community-based study of adults in southeastern Pennsylvania (N = 1007). Sleep duration was assessed using the NHANES question and was categorized as very short (≤ 4 h), short (5–6 h), normal (7–8 h, reference), or long (≥ 9 h). Subjects were also asked if they awaken naturally AND are satisfied with the amount of sleep they get (N = 267/1007). Anxiety symptoms assessed using the GAD-7 included nervousness, lack of control, worry, trouble relaxing, restlessness, irritability, and fearfulness. These items were scaled from 0 (“Not at all”) to 3 (“Nearly every day”). Multinomial logistic regressions included sleep duration as dependent variable, anxiety symptoms as independent variable, and age, sex, education, and race/ethnicity as covariates, overall and stratified by “natural” sleep status.

Results: Overall, very short sleep (≤ 4 h) was associated with “nearly every day” reports of nervousness (OR = 5.7, p < 0.0001), lack of control (OR = 6.1, p < 0.0001), worry (OR = 8.7, p < 0.0001), trouble relaxing (OR = 13.1, p < 0.0001), restlessness (OR = 7.3, p < 0.0001), irritability (OR = 7.9, p < 0.0001), and fear (OR = 5.2, p < 0.0001). Short sleep (5–6 h) was also associated with “nearly every day” reports of nervousness (OR = 2.8, p < 0.0001), lack of control (OR = 3.4, p < 0.0001), worry (OR = 3.0, p < 0.0001), trouble relaxing (OR = 4.3, p < 0.0001), restlessness (OR = 2.3, p < 0.0001), and irritability (OR = 2.1, p < 0.0001). When analyses were stratified by “natural” sleep, “natural” short sleepers did not show statistically significant associations compared to “natural” normal sleepers. In contrast, “non-natural” short sleepers (very short and short) exhibited strong associations between sleep duration and anxiety compared to “non-natural” normal sleepers.

Conclusion: Short sleep duration is associated with increased reporting of anxiety symptoms. However, these associations may only hold true for those who do not awaken “naturally” and report dissatisfaction with their sleep duration.

Support (If Any): The SHADES study was funded by R21ES022931. Dr. Grandner is also supported by K23HL110216.

0913

BINGE DRINKING AND HABITUAL SLEEP DURATION, AND THE ROLES OF DEPRESSION AND SMOKING: DATA FROM THE 2013 BEHAVIORAL RISK FACTOR SURVEILLANCE SYSTEM

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Introduction: Several studies have shown that both alcohol binges and smoking can disturb sleep, and that substance use is commonly seen in the context of depression, which itself is associated with poor sleep. The present study sought to explore these relationships in a national sample with the goal of determining pathways linking binge drinking with sleep duration.

Methods: Data from the 2013 BRFSS, a large survey conducted by the CDC, was used (N = 199,009). Sleep duration was assessed as amount of sleep in typical 24 h and was categorized as very short (≤ 4 h), short (5–6 h), normal (7–8 h, reference), and long (≥ 9 h). Binge drinking frequency was assessed as number of occasions in the past 30 days of ≥ 5 drinks. Smoking and depression were self-reported. Covariates included age, sex, race/ethnicity, education, income, marital status, and BMI. Multinomial logistic regression, with sleep duration as dependent variable, examined the role of binge drinking, smoking, and depression. Sobel tests examined the role of smoking and depression as mediators of relationships with heavy drinking.

Results: In analyses adjusted for covariates, each binge episode was associated with increased likelihood of very short (OR = 1.05; 95% CI [1.04–1.06]; p < 0.0001), short (OR = 1.02; 95% CI [1.01–1.02]; p < 0.0001), and long (OR = 1.03; 95% CI [1.02–1.04]; p < 0.0001) sleep. Similarly, smoking was associated with very short (OR = 2.38; 95% CI [2.21–2.57]; p < 0.0001), short (OR = 1.53; 95% CI [1.47–1.59]; p < 0.0001), and long (OR = 1.22; 95% CI [1.14–1.32]; p < 0.0001) sleep. After adjusting for smoking and depression, effects for binge drinking were still significant for very short (OR = 1.04; 95% CI [1.03–1.05]; p < 0.0001), short (OR = 1.01; 95% CI [1.01–1.02]; p < 0.0001), and long (OR = 1.03; 95% CI [1.02–1.04]; p < 0.0001) sleep. In partial mediation analyses, smoking accounted for 29%, 36%, and 6% of the relationship between binge drinking and very short, short, and long sleep, respectively, and depression accounted for 14%, 10%, and 7% of these relationships.

Conclusion: In analyses adjusted for covariates, each binge episode was associated with increased likelihood of very short (OR = 1.05; 95% CI [1.04–1.06]; p < 0.0001), short (OR = 1.02; 95% CI [1.01–1.02]; p < 0.0001), and long (OR = 1.03; 95% CI [1.02–1.04]; p < 0.0001) sleep. Similarly, smoking was associated with very short (OR = 2.38; 95% CI [2.21–2.57]; p < 0.0001), short (OR = 1.53; 95% CI [1.47–1.59]; p < 0.0001), and long (OR = 1.22; 95% CI [1.14–1.32]; p < 0.0001) sleep. After adjusting for smoking and depression, effects for binge drinking were still significant for very short (OR = 1.04; 95% CI [1.03–1.05]; p < 0.0001), short (OR = 1.01; 95% CI [1.01–1.02]; p < 0.0001), and long (OR = 1.03; 95% CI [1.02–1.04]; p < 0.0001) sleep. In partial mediation analyses, smoking accounted for 29%, 36%, and 6% of the relationship between binge drinking and very short, short, and long sleep, respectively, and depression accounted for 14%, 10%, and 7% of these relationships.

Support (If Any): K23HL110216, R21ES022931

0914

ASSOCIATIONS BETWEEN SLEEP DURATION, NEURAL ACTIVITY AND CONNECTIVITY DURING AN FMRI REWARD PARADIGM, AND EMERGING MANIC SYMPTOMS IN YOUTH AT RISK FOR BIPOLAR DISORDER

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Introduction: Although disturbed sleep has been implicated in the development of bipolar disorder (BD), the neural pathways through which sleep may influence BD risk have been minimally examined. The aim of the present study was to investigate the relationship between sleep duration and reward processing neural circuitry in youth at risk for BD, and evaluate whether sleep-related functional changes in
reward circuitry mediate the relationship between sleep duration and emerging mania symptoms.

**Methods:** 23 offspring of a parent with BD (BO) and 25 control participants (CTL) completed an fMRI reward paradigm. Groups were matched on age (8–16 yr, mean = 14.0 ± 2.3 yr), sex, IQ, and Axis I disorders. All youth were BD-negative. Analyses focused on a win > control contrast. Regression tested group status and self-reported sleep duration in the week prior to scan as predictors of BOLD activity within a prefrontal-ventral striatal region-of-interest and whole-brain connectivity to a bilateral ventral striatum (VS) seed region. Sleep-related BOLD activity and connectivity were tested as mediators of the relationship between sleep duration and emerging mania symptoms (Parent General Behavior Inventory-10 Item Mania Scale; PGBI-10M).

**Results:** There were significant group-by-sleep duration interactions for bilateral anterior cingulate cortex activity (ACC; p < 0.05, corrected) and for bilateral VS-left amygdala/insula connectivity (p < 0.05, FWE-corrected). Sleep duration and ACC activity were positively associated in BO, but inversely associated in CTL [Left: F(3,44) = 4.51, p = 0.008, R² = 0.24; Right: F(3,44) = 3.14, p = 0.035, R² = 0.17]. Sleep duration and VS-left amygdala/insula connectivity were inversely related in BO, but positively related in CTL [F(3,44) = 6.61, p = 0.001, R² = 0.56]. In BO only, greater VS-left amygdala/insula connectivity mediated the relationship between shorter sleep duration and higher PGBI-10M score (Indirect effect b = −0.05, BCa CI [−0.11, −0.002]).

**Conclusion:** In youth at risk for BD, shorter sleep duration may increase risk of manic symptoms through disrupted functional connectivity during reward processing, suggesting that mitigating sleep loss could be an important intervention target for this population.

**Support (If Any):** R01MH060952; T32MH018269

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### 0915 DAYTIME COGNITIVE FUNCTION ASSOCIATED WITH HABITUAL SLEEP DURATION

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**Introduction:** Sleep duration has been associated with adverse cardiometabolic outcomes. Sleep deprivation has been shown to impair cognitive function in the laboratory, but few studies have examined associated between sleep duration and cognitive function at the population level. This is relevant because poor cognitive function could lead to accidents, decreased functioning, and other adverse outcomes. It is possible that habitual sleep duration confers risk in this domain as well.

**Methods:** Data from the 2013 Behavioral Risk Factor Surveillance System (BRFSS) was used. The BRFSS is a phone-based survey conducted annually by the CDC. N = 390,959 adults age ≥ 18 provided complete data. Sleep duration was assessed as habitual sleep within 24 hours and was categorized as very short (≤ 4 h), short (5–6 h), normal (7–8 h, reference), and long (≥ 9 h). Daytime cognitive dysfunction was operationalized with, "Because of a physical, mental, or emotional condition, do you have serious difficulty concentrating, remembering, or making decisions?" Covariates included age, sex, education, income, race/ethnicity, overall health, and days poor physical and/or mental health in the past month. Logistic regression analyses were weighted for representativeness to the US population.

**Results:** In unadjusted analyses, daytime cognitive function was more frequently endorsed in very short (OR = 8.07; 95% CI [7.48, 8.71]; p < 0.0001), short (OR = 2.20; 95% CI [2.09, 2.32]; p < 0.0001), and long sleep (OR = 2.72; 95% CI [2.52, 2.93]; p < 0.0001). After adjustment for demographics and socioeconomics, these were attenuated somewhat for very short (OR = 5.52; 95% CI [5.09, 6.00]; p < 0.0001), short (OR = 2.03; 95% CI [1.92, 2.14]; p < 0.0001), and long sleep (OR = 2.09; 95% CI [1.93, 2.26]; p < 0.0001). After including overall, physical, and mental health, these relationships were further attenuated but still significant for very short (OR = 2.32; 95% CI [2.10, 2.57]; p < 0.0001), short (OR = 1.44; 95% CI [1.35, 1.52]; p < 0.0001), and long sleep (OR = 1.72; 95% CI [1.58, 1.87]; p < 0.0001).

**Conclusion:** Short and long sleep duration are associated with cognitive dysfunction, even after accounting for demographics, social factors, and physical and/or mental health problems. Population-level concerns about the adverse impact of sleep duration should consider cognitive as well as cardiometabolic risks.

**Support (If Any):** K23HL110216, R21ES022931

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### 0916 INSUFFICIENT SLEEP, TOTAL SLEEP TIME, AND SLEEP QUALITY AS PREDICTORS OF BIOPSYCHOSOCIAL OUTCOMES

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**Introduction:** Most research examining sleep and biopsychosocial outcomes (e.g., fatigue, depression, anxiety) focuses on sleep duration or sleep quality. However, insufficient sleep—getting less sleep than one desires or needs—may also play an important role in these outcomes. The present study examines insufficient sleep, total sleep time, and sleep quality as predictors of fatigue.

**Methods:** Participants were 965 undergraduate students from a large public university in Texas (U.S.; 74.6% female; M age = 20.4 [SD = 3.9]). Participants completed one week of daily sleep diaries and a questionnaire battery assessing demographics, sleep quality, ideal amount of sleep, and fatigue. A linear regression was run to determine if, in addition to total sleep time and sleep quality, insufficient sleep significantly contributed to prediction of fatigue.

**Results:** Average insufficient sleep was 57.8 minutes (SD = 79.5). Sleep quality, insufficient sleep, and gender were all significant predictors of fatigue (ps < 0.001), and the overall model was significant (p < 0.001). Total sleep time was not a significant predictor (p = 0.288). Additional analyses examining these variables as predictors of other biopsychosocial outcomes will be presented at conference.

**Conclusion:** The results indicate higher levels of insufficient sleep are significantly related to higher levels of fatigue. Insufficient sleep, in addition to factors such as sleep quality and total sleep time, may be an important variable to consider in the examination of biopsychosocial outcomes. More research is needed to adequately assess insufficient sleep, and to determine the role it plays in individuals’ overall health and quality of life.

**Support (If Any):** Research supported by a grant from University of North Texas [G69250].

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### 0917 ASSOCIATIONS BETWEEN SLEEP DISTURBANCE, COGNITIVE FUNCTIONING AND WORK DISABILITY IN BIPOLAR DISORDER

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**Introduction:** Bipolar Disorder (BD) is associated with poor functional outcomes often despite the remission of mood symptoms. Research has pointed toward deficits in cognitive functioning as playing an
portant role in this persistent disability, whereas other reports associate clinical variables with functional outcomes. Comparatively understudied is the role of chronic sleep disturbance in the maintenance of functional disability in BD. The present study aimed to extend this line of inquiry by examining the relative contributions of sleep disruption and cognitive functioning specifically to work-related disability among individuals with BD.

Methods: Twenty-four euthymic BD participants and 24 healthy controls completed a week of prospective assessment of sleep via self-report (Pittsburgh Sleep Quality Index (PSQI), Insomnia Severity Index) and actigraphy, a battery of neuropsychological tests of executive functioning, working memory, and verbal learning, and assessments of work functioning.

Results: BD participants experienced significantly poorer sleep ($p < 0.016$ for Insomnia Severity Index, PSQI variables of Daytime Dysfunction, Onset Latency, Sleep Quality, and Total Score) though no significant differences were observed on actigraphy. BD participants experienced worse cognitive functioning ($p < 0.04$ across all domains), and greater lifetime histories of unemployment and being fired from one’s job ($p < 0.03$). Moderation analyses revealed that both poor sleep and cognitive functioning were significantly associated with poor work performance in BD participants but not control participants ($p < 0.05$).

Conclusion: This is the first study to directly associate sleep functioning with employment-related disability in BD. Sleep and cognitive functioning among individuals with BD is impaired relative to controls and is more strongly related to work functioning than among individuals with no diagnosis, highlighting the importance of sleep as a treatment target for individuals with BD. More research should be conducted to better understand how sleep may impact cognitive functioning in BD to elicit work disability.

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ASSOCIATIONS OF DEPRESSIVE SYMPTOMS WITH SLEEP DURATION, CHRONOTYPE, AND SKIPPING BREAKFAST IN RotATING SHIFT WORKERS

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Introduction: Recent studies have suggested that depressive symptoms in adults uninvolved in night work are associated with daily sleep duration and chronotype. However, it has been remained unclear whether habitual sleep duration and chronotype independently contribute to increasing the level of depressive symptoms in rotating shift workers. Chronotype is associated with timing of behaviors such as eating. Therefore, the purpose of this study is to determine the relationships between depressive symptoms, daily sleep duration, and chronotype or skipping breakfast habit in rotating shift workers.

Methods: Japanese female nurses (1141 day workers and 1522 rotating shift workers, aged 20–59) were studied using self-administered questionnaires. The questionnaires included sleep habits, chronotype, the rate of skipping breakfast, depressive symptoms, and demographic characteristics of participants: age, height, weight, current work schedule, position, years of experience as a rotating shift worker, and marital status.

Results: The level of the depressive symptoms of shift workers was significantly ($p < 0.05$) higher than that of day workers. Shift workers slept for significantly ($p < 0.05$) shorter durations on nights between days on the day shift, shifted significantly ($p < 0.05$) more toward an evening type, and skipped breakfast significantly ($p < 0.05$) more frequently compared with day workers—factors which were also associated with higher level of the depressive symptoms. In addition, multivariable linear regression coefficients for the level of the depressive symptoms showed a significant correlation with sleep duration and chronotype or the rate of skipping breakfast in rotating shift workers, after controlling for demographic characteristics.

Conclusion: Shorter sleep duration and evening type in chronotype, or more frequent breakfast skipping were associated with higher depres-
sive symptoms in rotating shift workers, which should be considered in preventing poor mental health in rotating shift workers.

**0920**

**SLEEP QUALITY AND SLEEP DISTURBANCE IN THOSE AT RISK FOR HOARDING DISORDER**

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**Introduction:** Hoarding Disorder (HD) was designated as an independent mental illness in the most recent edition of the DSM. Many patients with HD experience difficulty using the rooms in their homes for the purposes intended. The difficulty that those with HD may experience in using their bedrooms for sleep might result in worsening sleep patterns over time. Our study surveyed a range of respondents to discover whether sleep, hoarding, and clutter, particularly in the bedroom, might be inter-related.

**Methods:** We recruited a sample of respondents from Amazon’s “Mechanical Turk” website to collect survey responses from the internet. All data were collected between 5 pm and 10 pm. Our advertisement asked for those interested in hoarding, sleep, or clutter, whether or not they had problems with these areas. Questionnaires: Demographics; Pittsburgh Sleep Quality Index (PSQI); Clutter and Hoarding Rating Scale (CHRS); Sleep Habits Survey (SH).

**Results:** Respondents whose scores on the CHRS were greater than 35 were deemed at risk of HD (Risk-HD, n = 83); others were minimally at risk and comprised our control group (n = 198). The Risk-HD group was not different in age or gender compared to the control group. Contrary to our hypotheses, Risk-HD participants identified living rooms as most cluttered/unused (F = 89.8, df 1,279). Kitchens (F = 21.5, df 1,279) and bedrooms (F = 21.5, df 1,279) were also significantly more cluttered than the control group (all p < 0.001). Risk-HD participants scored significantly higher on the SH (F = 7.6, p < 0.01) and on three sub-scales of the PSQI, including Sleep Latency (F = 10.3 (df 1, 279), p < 0.001); Sleep Disturbances (F = 17.5, p < 0.001), and Daytime Disturbances (F = 5.0, p < 0.05).

**Conclusion:** Those at risk of Hoarding Disorder may have serious complaints about sleep. Using the bedroom for restful and adequate sleep may be considerably more difficult for those with behaviors and symptoms consistent with Hoarding Disorder.

**0921**

**SLEEP DISTURBANCE IN TREATMENT-SEEKING INDIVIDUALS WITH COMPLICATED GRIEF**

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**Introduction:** In complicated grief (CG), the mourning process becomes derailed and symptoms of acute grief are prolonged, including persistent yearning for the deceased, preoccupation with the loss, and intense sorrow. Individuals with CG, with and without comorbidity, also report having poor sleep quality. We recently completed recruit-ment for a multicenter treatment study for CG. We examined baseline sleep disturbance in this study.

**Methods:** 387 adults (78.3% female; mean age = 53.0, SD = 14.6) met criteria for CG and completed the Quick Inventory of Depressive Symptomatology (QIDS-SR) at baseline. All patients were interviewed with the Structured Clinical Interview for DSM-IV to assess for current MDD (n = 256, 66.1%) and PSTD (n = 151, 39.0%). Sleep disturbance was assessed by items 1–4 on the QIDS-SR. Fisher’s Exact tests were conducted to examine differences in sleep disturbance based on comorbidity.

**Results:** 387 study participants (91.2%) endorsed some degree of impaired sleep (≥ 2 on any QIDS-SR item 1–4). Rates of endorsing difficulty falling asleep differed according to comorbidity with 43.0% of those with CG only (n = 93), 54.5% of those with CG+MDD (n = 143), 42.1% of those with CG+PSTD (n = 38), and 67.3% of those with all three diagnoses (n = 113) (p = 0.0020). Similarly, waking too early differed by comorbidity with rates for CG only significantly lower than those with GG+MDD, CG+PSTD, and all three diagnoses (p = 0.0012), as did sleeping too much (p = 0.0051). However, restless sleep during the night was endorsed by 74.2% with CG only and did not differ significantly by condition (p = 0.4254).

**Conclusion:** We found that the great majority of study participants endorsed sleep disturbance. Similar to previous reports, those with comorbidity more often endorsed sleep problems than those with CG alone. However, it appears that sleep disturbance is a common associated feature with CG and is likely to be clinically significant.

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ty in daytime functioning. In the CG + MDD group 59.38% of patients indicated that keeping up enough enthusiasm to get things done was a very big problem compared to 19.74% of CG only patients (p < 0.0001).

**Conclusion:** About half of older adults seeking treatment for CG reported poor sleep quality, including 62% with and 47% without current MDD. Those with current MDD reported higher rates of sleep disturbed by feeling too hot or too cold and greater difficulty maintaining enthusiasm to get things done. High rates of poor sleep quality in the participants both with or without MDD replicates previous findings in younger adults and suggests disturbed sleep may be a clinically significant cause and/or consequence of prolonged acute grief.

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### 0923

**SLEEP DISTURBANCE IN PSYCHOTIC AND NON PSYCHOTIC BIPOLAR AFFECTIVE DISORDERS**

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**Introduction:** Bipolar affective disorder is a severe, recurrent mental illness affecting 1–4% of the population. Reduced need for sleep and insomnia/hypersomnia are common symptoms of the manic and depressive phases of bipolar disorder. Sleep disturbance persists in the period between episodes and may be a mechanism contributing to illness relapse. Purpose of our study is to evaluate sleep disorders and polysomnographic findings in psychotic (PBPD) and non psychotic bipolar disorder (NPBPD) during the inter-episodes period.

**Methods:** We made prospective study of 14 PBPD and 14 NPBD patients. Sleep was evaluated via Pittsburgh sleep quality index (PSQI), Epworth sleepiness scale (ESS) and polysomnography.

**Results:** The mean age of patients was 31 ± 10 years in PBPD, 35 ± 8 years in NPBPD. PSQI scores were found high both of these groups (7 in PBPD, 8 in NPBPD, respectively). ESS scores were high in PBPD group. Sleep latency in NPBPD group longer than in PBPD group. Sleep apnea was more common in both groups (57% of total patients, mean AHI: 7/hour, min O2 sat 72%).

**Conclusion:** Sleep disturbances are often reported by patients with Bipolar Disorder. The high prevalence of obstructive sleep apnea among these patients may play a major role in the mortality and morbidity of bipolar disorders.

### 0924

**EMOTIONAL REGULATION AND DEPRESSION SYMPTOMS: THE IMPACT ON SLEEP AND NIGHTMARES**

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**Introduction:** Depression and emotional dysregulation are linked to poor sleep quality (Knudsen, Ducharme, & Roman, 2007; Mauss, Troy, & LeBourgeois, 2013). Depression is also related to experiencing nightmares, particularly in individuals with posttraumatic stress disorder (PTSD; Nadorff, Nazem, & Fiske, 2011). Biological understanding of this relationship shows that problems in limbic areas of the brain associated with emotional functioning significantly predict nightmares (Levin, & Nielsen, 2009). Given that research has linked depression to the onset of emotional regulation difficulties (Joormann, & Gotlib, 2010), and both constructs relate to sleep quality and nightmare frequency, this study explores the amount of variance these variables predict in poor sleep quality and nightmare frequency. Determining how these variables influence sleep could inform prioritization in sleep-focused treatment.

**Methods:** Data was collected via self-report surveys distributed to university students (N = 34). Measures included the Difficulties in Emotional Regulation Scale, the Center for Epidemiologic Studies Depression Scale, the Pittsburgh Sleep Quality Index, and the Trauma-Related Nightmare Survey. A two-step hierarchical multiple regression was conducted. Due to depression’s role in emotional regulation difficulties, depression was entered in step 2 to assess incremental validity in predicting poor sleep quality and nightmare frequency.

**Results:** Depression predicted incremental validity above and beyond emotional regulation difficulties (p < 0.05), for both sleep quality and nightmare frequency.

**Conclusion:** These findings suggest that depression may be more influential than emotional dysregulation, in regards to causing poor sleep quality and nightmare frequency. Mirroring previous research, this outcome suggests that depression, perhaps due to its relationship with emotional dysregulation, may be partially responsible for nightmares in individuals with PTSD. These findings provide relevant information to clinicians treating individuals suffering from sleep-related problems. Future research should explore the potential reciprocal relationship between these factors.

### 0925

**POOR SLEEP QUALITY AT DISCHARGE AS A PREDICTOR OF READMISSION TO A PSYCHIATRIC PARTIAL HOSPITALIZATION PROGRAM**

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**Introduction:** Prospective longitudinal studies have demonstrated that insomnia is a risk factor for psychiatric disorders and suicidal ideation or behavior. This research highlights the importance of treating sleep disturbances to prevent new onset and future relapse of psychiatric illness. We had previously reported an improvement in sleep quality following treatment in a psychiatric partial hospitalization program. This study examines the long-term follow up over 18 months after discharge from this program to determine if poor sleep quality at discharge predicts early readmission into the program.

**Methods:** As part of a continuous improvement project from November 2007 to March 2009, the Pittsburgh Sleep Quality Index (PSQI) was completed by 183 patients at the time of entry into a VHA psychiatry partial hospitalization program and again at discharge. A retrospective chart review was conducted to examine predictors of readmission over an 18-month follow-up period.

**Results:** We found that poor sleep quality at discharge (defined by a PSQI score of ≥ 6) was significantly associated with readmission to the partial hospitalization program, with 13.2% of patients with poor sleep quality readmitted compared to 0% with good sleep quality. PSQI scores significantly predicted readmission over 18 months after controlling for covariates associated with mental health status, including total number of mental health diagnoses, employment status, marital status, age, gender and ethnicity (OR = 2.10).

**Conclusion:** Overall, we found that persistent sleep disturbance following intensive mental health treatment is predictive of recidivism and need for a higher level of psychiatric care. It may be particularly important to identify and treat residual sleep disturbances following intensive mental health treatment to reduce rates of relapse and readmission.
ASSOCIATION BETWEEN PSYCHOLOGICAL DISTRESS AND SLEEP DURATIONS: ROLE OF RACE/ETHNICITY

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Introduction: Short and long sleep duration are important public health burden in the United States. They are influenced by race/ethnicity and socioeconomic status. Little is known about the relationships between psychological health and short and long sleep across race/ethnicity. Our study examined the racial/ethnic influence on the relationship between psychological distress and sleep duration.

Methods: Data from the 2009 National Health Interview Survey (NHIS), N = 27,731 participants ages ≥ 18 years, were analyzed to investigate the associations of psychological distress with inadequate sleep duration, adjusting for socio-demographic factors, health risk behaviors, and chronic diseases. Short sleep was coded as 8 hours. Psychological distress (PD), based on Kessler’s 6 scale, assessed the frequency of feeling sad, nervous, restless, hopeless, worthless, and burdened over a 30-day period. Scores range from 0 to 24 and scores ≥ 13 likely indicate serious mental illness.

Results: Of the sample, 51.6% were female; 76.2%, White and 15.6%, Black/African-American, with a mean age of 35.79 ± 22.4 yrs. Of the sample, 8.1% of Blacks vs. 7.1% of Whites reported PD. Logistic regression analysis indicated that blacks and whites with PD have similar odds of reporting short sleep (Blacks: OR = 2.33, p < 0.05 and Whites: OR = 2.36, p < 0.05). However, different odds for long sleep were observed (Blacks: OR = 1.23, p < 0.05 and Whites: OR = 1.63, p < 0.05). These analyses adjusted for demographic, health risk behaviors, and chronic diseases. We also found discrepancies in the predictive model. For Whites, gender, marital status, family income, body mass index, arthritis, diabetes, hypertension, heart condition and PD predicted short sleep. For Blacks, only age, family income, hypertension and PD predicted short sleep.

Conclusion: Psychological distress was the strongest predictor of short and long sleep for both groups. PD and short and long sleep were more prevalent among blacks than among whites. Our study underscored the significant role of PD in racial/ethnic sleep disparities.

Support (If Any): This work was supported by funding from the NIH (R01MD007716, R01HL78566, R01HL78566, R01HL095799)

0928
SLEEP QUALITY AS A LINK BETWEEN NEIGHBORHOOD QUALITY AND PHYSICAL AND MENTAL HEALTH OUTCOMES IN A NATIONALLY REPRESENTATIVE SAMPLE

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Introduction: Perceived neighborhood quality has been linked to poor mental and physical health outcomes, but less is known about underlying mechanisms. Recent research suggests that neighborhood quality is associated with sleep outcomes. Furthermore, sleep is shown to have a pervasive impact on mental and physical health. Therefore, sleep may serve as a pathway to poorer health for individuals in disadvantaged neighborhoods. This study examines a meditated model of neighborhood quality and health outcomes in a population-based sample from mid- to late-adulthood.

Methods: An archival analysis used cross-sectional data from the Midlife in the United States-II study, Projects 1 and 4. The selected sample was comprised of 958 community-dwelling adults aged 34 to 84 years. Both perceived neighborhood quality and physical health were assessed with a self-report questionnaire. Depressive symptoms were assessed using the CES-D, and global sleep quality was measured using the PSQI.

Results: Multiple hierarchical regression analyses indicated neighborhood quality significantly predicted depressive symptoms, β = −0.25, p < 0.001, and self-reported health, β = −0.16, p < 0.001, after controlling for age, gender, race, and income. A Sobel test indicated that global sleep quality partially mediated the association of neighborhood quality with depressive symptoms (z = −4.13, p < 0.001) and self-reported health (z = −3.78, p < 0.001).

Conclusion: Poorer neighborhood quality predicted greater depressive symptomatology and worse self-rated physical health. However, the association between neighborhood quality and health was partially mediated by sleep quality.
mediated by global sleep quality, suggesting that sleep may serve as a pathway from poorer neighborhood quality to poorer health outcomes. Given that sleep is a salient and modifiable behavior, future research should focus on developing psychosocial interventions to improve sleep health in poorer quality neighborhoods.

0929
SLEEP QUALITY: A KEY COMPONENT TO OVERALL MENTAL AND PHYSICAL HEALTH AMONG FIREFIGHTERS
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Introduction: Firefighters face unique stressors and health risks due to their occupation (e.g., chronic trauma exposure, toxins, injury). Recent studies have shown that firefighters identify sleep deprivation as one of their most prevalent health concerns. However, it is unclear how poor sleep quality affects the physical and mental health of firefighters. This study is designed to explore the relationship between sleep quality and indices of mental and physical health among firefighters.

Methods: As part of a larger study, 127 firefighter paramedics (110 Males; 17 Females) completed self-report questionnaires including a demographic questionnaire, the Pittsburgh Sleep Quality Index (PSQI), the Posttraumatic Stress Disorders Checklist-Civilian (PCL-C), the Perceived Stress Scale (PSS) and the World Health Organization Quality of Life-BREF (WHOQOL-BREF).

Results: Preliminary analyses of the data show that PSQI total score is significantly correlated with the physical health component on the WHOQOL-BREF (r = 0.53, p < 0.001), ratings of stress on the PSS (r = 0.52, p < 0.001), endorsement of posttraumatic stress symptoms on the PCL-C (r = 0.54, p < 0.001), and the number of calls responded to per shift (r = 0.24, p < 0.01).

Conclusion: These results indicate that sleep quality is significantly related to the health of firefighters on several dimensions. Significant correlations observed between sleep quality and symptoms of posttraumatic stress and overall stress support that sleep and aspects of stress and trauma are related in this population. This relationship is consistent with the literature, which supports a link between sleep, stress and trauma in other professions that experience high levels of stress. Additionally, the finding that self-reported poor physical health was also related to poor sleep quality, suggests that firefighters who experience poor sleep are more likely to endorse physical health complaints. The literature suggests that firefighters who experience higher call volumes per shift experience greater stress and fatigue. The current study findings expand this further to include greater sleep impairment associated with higher call volumes. These preliminary findings support the role of sleep in the mental and physical health of firefighters and emphasize the need to evaluate further the role of sleep in this population.

0930
SLEEP DISTURBANCES AND DEPRESSION IN THE MULTI-ETHNIC STUDY OF ATHEROSCLEROSIS
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Introduction: While separate literatures have documented differences in the prevalence of sleep disturbances and depression by race/ethnicity, socioeconomic status (SES), and gender, to our knowledge, no studies to date have explored whether the association between sleep disturbances and depression substantially (or importantly) differs by these sociodemographic characteristics. Our aims were to examine the association of objectively- and subjectively-measured sleep disturbances with depression, and to explore if race/ethnicity, socioeconomic status, and sex modified these associations.

Methods: We analyzed cross-sectional data from community-dwelling adults enrolled in the Multi-Ethnic Study of Atherosclerosis Sleep Study. Sleep was assessed with actigraphy, polysomnography (PSG), and self-report. Depressive symptoms were assessed using the Center for Epidemiologic Studies Depression (CES-D) scale. We used generalized linear models with robust error variances to evaluate the association of sleep measures and depression (CES-D score ≥ 16) adjusting for site, socio-demographics, behavioral, and medical risk factors. Participants included 1,784 adults (ages 54–93), 36.8% non-Hispanic Whites, 28.0% African Americans, 23.7% Hispanics, 11.5% Chinese, 46.0% males, and 29.8% with ≤ high school education.

Results: Overall, 14.5% had depression, 29.3% had insomnia, 14.1% had excessive daytime sleepiness, 15.1% had severe obstructive sleep apnea, and 30.4% experienced short sleep (< 6 hours). Depression was associated with actigraphy-estimated short sleep duration (adjusted Relative Risk = 1.47 [95% CI = 1.11, 1.94]), PSG-estimated low proportion REM sleep [RR = 1.57 [95% CI = 1.08, 2.27]] and high proportion REM sleep [RR = 1.42 [95% CI = 1.03, 1.95]], self-reported insomnia [RR = 1.85 [95% CI = 1.41, 2.44]] and excessive daytime sleepiness [RR = 1.61 [95% CI = 1.19, 2.18]]. Insomnia was more strongly associated with depression among men compared to women. Short sleep duration was strongly associated with depression among those with more than a high school education.

Conclusion: Sleep disturbances are associated with depression among middle-aged and older adults, and these associations may be modified by education and gender. Future research should focus on the psychological mechanisms linking specific sleep dimensions to depression.

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0931
GENDER AND PSYCHOLOGICAL CORRELATES OF SHORT SLEEP DURATION AND POOR SLEEP QUALITY IN ADULTS WITH CORONARY HEART DISEASE: RESULTS FROM A NATIONAL SURVEY
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Introduction: Although the association between psychological factors and sleep has been well studied in the general population, research into the relationship between modifiable psychological factors and specific sleep deficiency dimensions in adults with coronary heart disease (CHD) is sparse. Further, research has often not examined how gender modifies the effect of psychological factors on sleep in CHD adults despite well-established evidence of effect modification.
Methods: We analyzed weighted cross-sectional data from a nationally representative online survey of US adults (n = 1441) who reported a doctor or health professional diagnosis of myocardial infarction (MI). Self-reported short sleep duration (< 7 hours) and poor sleep quality (fairly/very bad sleep) were measured with items from the Pittsburgh Sleep Quality Index. Self-reported anxiety sensitivity, depressive symptoms, and perceived stress were measured using the Anxiety Sensitivity Index, Patient Health Questionnaire-8, and Perceived Stress Scale-4, respectively. We used a modified Poisson regression with robust error variances to determine the independent association of each psychological factor with sleep, adjusting for age, race/ethnicity, gender, education, and number of MIs; we also tested gender*psychological factor interactions.

Results: In aggregate models, only depressive symptoms and perceived stress were independently associated with short sleep duration (depressive: RR = 1.02 [95% CI = 1.01, 1.04]; stress: RR = 1.03 [95% CI = 1.01, 1.05]) and poor sleep quality (depressive: RR = 1.08 [95% CI = 1.06, 1.09]; stress: RR = 1.06 [95% CI = 1.03, 1.09]). Gender was a significant effect modifier (p for interaction = 0.02) such that a unit increase in depressive symptoms resulted in higher RR of poor sleep quality among men (RR = 1.10 [95% CI = 1.09, 1.12]) versus women (RR = 1.08 [95% CI = 1.07, 1.10]).

Conclusion: Depressive symptoms and perceived stress are consistent correlates of short sleep duration and poor sleep quality in CHD adults. Men with CHD and depressive symptoms may be at greater risk for poor sleep quality, which may affect their medical prognosis. Future research should determine the causal relations between psychological vulnerabilities, sleep, and medical prognosis in CHD adults.

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0932 COMPLAINTS OF INSOMNIA, HYPERSONNIA AND FATIGUE IN DEPRESSIVE DISORDERS WITH MEDICAL COMORBIDITIES: A CASE-CONTROL STUDY FROM A NATIONALLY REPRESENTATIVE US SAMPLE

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Introduction: Insomnia, hypersomnia and fatigue are primary symptoms of depressive disease (DD) and are also associated with many medical disorders. This overlap of sleep-related symptoms can lead to difficulties in distinguishing depressive disorders (DD) from symptoms of medical conditions. We examined complaints of insomnia, hypersomnia and fatigue in patient visits with DD and one or more medical comorbidities (MC) (DD+MC group) (versus DD without a MC or DD-MC group), in a nationally representative sample from the US.

Methods: We examined data collected from 1995–2010 by the National Ambulatory Medical Care Survey and National Hospital Ambulatory Medical Care Survey; each patient visit was assigned up to 3 ICD9-CM diagnoses and up to 3 ‘Reasons for Visit’ (RFV) (coded as per National Center for Health Statistics or NCHS consensus). Variables included ‘Depressive Disorders’ (DD) denoting patient visits with ICD9-CM codes 296.2, 296.3, 296.82, 296.20–296.36 or 311; and ‘Medical Comorbidities’ (MC) denoting patient visits for any ICD9-CM diagnosis excluding Mental Disorders (ie., excluding ICD9-CM codes 290-299.9). A dichotomous ‘DD+MC’ versus ‘DD-MC’ variable denoted ‘Comorbid Depression’. A ‘Suicide’ variable (ICD9-CM codes E950-E959) was created to obtain an an index of depression severity. Sleep-related variables included ‘Insomnia’ (NCHS RFV code 1135.1), ‘Hypersomnia’ (NCHS RFV code 1135.2) and ‘Fatigue’ (NCHS RFV code 1015.0).

Results: There were 34,743 (representing an estimated ± SE: 381,533,965 ± 17,647,157) patient visits with DD; among these 44.4% (95% CI 42.3%-46.4%) had a MC. Logistic regression using ‘Comorbid Depression’ as dependent variable revealed ‘Fatigue’ (OR = 2.16, 95% CI 1.67–2.79) but not ‘Insomnia’ (OR = 0.93, 95% CI 0.72–1.20) or ‘Hypersomnia’ (OR = 1.25, 95% CI 0.63–2.49) was a significant predictor of ‘DD+MC’; after controlling for age (> 50 vs ≤ 50 years) (OR = 1.74, 95% CI 1.58–1.92), sex (female vs male) (OR = 1.31, 95% CI 1.18–1.44), all medications (OR = 1.88, 95% CI 1.59–2.23), race (‘white’ vs ‘non-white’) (OR = 0.77, 95% CI 0.66–0.91), and ‘Suicide’ (OR = 2.91, 95% CI 2.00–4.24).

Conclusion: Fatigue emerged as the only significant sleep-related predictor of DD+MC (when compared to DD-MC) in a model examining insomnia, hypersomnia and fatigue. This may help assess the relative contribution of medical comorbidity to sleep-related symptoms that are also encountered in depressive disorders. The higher rate of suicide in the depression group with medical comorbidity (‘DD+MC’ group) is consistent with the fact that depression severity generally increases with medical comorbidity; this further supports the representativeness of our study sample.

0933 POSTPARTUM HYPMANIA SYMPTOMS ARE ASSOCIATED WITH LATER SLEEP TIMING IN WOMEN AT RISK FOR POSTPARTUM DEPRESSION

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Introduction: Hypomanic symptoms in the early postpartum period are linked to a risk of postpartum depression (PPD). Although women experience profound sleep changes during the perinatal period and decreased sleep may precipitate mania/hypomania, links between hypomanic symptoms and sleep/circadian rhythms have not been studied at this life transition.

Methods: We studied 30 women (mean age 28.3 ± 5.3 years) with a history of major depression from 3rd trimester to 16 weeks postpartum. Potential participants who met criteria for a mood episode at enrollment (33 weeks gestation) were excluded. Participants rated hypomania symptoms on the Highs Scale (Glover et al., Br J Psych, 1994); depressive symptoms were measured with the Hamilton Rating Scale for Depression (HAM-D-17) at 2, 6, and 16 weeks postpartum. Sleep onset, sleep offset, and total sleep time (TST) were estimated with wrist actigraphy averaged over one week at 33 weeks gestation and postpartum weeks 2, 6, and 16. Salivary dim light melatonin (DLMO) was measured at 3rd trimester and 6 weeks postpartum.

Results: At postpartum week 2, average Highs score was 1.8 ± 2.0 (range = 0–8). The most common symptoms were racing thoughts (endorsed by 44.3%) and feeling more active than usual (endorsed by 30%). Two groups based on Highs Score at postpartum week 2 included a Euthymic Group (EG; n = 15) with Highs Scores < 2 (mean = 0.3 ± 0.5) and Hypomanic Symptom Group (HG; n = 15) with Highs Scores ≥ 2 (mean = 3.3 ± 1.6). At 3rd trimester and 2 weeks postpartum, HG women had later estimated sleep onset (Week 33: HG = 00:16 ± 66 min vs. EG = 22:47 ± 50 min, t = −4.15, df = 28, p < 0.001; Week 2: HG = 00:06 ± 80 min vs. EG = 23:11 ± 60 min, t = −2.12, df = 28, p = 0.04) and sleep offset times (Week 33: HG = 8:31 ± 85 min vs. EG = 7:22 ± 72 min, t = −2.41, df = 28, p = 0.02; Week 2: HG = 8:55 ± 101 min vs. EG = 7:47 ± 63 min, t = −2.18, df = 28, p = 0.04) than EG
women. DLMO tended to be later in HG (21:54 ± 95 min) compared to EG (20:53 ± 88 min; t = -1.73, df = 24, p = 0.09) at 33 weeks. There were no differences in sleep timing at 6 or 16 weeks postpartum; TST did not differ between groups at any time point. HAM-D-17 scores were higher in HG vs. EG at all postpartum weeks, even with sleep items excluded.

Conclusion: Self-reported hypomanic symptoms during the early postpartum are associated with later bedtimes and rise times at 3rd trimester of pregnancy and 2 weeks postpartum. Women with mixed depressive/hypomanic symptoms are more likely to experience PPD. Later sleep timing may be a modifiable risk factor for development of PPD.

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0934

SUBJECTIVE AND OBJECTIVE MEASURES OF SLEEP DURATION AND QUALITY IN MAJOR DEPRESSIVE DISORDER WITH COMORBID HYPSOMNOLENCE

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Introduction: Hypersomnia is commonly comorbid with Major Depressive Disorder (MDD) and is a significant cause of functional impairment. Prior research examining objective and subjective measures of hypersomnolence in patients with mood disorders has been inconsistent. The goal of this study was to assess sleep duration and quality among individuals with MDD and comorbid hypersomnia compared to healthy controls.

Methods: Nineteen unmedicated patients with unipolar MDD and hypersomnia and nineteen age- and sex-matched controls were recruited as part of a larger study on EEG biomarkers of hypersomnia in neuropsychiatric disorders. After initial screening, participants completed daily sleep logs and were monitored with wrist-worn actigraphy for a minimum of 1 week prior to ad libitum in-laboratory polysomnography (PSG). Sleep diary, actigraphy, and PSG data were compared between groups, and differences in total sleep time (TST) between sleep logs and actigraphy were compared using Bland-Altman analysis.

Results: Hypersomnolent MDD participants demonstrated increased TST compared to matched controls using sleep logs (8.37 ± 0.72 vs. 7.71 ± 0.71 hrs, p = 0.008), actigraphy (7.35 ± 0.63 vs. 6.85 ± 0.53 hrs, p = 0.015), and PSG (9.01 ± 1.63 vs. 7.45 ± 1.05 hrs, p = 0.001). All measures also demonstrated significantly increased time in bed in hypersomnolent MDD participants. Among sleep continuity variables, sleep onset latency was greater and sleep efficiency lower among hypersomnolent MDD subjects only when assessed using sleep diaries. Sleep staging using PSG differed between groups for N1 and N2, but not N3 or REM sleep. Bland-Altman analysis demonstrated both groups similarly overestimated subjective sleep time relative to actigraphy (mean difference 0.9 hours for both groups).

Conclusion: Our results demonstrate MDD patients with comorbid hypersomnolence demonstrate subjective and objective increases in sleep duration relative to healthy sleepers both in the natural environment and during unrestricted sleep in the laboratory setting. Further research is indicated to determine the cause of increased sleep duration in this patient population.

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0935

SLEEP EEG CHARACTERISTICS OF PATIENTS WITH SCHIZOPHRENIA

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Introduction: In current study, we aimed to investigate sleep EEG characteristics of schizophrenia via quantitative spectral power analysis.

Methods: A standard nocturnal polysomnography was performed to 7 schizophrenic patients on medications (SPR, 31.4 ± 14.1 yrs; 4 males) and age-matched 15 healthy controls (CON, 37.8 ± 10.8 yrs; 4 males) at the Center for Sleep and Chronobiology of Seoul National University Hospital. For each 30 s epoch, spectral power in delta (0.5–4.5 Hz), theta (4.5–8 Hz), alpha (8–12 Hz), beta1 (12–15 Hz), beta2 (15–32 Hz), slow sigma (11–13 Hz), and fast sigma (13–17 Hz) frequency bands were calculated. Time series of EEG delta power were rescaled and averaged into 10 periods to assess differences in dynamical sleep structures in the two groups.

Results: The sleep efficiency and REM sleep were significantly reduced in SPR, compared to CON (%: 80.3 ± 8.1 vs. 88.8 ± 6.1, p = 0.01; 17.2 ± 8.0 vs. 22.7 ± 4.1, p = 0.04, respectively). The onset of REM sleep was delayed in SPR (minutes, 161.4 ± 52.1 vs. 97.8 ± 29.4, p < 0.01). Alpha, beta1 and slow sigma power of SPR were significantly decreased in SPR than in CON (%: 2.2 ± 1.2 ± 3.9 ± 1.6; 1.0 ± 0.5 ± 1.7 ± 0.5; 0.7 ± 0.3 vs. 1.3 ± 0.5, p = 0.02, p = 0.01 and p = 0.02, respectively). There were no significant differences in delta, theta, beta2 and fast sigma powers between the two groups. However, SPR group showed enhanced delta power in early night sleep (i.e., 72.7 ± 6.7 vs. 50.6 ± 4.8, p = 0.01 during the second 50 min).

Conclusion: Our results suggest that patients with schizophrenia showed distinctive sleep EEG activities from healthy controls on power of spectrums and time courses of EEG delta power. Enhanced EEG delta power during the early sleep period may be related with delayed REM sleep onset in SPR. These EEG characteristics may be associated with neurocognitive impairment or medication effects in patients with schizophrenia.

0936

REM SLEEP MARKERS OF EMOTIONAL FACE MEMORY CONSOLIDATION IN TYPICALLY DEVELOPED AND AUTISTIC CHILDREN

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Introduction: REM sleep is involved in emotional memory processing. We tested the relationship between REM sleep markers and memory consolidation in autistic (AUT) and typically developing (TD) children.
Methods: Twenty-six boys (13 AUT:10.23 ± 2.09 years, 13 TD:10.23 ± 2.01 years) were recorded for two consecutive nights. Recall of previously unknown faces showing positive, negative or neutral emotions was assessed before/after night 2 (immediate/delayed recall). Improvement scores (delayed recall performance minus immediate recall performance) on accuracy (AIS) and reaction time (RTIS) were calculated for total hits and each emotion type. REM sleep duration, REM density and EEG activity (Beta and Theta bands; P7, P8, O1, O2 electrodes) were computed for night 2. Groups were compared with t-tests and correlations between REM sleep measures and improvement scores were tested with Pearson’s r.

Results: No group differences for REM sleep duration, REM density, Beta EEG activity. AUT showed more Theta activity than TD at P7 (45.79 ± 72.11 vs. 21.50 ± 12.43) and longer reaction times for delayed recall of neutral faces (1353.35 ± 484.38 vs. 1006.99 ± 308.61). TD showed positive correlations between AIS for neutral emotions and EEG at every electrodes (Beta: 0.58 to 0.73; Theta: 0.58 to 0.66) and a positive correlation between RTIS over total trials and REM density (r = 0.58). AUT children showed different patterns: positive correlations between RTIS for negative emotions and Beta activity at P7, P8, O2 (0.62 to 0.63) and a positive correlation between RTIS for positive emotions and theta O1 activity (r = 0.56).

Conclusion: TD and AUT children showed a relationship between REM sleep and emotional memory. Results suggest an atypical sleep processing of emotional memory in autism.

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0937 DIFFERENCES IN RAPID-EYE-MOVEMENT SLEEP PRESSURE BETWEEN HIGH AND LOW RUMINATORS

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Introduction: Both individuals with depression and never-depressed at-risk probands show evidence of elevated rapid-eye movement (REM) sleep pressure, including increased REM density and reduced REM latency. Depressed individuals also show greater activation in the hippocampus, basal forebrain, medial prefrontal cortex, and anterior cingulate cortex from waking to REM sleep. Over-activation of these limbic systems during REM sleep may thus be a biomarker of the intense affect states characteristic of depression. Given the role of rumination in potentiating negative affect, rumination may account for the REM pressure observed in depression. Yet, the impact of rumination on REM sleep has never been studied.

Methods: A sample of 15 young adults (26 ± 9.2 yo; 64.7% female) with DSM-IV based insomnia were divided into groups of high (n = 7) and low (n = 8) ruminators via median-split on a trait measure of rumination (RRS-R: Response Style Questionnaire-Rumination Scale). Following an adaptation night, all participants completed an overnight polysomnography study, including eight scalp electrodes (F3, F4, C3, C4, P3, P4, O1, O2) with placement according to the International 10-20 system.

Results: High-ruminators had significantly shorter (t = 2.29; p < 0.045; Cohen’s d = 1.27) REM latencies (42.4 ± 26.1 min) than low-ruminators (82.7 ± 41.1 min). Notably, MDD severity on the Beck Depression Inventory-II (BDI-II) did not differ significantly between groups (t = 1.41; p = 0.18). Similarly, differences in REM density during the first REM period between groups approached significance (t = −2.13; p = 0.054), with high-ruminators experiencing higher REM density (2.5 ± 0.7) than low-ruminators (1.7 ± 0.6).

Conclusion: These data suggest that high ruminators exhibit signs of heightened REM pressure, independent of depression severity. This study thus offers preliminary evidence linking REM sleep to rumination processes, a finding that could help integrate sleep and cognitive models of depression.

0938 EFFECTS OF A MINDFULNESS-BASED DEPRESSION RELAPSE PREVENTION PROGRAM ON QUANTITATIVE SLEEP EEG

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Introduction: While meditation training has been associated with subjective improvements in sleep in a number of studies, polysomnography assessment has demonstrated several indices of increased arousal during sleep, proportional to the amount of meditation practice. However, the generalizability and functional significance of these effects remain unclear. This secondary analysis evaluated changes in quantitative sleep electroencephalography (EEG) following mindfulness meditation training in unmedicated individuals with partially remitted depression.

Methods: Nineteen-channel sleep EEG was evaluated with spectral analysis in 12 participants (9 female; age 44.2 ± 6.3 years) randomized to 8-week mindfulness-based cognitive therapy (MBCT) and 8 (waitlist) controls (7 female; age 48.1 ± 8.9 years). All participants were medication-free for at least 2 months and reported a lifetime history of at least 3 major depressive episodes with improvement in symptoms within the past 2 months, with varying degrees of residual symptoms, including persisting insomnia complaints. Between-group differences in EEG changes were assessed via 2-way mixed-model ANOVA’s and linear correlation.

Results: MBCT was associated with a significant increase in occipital gamma (30–40 Hz) power during all-night NREM sleep (p < 0.05). In addition, a significant decrease in NREM spindle-range (12–16 Hz) power was found for the MBCT group (p < 0.05), most prominently in frontal channels in the lower subrange (~12–14 Hz) and proportional to the increase in number of NREM awakenings from pre- to post-intervention.

Conclusion: These results corroborate and extend previous findings of increased arousal during NREM sleep associated with meditation training. EEG effects emerged in individuals with baseline sleep complaints undergoing a relatively short amount of cumulative meditation training (~40 total hours across 8 weeks), evident in gamma and spindle frequency ranges. Potential implications for physiological sleep maintenance, sleep quality, and cognitive functioning are discussed.

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0939
EXPANDED TOPOGRAPHY OF SLOW WAVE ACTIVITY DYNAMICS IN DEPRESSED MALE AND FEMALE ADOLESCENTS; PRELIMINARY FINDINGS
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Introduction: Gender differences in sleep homeostasis, as reflected by slow wave activity (SWA) dynamics, have been reported in adolescent depression, with indications of decreased sleep pressure and dissipation in males but not in females. While previous studies have focused on SWA in the central derivation, this study assessed SWA dissipation across the parasagittal axis.

Methods: Forty-five drug-free outpatients with major depression (64% females; mean ± SD: 16.8 ± 8.0 y.o.) and 39 healthy controls (48% females, mean ± SD = 17.3 ± 8.0 y.o) completed the Quick Inventory of Depressive Symptomatology (QIDS) and underwent two nights of polysomnography. SWA (0.5–4 Hz) in F4, C4, P4, and O2 was modeled using an exponential decay function. The y intercept, decay rate and plateau were compared across clinical groups using corrected Akaike’s information criterion (AICc). Within the depression subgroup, correlations were conducted between QIDS scores and SWA for each sleep cycles.

Results: Significantly higher y intercepts were found in the depressed compared to the controls for both females and males in F4 (AICc differences of 1.740 and 0.68, probability of 70.5% and 58.4% respectively), and for females in C4 (AICc difference of 0.12 and probability of 51.5%). There was no other significant group difference for dissipation curve parameters. In depressed females, significant correlations were found between QIDS scores and SWA in the first sleep cycle for C4 (r = 0.41, p = 0.026), with a similar trend for F4 (r = 0.35, p = 0.061), and in the fourth sleep cycle for F4, C4 and P4 (all r > 0.40, p < 0.050).

Conclusion: These preliminary findings suggest that depressed adolescents present higher initial levels of SWA in anterior cortical regions, and that this effect may be slightly more pronounced in females Importantly, in females, higher depression severity may be linked to higher sleep pressure at the beginning of the night and poorer subsequent sleep recovery.

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0940
SLEEP-RELATED COGNITIONS IN INDIVIDUALS WITH INSOMNIA AND DEPRESSIVE SYMPTOMS
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Introduction: Depression has been identified as the most common condition comorbid to insomnia, with findings pointing to the possibility that these disorders may be causally related to each other or may share common mechanisms. Comorbid symptoms of insomnia and depression may have a different clinical course than either alone, and may thus require specific treatment procedures. In this report we examined the clinical characteristics of individuals referred to an academic sleep center, most of whom were referred for obstructive sleep apnea (OSA). We identified differences between individuals with comorbid symptoms of insomnia and depression from those with symptoms of insomnia alone with regard to several cognitive-related variables.

Methods: Logistic regression analyses examined whether the past week worry, dysfunctional beliefs about sleep, and insomnia-related ruminations differentiated individuals with symptoms of insomnia and depression (Insomnia Severity Index (ISI) ≥ 11 and Quick Inventory of Depressive Symptomatology (QIDS) > 10) from those with symptoms of insomnia alone (ISI < 11 and QIDS ≤ 10).

Results: Individuals with symptoms of both insomnia and depression reported more dysfunctional beliefs about sleep, past week worry, and insomnia-related ruminations than those with symptoms of insomnia alone. Only the effect of insomnia-related rumination remained significant after controlling for a continuous variable assessing mental health severity (Exp(B) = 1.085, p < 0.001). When including all three cognitive-related variables in our model, those with comorbid symptoms reported more severe insomnia-specific ruminations (Exp(B) = 1.082, p = 0.001), even when controlling for insomnia and mental health severity, among other relevant covariates.

Conclusion: The findings contribute to our understanding of the complex nature of comorbid sleep and mood disturbance, and the specific symptom burden experienced by those with comorbid symptoms. The findings also highlight the need for increased clinical attention to the sleep-focused rumination reported by these patients. Since the vast majority of individuals in this sample were referred for OSA, the implications of these findings for OSA treatment will be explored.

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0941
WHAT MAKES POOR SLEEPERS ANXIOUS AND DEPRESSED? AN EXPLORATION OF PSYCHOLOGICAL MECHANISMS UNDERLYING THE EFFECT OF POOR SLEEP ON NEGATIVE MOOD SYMPTOMS
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Introduction: Poor sleep is considered as a transdiagnostic feature across psychopathologies. Psychological intervention on sleep problems is also shown to improve negative mood symptoms. Yet, the underlying psychological mechanisms between poor sleep and negative mood symptoms were unspecified. We aimed to explore the mediating role of some psychological constructs shown to associate with both mood and sleep problems in the sleep-mood relationship.

Methods: A cross-sectional design in which participants (n = 114, aged 17–24, 60.7% female) completed measures of sleep (Insomnia Severity Index), depressed and anxious mood (Depression Anxiety Stress Scale) and psychological constructs, including acceptance and psychological flexibility (Acceptance and Action Questionnaire), sleep-related negative belief and attitude (Dysfunctional Belief and Attitude about Sleep) and subjective complaints on cognitive function (Cognitive Failure Questionnaire).

Results: Poor sleep was found to significantly predict lower acceptance and psychological flexibility, standardized coefficient (beta) = −0.367, p = 0.001, more sleep-related negative belief and attitude, beta = 0.329, p = 0.002, and more subjective complaints on cognitive functions, beta = 0.425, p < 0.001. With poor sleep in the previous step of a hierarchical regression model, 1)acceptance and psychological flexibility remained to significantly predict lower anxious, beta = −0.519, p < 0.001, and depressed mood, beta = −0.600, p < 0.001; 2)subjective complaints on cognitive function also predicted higher anxious, beta = 0.500,
p < 0.001, and depressed mood, beta = 0.429, p < 0.001; Results from Sobel tests suggested that poor sleep’s relationships with anxious and depressed mood were mediated by acceptance and psychological flexibility (anxiety: z = 2.901, p = 0.004, depression: z = 3.019, p = 0.003) and subjective complaints on cognitive function (anxiety: z’ = 3.160, p = 0.005, depression: z’ = 2.820, p = 0.002). No other significant results were noted.

**Conclusion:** From a non-clinical sample, our findings suggested that lower acceptance and psychological flexibility, as well as more subjective cognitive complaints were candidate mediators explaining the effect of poor sleep on negative mood. We provided foundation for longitudinal studies to further assess the directional relationships among poor sleep, mood problem and the associated psychological mechanisms.

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**0943**

**AFFECTIVE RESPONSE TO DAYTIME TRAUMA CUES PREDICTS ANXIETY AND DEPRESSION RATINGS DURING A NIGHT OF SLEEP DEPRIVATION**

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**Introduction:** A breadth of work has demonstrated strong associations among trauma exposure, PTSD, poor sleep, and elevated levels of affective responding. However, less work has examined the association between affective responses to daytime trauma cues and affective symptoms experienced during a night of sleep deprivation. The purpose of the current study was two-fold: (1) examine the association between affective responding to daytime trauma cues and average mood and anxiety symptoms experienced over a night of sleep deprivation; and (2) examine the pattern of mood and anxiety symptoms experienced during a night of sleep deprivation.

**Methods:** Participants were 20 trauma-exposed adults without PTSD. Individuals completed script driven imagery (SDI) of a personalized trauma script before and after a night of acute sleep deprivation. During SDI, ratings of 6 affective responses were made: anxiety, anger, sadness, surprise, happiness, and disgust. During the night of sleep deprivation ratings of mood and anxiety symptoms were completed hourly.

**Results:** In terms of Aim 1, anxious responding to SDI predicted greater mean anxiety and depression ratings over the night of sleep deprivation. In addition, disgust responding to SDI predicted greater mean anxiety symptoms during sleep deprivation. Anger, surprise, happiness, and sadness responding to SDI were unrelated to average mood and anxiety symptoms. In terms of Aim 2, repeated measures ANOVAs indicated that anxiety symptoms increased in a linear pattern over the course of sleep deprivation, while depression symptoms did not significantly change.

**Conclusion:** Anxious and disgust responses to trauma cues predicted elevated levels of anxiety during a night of sleep deprivation. In addition, anxiety symptoms (but not depression) increased in a significant linear pattern during sleep deprivation. Results will be discussed in terms of clinical implications.

**Support (If Any):** NIH F31 (Babson)

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**0944**

**ASSOCIATION OF POSTTRAUMATIC STRESS DISORDER SEVERITY TO REM AND SLOW WAVE SLEEP AMONG SURVIVORS OF INTERPERSONAL VIOLENCE**


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**Introduction:** PSG characteristics that most consistently distinguish the sleep of patients with PTSD from the sleep of controls are increased REM arousals, diminished REM time and, to a lesser extent, reductions in slow wave sleep (SWS). We sought to compare PSG variables with PTSD severity, among a sample of PTSD patients, hypothesizing that only REM and SWS abnormalities would be associated with PTSD severity.

**Methods:** Data were collected from a court-based sample of survivors of interpersonal violence who met diagnostic criteria for PTSD (N = 53). Participants completed the Clinician-Administered PTSD Scale (CAPS) at baseline followed by one night of laboratory PSG. Para-
Participants with AHI > 10 were excluded. Linear regressions were used to determine the relationships between baseline CAPS severity scores and sleep disturbances in REM and SWS.

**Results:** The mean (SD) baseline CAPS severity score was 66.8 (12.3). The sample had the following mean (SD) minutes of sleep by stage: N1 of 37.5 (19.6); N2 of 195.7 (52.3); N3 of 70.8 (38.8); and REM of 68.9 (27.2). Total sleep time was 372.9 (57.1) minutes, sleep efficiency was 87.2% (10.2%) and REM latency was 100.0 (56.9) minutes. We found significant negative relationships between baseline CAPS and minutes in REM (β = −0.29, p < 0.05) as well as with arousals in REM (β = −0.32, p < 0.05). The relationships between baseline CAPS and REM latency (β = 0.19, p = 0.18) as well as SWS minutes (β = 0.06, p = 0.66) were not significant.

**Conclusion:** As expected, there were few associations between PTSD severity and PSG variables. We did observe that higher baseline CAPS scores predicted less REM time, but we did not expect higher CAPS scores to predict fewer REM arousals. It is possible that PTSD status, rather than PTSD severity, is more robustly associated with REM and SWS abnormalities.

**Support (If Any):** This work is supported by R01 NR013909-01.

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**0945**

**SLEEP AND EXPRESSIVE SUPPRESSION: INDEPENDENT PREDICTORS OF PTSD SYMPTOM SEVERITY IN A SAMPLE OF MILITARY VETERANS ENGAGED IN RESIDENTIAL TREATMENT**

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**Introduction:** Empirical study has consistently demonstrated that poor sleep quality and emotion dysregulation are related to elevated PTSD symptom severity. Indeed, poor sleep quality has been shown to positively predict PTSD symptom severity, with sleep interventions for individuals with PTSD and co-occurring insomnia associated with improved sleep and PTSD outcomes. Concurrently, research has demonstrated that increased use of expressive suppression, a maladaptive emotion regulation strategy used to inhibit emotional expression, is uniquely associated with elevated PTSD symptom severity. Taken together, these independent lines of work have highlighted poor sleep quality and expressive suppression as substantial predictors of PTSD. However, the integration of these two separate lines of research for the purpose of determining the incremental associations of both sleep quality and expressive suppression in terms of PTSD symptom severity, particularly within the context of treatment, has yet to be examined in the literature. Therefore, the present study sought to determine the incremental associations of changes in sleep quality and the use of expressive suppression, over the course of residential PTSD treatment, in terms of PTSD symptom severity at treatment discharge.

**Methods:** Participants were 87 (Mage = 43.9, SD = 14.5) military veterans enrolled in a residential PTSD program at a large VA medical center. Participants completed a series of questionnaires including the Pittsburgh Sleep Quality Index and the Emotion Regulation Questionnaire at treatment intake and discharge.

**Results:** Improvement in sleep quality and a reduction in the use of emotional suppression were independently associated with lower PTSD symptom severity at discharge after accounting for each other and PTSD symptom severity at treatment intake (all p’s < 0.05).

**Conclusion:** Data suggests that targeting both sleep quality and emotion regulation within the context of treatment may optimize PTSD treatment outcomes for veterans.

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**0946**

**UNDERSTANDING RECURRENT POSTTRAUMATIC NIGHTMARES: VARIABLES CONTRIBUTING TO NIGHTMARE SYMPTOMATOLOGY**

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**Introduction:** Although sleep disturbance is a prominent feature of PTSD, its phenomenology and factors associated with posttraumatic nightmares, in particular, are not well understood. Prior research has identified higher PTSD severity, vigilance, lower unit support and reduced distraction skills as predictive of more severe general sleep disturbance. This study examined factors that may characterize those Veterans with persistent nightmare symptoms.

**Methods:** Participants were 108 male and female (14%) OEF/OIF/OND Veterans with PTSD, insomnia, and recurrent nightmares in a RCT of sleep and nightmare treatments. We assessed baseline independent variables (clinician-rated PTSD severity adjusted for nightmare symptoms, depression, deployment-related experiences, demographics) to predict nightmare symptoms: frequency (NFQ) and distress (NDQ).

**Results:** Nightmare frequency was significantly associated with PTSD severity, combat exposure (r = 0.27, 0.28, p < 0.01), and decreased post-deployment social support (r = −0.20, p < 0.05). Nightmare distress was significantly correlated with PTSD, depression, perceived threat during deployment, combat exposure and post-deployment stressful events (r = 0.32, 0.30, 0.33, p < 0.01; r = 0.21, 0.22, p < 0.05, respectively). After adjusting for demographics, PTSD (B = 0.08, SE = 0.03, p = 0.01) and combat exposure (B = 0.31, SE = 0.15, p = 0.05) were significant predictors of nightmare frequency; depressive symptoms (B = 0.15, SE = 0.087, p = 0.03) significantly predicted nightmare distress in regression analyses. These factors accounted for 25% of the variance in nightmare frequency and 28% in nightmare distress.

**Conclusion:** Nightmare frequency and nightmare distress had different predictors. While nightmare frequency was associated with PTSD severity and combat exposure, nightmare distress (the common impetus for treatment-seeking) was predicted only by the depression severity. Results emphasize the importance of distinguishing between nightmare frequency and nightmare distress. Results also suggest that alleviating nightmare distress may improve posttraumatic mood disturbance and treating depression may reduce nightmare distress.

**Support:** Department of Defense

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**0947**

**EXAMINING THE RELATIONSHIP BETWEEN PTSD SYMPTOM CLUSTERS AND INSOMNIA SYMPTOMS IN A VETERAN SAMPLE**

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**Introduction:** Insomnia occurs in 66–90% of individuals with posttraumatic stress disorder (PTSD). Despite research examining the relationship between overall PTSD severity and insomnia severity, the relationship between PTSD symptom clusters (e.g., re-experiencing) and insomnia symptoms (e.g., trouble falling asleep) has yet to be examined.

**Methods:** Participants were 46 Veterans with PTSD and alcohol use disorder consented for a longitudinal treatment study (Age = 40.78 ± 10.97; 89.1% male). Baseline assessments of sleep included Insomnia Severity Index (ISI; n = 46) and sleep diary variables (n = 29): sleep latency (SL), wake after sleep onset (WASO), time in bed after wake (TIBW), and sleep efficiency (SE), averaged over one week. PTSD measures included the DSM-5 Clinician Administered PTSD Scale (CAPS) sub-
scales (re-experiencing, avoidance, negative alterations in cognitions and mood, and hyperarousal) with the trouble sleeping item removed. Multiple regressions were used to examine the relationship of CAPS symptom clusters, controlling for alcohol use in the past 90 days, on sleep variables. 

**Results:** Veterans reported moderate insomnia (ISI = 16.82 ± 7.18; SL = 51.79 ± 51.38; WASO = 47.18 ± 37.30; TIBW = 47.71 ± 69.80; SE = 74.37 ± 17.72) and PTSD (CAPS = 40.46 ± 13.71). The total CAPS only related to the ISI (β = 0.40, p = 0.02). When the CAPS was broken into symptom clusters, hyperarousal (β = 0.41, p = 0.01) accounted for the relationship to the ISI and approached significance (β = 0.40, p = 0.057) with SL. Avoidance approached significance (β = 0.40, p = 0.055) with WASO.

**Conclusion:** The relationship between overall PTSD severity and insomnia severity was most accounted for by hyperarousal. PTSD hyperarousal also associated with trouble falling asleep; being on guard and being aroused by sounds in the night may partially account for trouble with SL. PTSD avoidance was related to WASO suggesting that avoiding memories and reminders of the trauma event may manifest itself with middle of the night awakenings. Given the cross sectional data, it is also feasible that WASO leads to higher daytime avoidance. The approaching significance of hyperarousal and avoidance is most likely due to lack of power with smaller Ns on the sleep diaries.

**Support (If Any):** Center of Excellence for Stress and Mental Health

#### 0948

**DETERMINANTS OF POSITIVE RESPONSE TO COGNITIVE BEHAVIORAL THERAPY FOR POSTTRAUMATIC STRESS DISORDER: EXAMINING SLEEP DISORDERED BREATHING AND OTHER PATIENT AND CLINICAL CHARACTERISTICS**

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**Introduction:** Sleep disordered breathing (SDB) is highly prevalent in veterans with posttraumatic stress disorder (PTSD), yet research suggests it is largely unassessed in mental health clinics. SDB is associated with chronic partial sleep deprivation, which may lead to avoidance of effortful tasks and cognitive performance deficits. Approximately 50–60% of patients who start cognitive behavioral therapy (CBT) for PTSD continue to meet PTSD criteria at the end of treatment. As such, we explored whether SDB in combination with other factors is consistently associated with response to CBT for PTSD.

**Methods:** Across two VA sites, we examined 34 Veterans at baseline and 30-days after receiving CBT for combat-related PTSD with trained VA providers. We employed a novel analytic technique, fuzzy-set qualitative comparative analysis, to identify combinations, or recipes, of fuzzy (f) and crisp (c) factors that achieve a clinically significant outcome, based upon Clinician Assessment of PTSD Scale scores. The factors examined included: (1) moderate SDB based on the apnea hypopnea index (f); (2) Vietnam War era (c); (3) prescription of a sedating medication (c); and (4) severe depression based on the Hamilton Depression Rating Scale-17 (f).

**Results:** The following three recipes were consistently associated with clinically significant response of PTSD to CBT: (1) Vietnam era veterans, without sedating medication, and without moderate SDB; (2) Veterans from other military conflicts, without severe depression but with sedating medication; (3) Veterans from other military conflicts with severe depression and moderate SDB but without sedating medication. Together, these recipes accounted for 50% of membership in the clinically significant PTSD response set.

**Conclusion:** Both the presence and absence of sleep apnea, severe depression symptoms, and combat era all play a role in PTSD outcomes in different combinations. These results provide valuable information about treatment response that may elaborate and clarify theory incorporating SDB as an important component for CBT response in some Veterans with PTSD.

**Support (If Any):** Department of Defense #W81XWH-10-1-0745

#### 0949

**PHYSIOLOGICAL HYPERAROUSAL IN MILITARY COUPLES: ASSOCIATIONS WITH PTSD AND SLEEP QUALITY**

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**Introduction:** Posttraumatic stress disorder (PTSD) is considered a disorder of hyperarousal, but scant research has evaluated physiological hyperarousal in PTSD, and most has focused on waking measures. Servicemembers are at high-risk for PTSD and sleep disturbances. Less is known about PTSD or sleep problems in military spouses, but they also may be a high-risk group. We examined the association between PTSD and sleep quality and nocturnal physiological hyperarousal in military couples.

**Methods:** Participants were male veterans and their spouses/partners (N = 50 individuals; Mean age = 30.3). Continuous electroencephalogram (EEG) and electrocardiogram (EKG) data were collected during in-home polysomnography (PSG) in both members of the couple. Hyperarousal measures included delta and beta activity, and parasympathetic tone (indexed by respiratory sinus arrhythmia; RSA), derived from spectral analysis of the EEG and EKG, respectively. Lifetime PTSD was evaluated using the Clinician Administered PTSD Scale (CAPS; Mean = 53.96). Sleep quality was measured using the PSQI (Mean = 4.85). Covariates included age, sex, body mass index, and depressive symptoms.

**Results:** Higher PTSD was associated with lower delta activity (B = −0.44; p = 0.005) and higher beta (B = 0.51; p = 0.001), but was not significantly associated with nocturnal RSA. PSQI scores were inversely associated with delta activity (B = −0.31; p = 0.06) as well as non-REM RSA (B = −0.16; p < 0.05) and REM RSA (B = −0.19; p < 0.05), and positively associated with beta activity (B = 0.34; p < 0.05), indicating that poorer sleep quality is associated with increased EEG arousal and decreased parasympathetic tone during sleep.

**Conclusions:** PTSD was associated with increased EEG arousal but not parasympathetic tone. Poorer sleep quality was associated with higher EEG arousal and lower parasympathetic tone. These findings extend our understanding of the relationship between PTSD and subjective sleep quality and physiological arousal mechanisms. Findings also highlight the importance of considering the impact of stress and trauma on servicemembers as well as their spouses and families.
B. Clinical Sleep Science

0950
SLEEP ONSET LATENCY AS A PROXY OF INSOMNIA SEVERITY IN THE CHARACTERIZATION OF VETERAN’S POSITIVE PTSD PSYCHOTHERAPY OUTCOMES

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Introduction: Insomnia is common amongst veterans in outpatient clinics and in posttraumatic stress disorder (PTSD). Consequences of insomnia, such as difficulty with response inhibition and emotion regulation, may negatively affect treatment response. Only about 40–50% of patients receiving Cognitive Behavioral Therapy (CBT) for PTSD achieve remission; therefore, we explored whether sleep onset latency in combination with other variables would consistently be associated with CBT for PTSD response.

Methods: The present study evaluated response of PTSD symptoms to CBT for PTSD in 34 veterans at two VA sites (Southern Arizona and Phoenix VA Health Care Systems). Fuzzy-set qualitative comparative analysis was used to create logically simplified recipes for clinically-significant symptom reduction on the Clinician Assessment for PTSD Scale (CAPS). Characteristics of interest from baseline measures were: (a) severe insomnia (fuzzy set, sleep onset latency (SOL) on the daily sleep diary); (b) Vietnam War era (crisp set); (c) sedating medications (crisp set); and (d) severe depression (fuzzy set, Hamilton Depression Rating Scale-17).

Results: The following four recipes contained characteristics consistent with positive PTSD outcomes: (1) Vietnam era with absence of prolonged SOL and absence of sedating medication; (2) Vietnam era with absence of prolonged SOL and with presence of severe depression; (3) non-Vietnam era with sedating medication and absence of severe depression; (4) absence of prolonged SOL, absence of sedating medication and presence of severe depression. These four recipes comprised 53% of the total sample exhibiting positive PTSD response.

Conclusion: Clinically-significant PTSD symptom reduction may result from a variety of factors in different combinations. These recipes may help explain variable response to CBT for PTSD in veterans. Three of the four recipes included absence of long SOL (29% of participants with positive outcome), which supports theory that treatment of insomnia may aid PTSD treatment response.

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0951
SLEEP DISTURBANCE MEDIATES THE ASSOCIATION BETWEEN PTSD SYMPTOMS AND PARENTING BEHAVIOR IN OIF/OEF SERVICE MEMBERS

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Introduction: Prolonged and repeated operational deployments take a considerable toll on service members and their families. Deployment is associated with increased rates of marital conflict and domestic violence (Ruscio et al., 2002) as well as child neglect and maltreatment (Gibbs et al., 2007). These negative family-related effects are often a byproduct of service members own clinically-significant distress (Saltzman et al., 2011). For example, greater PTSD symptoms predict poorer post-deployment parenting behaviors (Gewirtz et al., 2010). Although sleep problems are among the most common and impairing post-deployment complaints, associations with parenting have not been examined.

Methods: Participants were recruited from an ongoing study and included 18 U.S. military service members deployed as part of OIF/OEF, their spouses/partners, and 31 of their children ages 2 to 17 (M = 10.22, SD = 4.31). Services members represented a range of military branches and components. Questionnaires were filled out by each family member and completed by mail. We specifically examined whether associations between PTSD symptoms and post-deployment parenting behaviors are mediated by the presence of sleep disturbance (in the service member).

Results: Ordinary least squares regression with bootstrapping (10,000 samples) was used to estimate the indirect effect of PTSD symptoms on the use of corporal punishment through sleep disturbance (Hayes, 2013). PTSD symptoms predicted greater sleep disturbance (a = 0.196, p = 0.001), which in turn predicted greater use of corporal punishment (b = 0.077, p = 0.022). Whereas there was not a direct effect of PTSD symptoms on the use of corporal punishment (c’ = −0.005, p = 0.656), results revealed the hypothesized indirect effect through sleep disturbance, ab = 0.015; 95% CI [0.002, 0.049].

Conclusion: These findings suggest that sleep disturbance may be a critical mechanism through which PTSD symptoms influence parenting behavior post-deployment, particularly the use of corporal punishment. These results have significant implications for effectively targeting sleep problems in service members following periods of deployment.

0952
PTSD DIAGNOSIS IS ASSOCIATED WITH REDUCED PARASYMPATHETIC ACTIVITY DURING SLEEP IN US MILITARY PERSONNEL OF THE IRAQ AND AFGHANISTAN WARS

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Introduction: Impaired parasympathetic function and posttraumatic stress disorder (PTSD) are both associated with increased risk of cardiovascular disease (CVD). In addition, PTSD has been associated with attenuated parasympathetic activity during wakefulness, and poor sleep quality. The goal of the present study was to examine parasympathetic activity during sleep in service members of recent military conflicts. Parasympathetic activity was derived from a measure of high frequency period activity from heart rate variability (HRV), which allows continuous/non-invasive assessment of autonomic function during sleep.

Methods: Sixty-four military service members (M age = 32.29 years, 87.3% male, 88.9% Caucasian, BMI = 27.84, and 46% with PTSD) completed 2 consecutive polysomnographic study nights with concurrent assessment of HRV. Average HF-HRV was calculated for all epochs of NREM (N2, N3) and REM sleep. Self-report measures included the Pittsburgh Sleep Quality Index and PTSD Addendum (PSQI and PSQI-A), and the Insomnia Severity Index (ISI).

Results: Participants with PTSD reported significantly more trauma-related sleep disturbances (p < 0.001) on the PSQI-A and greater insomnia severity (p < 0.01) on the ISI. Only trend significance was found for differences between groups on PSG-derived sleep variables. Participants with PTSD trended towards greater percentage of NREM (p = 0.06) and lower percentage of REM (p = 0.06) relative to their non-PTSD counterparts. After adjusting for age, sex and BMI, participants
with PTSD showed reduced parasympathetic activity in NREM sleep ($p = 0.02$) relative to those without PTSD, and a similar trend appeared during REM sleep ($p = 0.06$).

**Conclusion:** These findings suggest that attenuated parasympathetic activity may be one mechanism by which PTSD conveys increased risk for CVD. Sleep treatment may normalize HRV during sleep, which in turn, may reduce the risk for CVD in those with PTSD.

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### 0953

**SLEEP PARAMETERS PREDICTING LENGTH OF STAY IN RESIDENTIAL TREATMENT FOR POSTTRAUMATIC STRESS DISORDER**

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**Introduction:** Entering inpatient psychiatric treatment is stressful for many patients. We investigated whether sleep parameters collected immediately upon admission to a Veteran’s Administration inpatient program for posttraumatic stress disorder (PTSD) could predict length of stay. Though patients leave programs for many reasons, length of stay is a rough index of fit between the clinical needs of the individual patient and the resources and culture of the treatment program.

**Methods:** Mattress actigraphy was used to obtain nightly estimates of sleep parameters such as scheduling, duration of quiet sleep, heart rate, respiration rate, heart rate variability, movement and snoring. The convenience sample was composed of 80 patients providing four contiguous nights of mattress actigraphy immediately after admission. Analysis of mattress actigraphy was automated except for manual determination of to-bed and out-of-bed times which were scored blind to length of stay.

**Results:** The mean amount of quiet sleep obtained and the mean of an estimate of snoring severity over the first 4 nights post-admission were significantly or near-significantly associated with length of stay. Combined in a linear multiple regression, they accounted for 9% of the variance (adjusted R-squared) in length of stay ($F(2,78) = 5.13$, $p = 0.008$). Quiet sleep duration was positively associated ($\beta = 0.28$, $t = 2.61$, $p = 0.011$), while snoring severity was negatively associated ($\beta = -0.24$, $t = 2.19$, $p = 0.032$) with length of stay.

**Conclusion:** Notwithstanding the many factors which can influence the duration of an episode of residential PTSD treatment, sleep parameters collected very early in the course of hospitalization may be useful in identifying patients in need of individualized programming such as referral to an alternative treatment context or concurrent interventions for sleep disordered breathing or insomnia.

### 0954

**EXAMINING THE DIFFERENTIAL RELATIONSHIP OF ALCOHOL USE AND PTSD ON INSOMNIA IN A VETERAN SAMPLE**

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**Introduction:** Insomnia occurs in 36–72% of individual with alcohol use disorder (AUD) and 66–90% of individuals with posttraumatic stress disorder (PTSD). Insomnia hinders treatment outcomes for both AUD and PTSD, increases relapse for AUDs, and increases daytime symptomology for PTSD. Despite research on insomnia in AU and PTSD independently, little is known about their differential or combined effects.

**Methods:** Participants were 45 Veterans with comorbid PTSD and AUD consented for a longitudinal treatment study (Age = 41.21 ± 12.58; 91.1% male). Measures included baseline assessments of Insomnia Severity Index (ISI), Clinician Administered PTSD Scale (CAPS), and percent of days drinking in the last 90 days (%AU). Bivariate correlation and multiple regression were used to determine 1) the independent relationship of %AU and PTSD on insomnia; 2) the differential relationship of %AU and PTSD on insomnia; 3) the interaction of %AU and PTSD on insomnia.

**Results:** Veterans reported moderate insomnia (ISI = 16.82 ± 7.18), PTSD (CAPS = 40.46 ± 13.71), and alcohol use (%AU = 64.27% ± 29.07) symptoms. Independently, CAPS and %AU were positively correlated with the ISI ($r(44) = 0.38$, $p < 0.01$, $r(34) = 0.52$, $p < 0.01$, respectively). When regressed together, both CAPS and %AU associated with the ISI ($\beta = 0.40$, $p < 0.01$; $\beta = 0.53$, $p < 0.001$, respectively). When the interaction of the CAPS and %AU was added to the omnibus model, neither the interaction ($\beta = 0.58$, $p = 0.34$), nor the main effects were significant.

**Conclusion:** Veterans seeking treatment for comorbid PTSD/AUD showed clinical levels of insomnia. Additionally, both PTSD and %AU associated with insomnia severity, suggesting two independent relationships to insomnia. Given insomnia can influence daytime PTSD symptoms and drinking relapse, and insomnia frequently does not decrease after PTSD and AUD treatments, addressing insomnia directly may be an important factor for PTSD and AUD treatments. Overall, furthering our understanding of the relationship between insomnia, AUD, and PTSD will benefit treatment outcomes for Veterans.

**Support (If Any):** Center of Excellence for Stress and Mental Health

### 0955

**ALCOHOL USE AND PTSD SYMPTOM SEVERITY AMONG VETERANS EXPERIENCING TRAUMA-RELATED NIGHTMARES**

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**Introduction:** Poor sleep quality and alcohol consumption are health behaviors that may negatively affect the naturalistic course of PTSD symptomatology. Nightmares are thought to contribute to the processing of trauma. Individuals experiencing trauma-related nightmares may increase alcohol consumption to avoid this symptom, continuing a cycle of avoidance and ultimately impairing recovery.

**Methods:** Veterans ($N = 87$) who met criteria for either PTSD or subthreshold-PTSD provided data on alcohol consumption, PTSD symptomatology, and other behavioral health variables over one year. Controlling for baseline depression and insomnia severity, we examined whether frequency of alcohol consumption, conceptualized as percentage of past-month drinking days (heavy ≥ 50%, moderate 25–49%, low 0–24%), was associated with PTSD symptom severity at 1, 6, and 12-months among a sample of veterans who reported moderate to severe nightmares.

**Results:** Random intercept modelling revealed significant main effects for depression, insomnia, and time. The overall test of slopes for time by drinking frequency did not reach significance [$F(177) = 2.05$, $p = 0.13$]. However, between group contrasts revealed a significant difference in the moderate versus heavy drinking group [$t(177) = -2.03$, $p < 0.05$] such that PTSD symptom severity remained more elevated for heavy drinkers.
Conclusion: In this sample of veterans experiencing PTSD and moderate to severe nightmares, PTSD symptom severity significantly decreased over time. When accounting for depression and insomnia severity at baseline, heavier alcohol consumption was associated with greater PTSD symptom severity during one year of follow-up. These findings suggest that both alcohol consumption and sleep problems, including presence of trauma-related nightmares, should continue to be considered in the treatment of PTSD.

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0956
THE ASSOCIATION OF A FAMILY HISTORY OF ALCOHOLISM WITH SLEEP DISTURBANCE AND ALCOHOL CONSUMPTION IN ALCOHOLIC SUBJECTS
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Introduction: There is no significant literature on the association between a family history of alcoholism and sleep-related complaints in alcoholics. In this investigation, we studied this association between a first-degree family history of alcoholism (FHA) with sleep-related complaints, and alcohol consumption in alcoholic subjects.

Methods: Treatment-seeking alcoholic subjects (N = 400) were evaluated at baseline visit, using structured instruments to assess for their family history of addictive disorders (Family History Interview for Substance Abuse disorders), sleep complaints (sleep disturbance, sleep adequacy and habitual sleep duration from the Medical Outcomes Study Sleep Scale) and alcohol consumption (drinking days and drinks per drinking day from Time Line Follow Back measure). Binary logistic regression analyses adjusted for covariates were use to determine the association between family history percentage (a quantitative measure of first-degree family history of alcoholism), with sleep complaints and alcohol consumption, and explore for their interactive effects in predicting FHA.

Results: The mean (SD) age was 47.81 (10.74) years, 85% were males, 64.80% identified themselves as Caucasian, 59.0% were employed and 45.5% were married. FHA was positive among 182 (45.50%) respondents. The mean (SD) for sleep disturbance scale was 44.39 (26.12), sleep disturbance was present in 113 (28.25%) subjects. FHA was positive among 182 (45.50%) subjects. FHA was positively associated with drinking days (OR = 0.93, p = 0.02), and sleep inadequacy scale (OR = 0.98, p = 0.01), and with a trend towards significance for sleep duration (OR = 0.85, p = 0.09). No association with the sleep disturbance scale was seen. In addition, no interactive effects of alcohol consumption on sleep variables were seen.

Conclusion: A history of alcoholism in their immediate family may increase the alcoholic subject’s risk for non-restorative sleep and frequent drinking.

Support (If Any): VA grant IK2CX000855 (S.C.) and NIH grants K23 HL110216 & R21 ES022931 (M.A.G.)

0957
DISTURBED SLEEP AND SLEEP TIMING DURING LATE CHILDHOOD ARE RISK FACTORS FOR LATER ALCOHOL AND DRUG INVOLVEMENT
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Introduction: Cross-sectional and limited longitudinal data suggest that sleep and circadian disturbances are risk factors for substance use disorders (SUDs). Only a handful of longitudinal studies have examined these relationships during adolescence, despite the elevated incidence of sleep/circadian disturbances and SUDs during this time. In the present analyses, we examined whether restless sleep and irregular sleep timing during late childhood predicted an earlier onset of alcohol, cannabis, and cocaine involvement.

Methods: The sample was 732 children (212 female) recruited at age 10–12 years old and followed over five visits to age 30. In 314, fathers had a history of SUDs involving illicit drugs. The Dimensions of Temperament Survey - Revised (DOTS-R) subscales assessed restless sleep (i.e., DOTS-R Activity Level - Sleep) and irregular sleep timing (i.e., DOTS-R Rhythmicity-Sleep). Alcohol, cannabis, and cocaine involvement were assessed via diagnostic interviews. Cox proportional hazard models were developed for two outcomes (“ever tried” or disorder) for each substance, as well as for the onset of major depressive disorder.

Results: Restless sleep at age 10–12 years old significantly predicted an earlier onset age for trying alcohol (Wald X² = 5.85, p = 0.016) and cannabis (Wald X² = 5.31, p = 0.02), and showed a trend towards predicting earlier onset of cannabis use disorder (Wald X² = 3.08, p = 0.079). Restless sleep also predicted an earlier onset of depressive disorder (Wald X² = 7.43, p = 0.006). Irregular sleep timing at age 10–12 years old significantly predicted an earlier onset age for alcohol use disorder (Wald X² = 6.67, p = 0.01), and showed statistical trends toward predicting earlier onsets of disorders of cannabis (Wald X² = 2.76, p = 0.097) and cocaine (Wald X² = 3.71, p = 0.054).

Conclusion: Consistent with findings in other age groups, restless sleep predicted earlier alcohol use onset and irregular sleep timing predicted earlier alcohol use disorder onset. Sleep-focused preventative efforts during early adolescence may reduce the incidence of mood and substance use disorders.

Support (If Any): This work was funded by the National Institutes of Health (P50DA05605, U01AA021690, and K01 DA032557).

0958
THE ROLE OF EXPRESSIVE SUPPRESSION IN TERMS OF THE RELATIONS BETWEEN SLEEP QUALITY AND DEPRESSION AND ANXIETY SYMPTOMS AMONG MEDICAL CANNABIS PATIENTS
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Introduction: Poor sleep quality and symptoms of depression and anxiety are often reported as reasons for individual medical cannabis use. Indeed, poor sleep quality has been consistently associated with the experience of depression and anxiety, including among medical cannabis users. However, an important gap in the existing literature relates to whether the observed relations between sleep and psychopathology are uniform across medical cannabis users, or whether particular subsets of individuals with other vulnerabilities, who also suffer from sleep problems, may be at particular risk of heightened psychological symptoms. Emotion dysregulation, and specifically strategies
aimed at expressive suppression, has been associated with poor sleep quality, symptoms of depression and anxiety, as well as coping-oriented cannabis use. So as to integrate these two literatures, the present study sought to determine the role of expressive suppression in terms of the relations between sleep quality and symptoms of depression and anxiety, among medical cannabis users.

**Methods:** 131 medical cannabis patients completed questionnaires, including the Pittsburgh Sleep Quality Index, the Inventory of Depression and Anxiety Symptoms, and the Emotion Regulation Questionnaire.

**Results:** Expressive suppression moderated the relation between sleep quality and symptoms of depression (R² = 0.48, p = 0.05) and PTSD (R² = 0.32, p = 0.00). Specifically, individuals with poor sleep quality who reported greater expressive suppression tended to have more severe symptoms of depression (β = 0.34, p = 0.01). In comparison, those with poor sleep quality who reported less expressive suppression tended to have more severe symptoms of PTSD (β = −0.62, p = 0.02). Sleep quality and expressive suppression were unrelated to symptoms of social anxiety or panic (all p's < 0.05).

**Conclusion:** Our results provide information regarding risk factors that may exacerbate psychological conditions for which cannabis is used. Results revealed unique effects based on the form of psychopathology.

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**0959**

**A PRELIMINARY REPORT FROM THE “REST-IT” STUDY: ACTIGRAPHIC SLEEP AND REST-ACTIVITY INDICES PREDICT SUICIDALITY IN DEPRESSED INDIVIDUALS**

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**Introduction:** Insomnia has been identified as a modifiable risk factor for suicidality. However, previous studies have relied mostly on self-reported sleep disturbance to explore this relationship and have not controlled for depressive symptom severity. The current analyses examined relationships between actigraphic indices and suicidality at the start of treatment in depressed outpatients experiencing insomnia and suicidality, while controlling for depressive symptoms.

**Methods:** At this time, 45 patients have consented to participate in the ongoing Reducing Suicidal Ideation through Insomnia Treatment (REST-IT) study, a multisite, double-blind, randomized controlled trial examining whether hypnotic medication (zolpidem CR or placebo) along with open-label anti-depressant therapy impacts suicidality in depressed outpatients with insomnia and suicidality. Participants completed actigraphic and questionnaire assessments throughout treatment. The current analyses focused on 22 patients who had valid actigraphic assessments during the first 2 weeks of treatment. Relationships between actigraphic indices (sleep onset latency (SOL); wake time after sleep onset (WASO); sleep efficiency (SE); total sleep time (TST); mesor; amplitude; and acrophase) and the Scale for Suicide Ideation were examined. Hypnotic medication condition remained blinded.

**Results:** All analyses controlled for depressive symptom severity. During week one of treatment, a later peak of activity (acrophase) was related to higher levels of suicidality (p = 0.02). In week two, greater SOL and variability in SOL, lower activity levels (mesor), and a weaker rest-activity rhythm (amplitude) were related to higher levels of suicidality (all p < 0.05).

**Conclusion:** At treatment start, a variety of actigraphy-derived indices demonstrated relationships with suicidality, independent of depressive symptoms. Participants exhibiting sleep initiation difficulties and a more eveningness pattern, decreased activity, and weaker rhythms reported greater suicidal ideation. Although power may have been limited due to sample size and these findings are only preliminary and need replication in a larger dataset, actigraphy may be a useful tool for further understanding the relationship between insomnia and suicidality.

**Support (If Any):** REST-IT is supported by National Institute of Mental Health (NIMH) award MH095776.

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**0960**

**A PRELIMINARY REPORT FROM THE “REST-IT” STUDY: INSOMNIA SEVERITY AND HYPERSONMIA SEVERITY EACH INDEPENDENTLY PREDICT THE INTENSITY OF SUICIDAL IDEATION**

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**Introduction:** Sleep disorders have been linked to suicidal ideas, suicidal behavior, and suicide death in more than 60 studies. However, past research rarely concurrently examined multiple variables about sleep in the same study. Herein we describe how insomnia, hypersomnia, patients' attitudes about sleep, and circadian rhythm type correlate with suicidal ideation.

**Methods:** Reducing Suicidal Ideation through Insomnia Treatment (REST-IT) is an NIMH-sponsored multisite clinical study that aims to assess the effect of treating insomnia with hypnotic medication on the intensity of suicidal ideation in depressed outpatients with insomnia and suicidal ideation. At baseline, suicidal ideation was assessed with the Scale for Suicide Ideation (SSI), insomnia symptoms were assessed with the Insomnia Severity Index (ISI), hypersomnia with the Epworth Sleepiness Scale (ESS), patients’ attitudes about sleep by Dysfunctional Beliefs and Attitudes about Sleep (DBAS), and circadian rhythm type by Reduced Morningness-Eveningness Questionnaire (rMEQ). As the outcome of interest, predictive models for baseline SSI were created using multivariable linear models for all 45 participants with ISI, ESS, DBAS, and rMEQ as independent variables, with adjustment for age and gender.

**Results:** 45 patients aged 41 ± 12.6 years (60% women) have thus far consented to participate and completed baseline screening. Greater insomnia (ISI) and hypersomnia (ESS) were independently correlated with significantly greater intensity of suicidal ideation (p < 0.02) in our multivariable model. Interestingly, ISI and ESS were not correlated (r = −0.06, p > 0.7). Dysfunctional beliefs about sleep and RMEQ were not associated with greater suicidal ideation.

**Conclusion:** The results support the concept that insomnia and hypersomnia may each contribute to suicidal ideation. Both insomnia and hypersomnia independently contributed to this model of suicidal ideation. Further research is needed to examine possible causation between hypersomnia and suicidal ideation in patients with major depression.
VIII. Psychiatric Disorders and Sleep

0961
SLEEP PATTERNS AND SUICIDAL IDEATION IN FIRST-YEAR COLLEGE STUDENTS
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Introduction: Self-reported short sleep duration is associated with suicidal ideation and behavior. Others report that adolescents with later bedtimes (BT) vs. those with earlier BT report more suicidal ideation, implicating sleep timing as a factor in suicidal ideation. We measured suicidal ideation and sleep patterns in first-year students, hypothesizing an association of less sleep, later BTs, earlier wake times (WT), and more variable sleep patterns with suicidal ideation.

Methods: Students (n = 846, mean age = 18.6 yrs; SD = 0.5) completed on-line sleep diaries daily for 9 weeks from the start of term, answering questions about sleep timing, sleep latency, and night waking. Sleep patterns were determined as mean and standard deviation of reported BT, WT, and computed total sleep time (TST). Students completed an online survey at week 9 including questions about suicidal ideation and the Center for Epidemiologic Studies-Depression Scale (CES-D). Endorsement of “did you seriously consider taking your life?”, “did you have thoughts of suicide, even though you would not really do it?”, and/or “did you think about a specific way to take your life?” placed 74 students in the suicidal ideation (SI+) group. Ultimately, 64 (female = 39) SI+ participants were matched on sex, age, and CES-D score (median = 26, IQR = 14.8) to 64 non-endoisers (SI−). One-tailed paired t-tests were performed separately for men and women sleep diary variables.

Results: Men: SI+ men reported significantly earlier WT (M = 9:12 h; SD = 0.48) compared to SI− (M = 9:42 h; SD = 54 mins) men (t(24) = 2.25, p = 0.017; Cohen’s d = 0.51). No additional sleep variables showed significant differences; however, a trend was observed for earlier BT (t(24) = 1.6, p < 0.06) in SI+ (M = 2:00 h; SD = 54 mins) versus SI− (M = 2:24 h; SD = 54 mins) men. Women: No significant differences were observed for SI+ compared to SI−; however, trends were seen for more variable BT (t(38) = −1.7, p = 0.052) and WT (t(38) = −1.6, p = 0.054) in the SI+ (BT: M = 1.3 h; SD = 0.3; WT: M = 1.3; SD = 0.4) vs. SI− women (BT: M = 1.2, SD = 0.4; WT: M = 1.2, SD = 0.4).

Conclusion: Unlike past studies, sleep length was unassociated with suicidal ideation in our sample. Furthermore, we found that sleep timing for SI+ men was earlier than for SI− men and unassociated with SI status in women, though trends for greater variability in SI+ women’s sleep timing occurred. These findings indicate an association between SI and sleep patterns that differs from previous reports and for young men and women.

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0962
THE ASSOCIATION OF DEPRESSION, SLEEP DIFFICULTIES AND SUICIDE RISK IN TEENAGERS
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Introduction: Sleep disturbances are commonly associated with psychiatric disorders. Among adolescents with sleep problems, increased rates of depressive symptoms have been identified. There is significant and temporal relationship between sleep problems and completed suicide in adolescents and the majority of depressed and suicidal youth exhibit increased sleep latency, increased REM density and decreased REM latency, when compared to controls. In contrast to adults, consistent sleep disturbances in adolescents are less defined and therefore require further examination. The objective is to evaluate the association of sleep problems, depression, and risk of suicide in youth.

Methods: A retrospective chart review of polysomnographic (PSG) studies and psychiatrist evaluations of 106 adolescents aged 7–16 years during their admission to an involuntary adolescent psychiatric inpatient facility.

Results: Less than 5% of cases had mild or no sleep problems. Adolescents with many co-diagnosed psychiatric disorders had greater frequencies of insomnia, decreased sleep efficiency, and arousals form SWS (p < 0.05). Self-harm behavior can be viewed to represent a more severe psychopathological state than affective disorders alone. Those patients evincing such behaviour had more frequently elevated sleep onset latency (SOL), reduced sleep efficiency, reduced slow wave sleep (p < 0.05), increased REM sleep, and reduced REM latency compared to patients with dysthymia and/or depression.

Conclusion: This study highlights the utility of PSG studies in the identification and management of adolescents with respect to sleep and mood problems and those at risk of suicidal behaviour and psychopathologies.

0963
PERCEIVED STIGMA TOWARD MENTAL HEALTH IN ASSOCIATION WITH SLEEP DISTURBANCES AND AS AN ACUTE PREDICTOR OF SUICIDAL SYMPTOMS
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Introduction: Suicide represents a global disease burden, accounting for 1 million deaths annually, yet selective interventions remain scarce. Sleep disturbances are listed in the top 10 warning signs of suicide by SAMHSA, and preliminary research suggests that sleep complaints may confer independent risk for suicidal behaviors. Sleep problems have been proposed as a novel treatment target as they may be less stigmatizing compared to mental health risk factors. However, no study to date has evaluated this relationship empirically.

Methods: Participants were recruited and screened for high suicide risk for inclusion in a suicide prevention trial, based on presence of current suicidal ideation according to standardized risk assessments, diagnosis of major depressive disorder (MDD), and insomnia symptoms. Data were collected among N = 33 individuals (30% female) assessed according to the following clinician-administered diagnostic interviews and validated symptom inventories: The Structured Clinical Interview for DSM-IV Disorders (SCID-I), the Beck Scale for Suicide (BSS), the Beck Depression Inventory (BDI), Suicidal Ideation Intensity Ratings (0–100 scale), the Insomnia Severity Index (ISI), the Disturbing Dreams and Nightmare Severity Index (DDNSI), and the Perceived Stigma Scale (PS).

Results: Participants (M Age = 41.5, SD = 12.6) demonstrated moderate to severe suicidal symptoms for worst point lifetime suicidal ideation, according to standardized risk assessment instruments, diagnosis of major depressive disorder (MDD), and insomnia symptoms (M DDNSI = 10.8, SD = 8.7). Pearson correlations revealed significant associations between higher perceived stigma toward mental health treatment and greater levels of psychopathology, according to the BDI (r = 0.52, p = 0.002), suicidal ideation intensity (r = 0.40, p = 0.02), and BSS as a nonsignificant statistical trend (r = 0.34; p = 0.05), but not sleep measures (ISI: r = 0.13, p = 0.43; PSQI: r = 0.12, p = 0.47; DDNSI: r = 0.24, p = 0.16).

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Conclusion: Results revealed significant associations between perceived stigma toward mental health and greater depressive symptoms and suicidal symptom intensity. Results indicated relationships highly specific to mental health symptoms, versus sleep, highlighting a potential focus on sleep complaints as a non-stigmatizing therapeutic target that may enhance access to care and intervention opportunity in the prevention of suicide. Future research is warranted investigating treatment development of sleep interventions that may reduce stigma among high risk, high-need samples.

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0964

SLOW-WAVE DISRUPTION IMPROVES MOOD IN MAJOR DEPRESSIVE DISORDER

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Introduction: Although it has been decades since the discovery of the antidepressant effects of sleep disruption, the underlying mechanism is still poorly understood. Prior research has implicated abnormalities in slow-wave homeostasis as a mechanism in the antidepressant effect of sleep deprivation, which has been corroborated with a recent study showing decreased depression severity following one night of selective slow-wave disruption. The current study aimed to extend this research by utilizing a dimensional approach in examining the antidepressant effects of SWA disruption. Of particular interest is the affective dimension, as negative affect in depression is arguably the most salient characteristic of depression, and remains a gateway criterion for a DSM-5 diagnosis of MDD (i.e., presence of depressed mood for two or more weeks).

Methods: This sample included 16 individuals with MDD (10 female) recruited from the community. Participants slept in the lab for three nights (adaptation, baseline night, and slow-wave disruption) with polysomnography, and completed measures of negative affect and depression severity in the following morning. Power spectral analysis was performed on digitized EEG signals, and delta power was defined as 0.5–4.0 Hz.

Results: Results show that reductions in delta power predicted improved negative affect the following morning, suggesting a relationship between SWA and affect in depression. Results also showed marginal decreases in cognitive-affective symptoms of depression, and that decrease was also marginally related to reductions in delta power.

Conclusion: This study aimed to extend previous research demonstrating an antidepressant effect following slow-wave disruption in depression by utilizing a dimensional approach. Results indicated that improved negative mood following slow-wave disruption was predicted by the reduction of slow-wave activity during the night.

0965

EFFECT OF CBTI ON ANTIDEPRESSANT SIDE-EFFECTS: A REPORT FROM THE TRIAD STUDY

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Introduction: Little is known about determinants of antidepressant side effects. The multi-site TRIAD (Treatment of Insomnia and Depression) study offers a unique opportunity to explore whether insomnia severity and insomnia treatment predict treatment side effects.

Methods: Participants were 148 individuals (73.3% female, age 46.6 ± 12.6 years) with insomnia comorbid with MDD, randomized to receive 16 weeks of treatment, consisting of 7 sessions of CBTI or CTRL and concomitant two-step medication algorithm, involving escitalopram, sertraline, and desvenlafaxine in a prescribed sequence. Other medications that could impact sleep or depression were proscribed. Medication side effects were measured with the Frequency, Intensity, and Burden of Side Effects Rating scale, which instructed to rate side effects of “the medication you have taken within the past week for your depression”. Sleep measures included the Insomnia Severity Index (ISI) and sleep diary.

Results: Starting antidepressant medications were escitalopram (78%), sertraline (14%), and desvenlafaxine (8%) (Group p = 0.44). The average maximum doses (Mg) were: 16.9 (4.8) for escitalopram, 109.0 ± 60.4 for sertraline, 75.0 ± 28.4 for desvenlafaxine (Groups p-values > 0.52). Baseline ISI, mean latency to sleep onset, and time awake in the middle of the night did not predict frequency, intensity, or burden of antidepressant side effects (p-values > 0.1). However, compared to CTRL, participants receiving CBTI reported greater maximum frequency and burden of medication side effects (p ≤ 0.03).

Conclusion: The higher maximum frequency and burden of side effects among CBTI recipients was observed even though participants in the two groups received the same medications and highest doses. One possible explanation for this finding is that the sleep restriction component of CBTI might have led to a transient partial sleep deprivation, which could have amplified the side effects of the antidepressants directly or indirectly, by decreasing tolerance to the side effects.

Support (If Any): MH078924, MH078961, MH079256, HL096492

0966

TREATING INSOMNIA IN DEPRESSION (TRIAD): IMPACT ON INSOMNIA SEVERITY AND DEPRESSION REMISSON

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Introduction: Disturbed sleep is common in major depressive disorder (MDD). This study evaluated the efficacy of cognitive behavioral therapy for insomnia (CBTI) versus a control insomnia therapy (CTRL) among patients with comorbid insomnia disorder and MDD, who also received 16 weeks of pharmacotherapy for depression. We also tested whether change in insomnia severity mediated depression outcomes.

Methods: Participants were 148 individuals (73.3% female, age 46.6 ± 12.6 years) with insomnia comorbid with MDD, randomized to receive seven sessions of CBTI or CTRL. All participants concomitantly received pharmacotherapy for depression following a standardized two-step algorithm, which consisted of escitalopram, sertraline,
and desvenlafaxine in a prescribed sequence. Outcome measures included the Insomnia Severity Index (ISI) and remission from depression. Remission was assessed using structured interviews, blind to randomization, and was defined by the absence of both core symptoms of MDD (depressed mood or anhedonia) and the presence of no more than two of the other 7 diagnostic symptoms of depression of MDD for at least three consecutive weeks.

**Results:** CBT-I was superior to CTRL in improving insomnia severity (p < 0.05). Differential effects of treatments on insomnia severity were observed already by week 6. Although a greater proportion of those receiving CBT-I (43%) achieved depression remission than did those assigned to the CTRL condition (36%), the difference was not statistically significant. Improvements in insomnia severity at week 6 mediated remission from depression in the entire sample.

**Conclusion:** CBT-I is an efficacious treatment for insomnia comorbid with MDD among patients treated with antidepressant medications. Although depression outcomes did not differ between groups, improvement in insomnia severity mediated reduction in depression remission, suggesting that improvement in insomnia may play some role in the change in depression. Future studies should identify when the addition of an insomnia-focused therapy can enhance standard antidepressant treatments.

**Support (If Any):** MH 078924, MH078961, MH079256, and HL096492

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**0967 A PRELIMINARY INVESTIGATION OF CIRCADIAN MEASURES AND RESPONSE TO FLUOXETINE AND REPEATED PARTIAL SLEEP DEPRIVATION FOR DEPRESSION**

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**Introduction:** Major depressive disorder (MDD) is associated with abnormalities in circadian rhythms. We investigated circadian rhythm changes and their relationship to depression symptoms in a study of fluoxetine plus repeated partial sleep deprivation.

**Methods:** Participants were 15 adults (27 ± 6.86 years old, 8 females, all met MDD criteria) randomly selected from the parent study. Saliva was collected in-laboratory to estimate dim light melatonin onset (DLMO) using the 3k threshold at baseline and after 14 days (T2) of fluoxetine with daily 6 hours’ time in bed (partial sleep deprivation; PSD) or 8 hours’ time in bed (no sleep deprivation; NSD). Circadian measures included DLMO and phase angle (in minutes) between DLMO and sleep onset per polysomnography. Mood was assessed at week 2, 4, and 8 of fluoxetine using the 17-item Hamilton Rating Scale for Depression (HRSD-17).

**Results:** Thirteen participants had phase shifts ≥ 30 minutes between baseline and T2. Nine participants had phase delays, and four had phase advances. The NSD group demonstrated a phase delay (−36.0 ± 13.42 minutes), in contrast to the advance in the PSD group (26.67 ± 90.55 minutes, p = ns). Phase angle (minutes between DLMO and sleep onset) increased by 42.0 ± 20.36 minutes in NSD group and 38.33 ± 78.70 minutes in the PSD group between baseline and T2. Baseline DLMO was correlated with HRSD score at week 8 (r = 0.61, p = 0.022). Remission was associated with earlier baseline DLMO (21:13 vs 23:00, t = 2.10, p = 0.057). On average, remitters showed phase advances (16.67 ± 79.53 minutes), whereas non-remitters had delays (−18 ± 78.23 minutes, p = ns).

**Conclusion:** In this preliminary study, earlier pre-treatment circadian phase was associated with lower depression scores after 8 weeks of treatment. Further, our results suggest that phase advancement may augment response to fluoxetine.

**Support (If Any):** NIH R01 MH077690 (JT Arnedt)

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**0968 THE EFFECTS OF DELAYING SCHOOL START TIME ON SLEEP AND EMOTION OF KOREAN ADOLESCENTS**

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**Introduction:** Recently, middle schools and high schools of Gyounggyi province in Korea delayed the school start time. Delayed times were 40 minutes for middle school and 60 minutes for high school. The aim of this study is to investigate the effects of delaying school start time on sleep, emotion and behaviors of middle school students.

**Methods:** 144 middle school students aged 14 through 15 were recruited from one middle school located in Suwon city of Gyounggyi province. All subjects fulfilled the questionnaires about demographic data, sleep quality, daytime sleepiness, overall mood and behaviors in school. We used Pittsburgh Sleep Quality Index, Daytime Sleepiness Scale modified for middle school students, and questions about overall mood and behaviors in school answered on 10 point visual analog scale basis.

**Results:** Results indicated that average bed time was 23:58, average wake up time was 7:24. Average wake up time was delayed about 40 minutes compared to previous studies. Average total sleep time was 6 hours 54 minutes. Subjects reported 0.9 in sleep quality and 2.14 in daytime dysfunction based on PSQI. There were significant improvements in subjective happiness, numbers of taking breakfast, number of being late for school, concentration on class, overall peer relationship, vitality, and degree of wishing to go to school.

**Conclusion:** Middle school Students wake up later, feel happier, take breakfast more frequently, get less late for school, more concentrate on class, improve peer relationship, and feel more vital. Delaying school start time might have positive impacts on their sleep quality and school life quality.

**Support (If Any):** Korean Society of Sleep Medicine
SHORT-TERM POTASSIUM SUPPLEMENT MIGHT IMPROVE SEVERITY OF OBSTRUCTIVE SLEEP APNEA IN HYPERTENSIVE PATIENTS WITH HYPOKALEMIA

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Introduction: Previous studies proposed the sleep-disordered breathing, sleep disruption and nocturnal desaturation are common in neuromuscular diseases, mainly attributing to weakness of respiratory muscle. Interestingly, the patients with hypertension who frequently complain of unrefreshing sleep, daytime sleepiness, impaired concentration, fatigue and lethargy were commonly detected of hypokalemia. Though, few published data support that correct hypokalemia might help to maintain sleep architecture and homeostasis, it is still unclear that whether potassium supplementation could contribute to reduction of sleep-breath events.

Methods: A self-before-after control study was designed to explore the potential influence of potassium on obstructive sleep apnea (OSA). 28 hypertensive patients with hypokalemia (mean age 50.6 yrs and body mass index 28.97 kg/m²) who attend the Hyperension Center of People’s Hospital of Xinjiang from 2013 and 2014 were consecutively recruited. 18 subjects underwent polysomnography (PSG) before and after oral potassium supplement, simultaneously, the other 10 patients performed PSG twice without potassium supplement.

Results: The mean levels of potassium in the whole population were (3.31 ± 0.15)mmol/l before potassium supplement and (4.08 ± 0.28) mmol/l after potassium supplement. Compared to pre-potassium supplement, the AHI [(24.62 ± 17.98) vs (31.94 ± 21.63)events/h, p = 0.001], apnea index [(9.38 ± 16.45) vs (15.00 ± 21.06) events/h, p = 0.025] and REM sleep (%) [(22.31 ± 5.20)min vs (19.07 ± 6.21)min, p = 0.044) were significantly improved after oral potassium supplement. Although the total time of SaO2 < 90% showed a tendency to reduce (64.71 ± 96.61 min vs 81.06 ± 105.73 min), the difference did not showed statistically significant, with p = 0.094. In patients without potassium supplement, the AHI (33.18 ± 26.76 vs 33.47 ± 24.66 events/h), apnea index (21.77 ± 21.39 vs 13.30 ± 17.80 events/h) and the total time of SaO2 < 90%(59.76 ± 91.37 min vs 56.77 ± 85.18 min) were similar between two PSG.

Conclusion: This study provided preliminary evidence that potassium chloride supplement probably improves the severity of OSA as well as sleep architecture in hypertensive patients with hypokalemia.

0970

SLEEP SYNCHRONY IN COUPLES IS ASSOCIATED WITH CARDIOVASCULAR DISEASE RISK MARKERS

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Introduction: Sleep is most often examined at the individual level. However, we recently found that couples’ sleep-wake patterns are synchronous, using a novel technique to assess sleep at the dyadic level. The next step is to determine how sleep-wake synchrony in couples relates to health outcomes. Given that an individual’s sleep is associated with cardiovascular disease (CVD) risk factors, we examined whether couples’ sleep-wake synchrony is associated with systolic and diastolic blood pressure (SBP, DBP) and systemic inflammation.

Methods: Forty-six couples wore wrist actigraphs for 10 days. The independent variable, percent sleep-wake synchrony (whether couples were awake or asleep at the same time), was defined as (#synchronous epochs/#total epochs)*100. Synchrony scores ranged from 54–88% (mean 74.8, SD 7.22). Ambulatory BP monitors were used to assess BP at 60 minute intervals during the day and night across 2 consecutive 24-hour periods. Systemic inflammation was assessed with plasma C-reactive protein (CRP). Mean systolic and diastolic BP during the sleep period, sleep-daytime SBP and DBP ratios, and CRP were the dependent variables. Mixed modeling was used to account for interdependence within couples. Covariates included age, sex, education, and waist circumference.

Results: Higher sleep-wake synchrony was associated with lower SBP, b = −0.32, SE = 0.129, p = 0.018, and DBP, b = −0.211, SE = 0.097, p = 0.035 during the sleep period. Synchrony was not associated with sleep-daytime SBP ratio, b = −0.001, SE = 0.001 or sleep-daytime DBP ratio, b = −0.001, SE = 0.001, ps > 0.05. Higher sleep-wake synchrony was associated with lower CRP, b = −0.153, SE = 0.031, p < 0.001. Significant findings were independent of age, sex, education, and waist circumference.

Conclusion: Greater sleep-wake synchrony in couples was associated with lower nighttime BP during the sleep period, but synchrony was not associated with sleep-daytime BP ratio. Couples with higher sleep-wake synchrony also had lower individual CRP, which suggests that synchrony is linked to systemic inflammation, a marker of CVD risk. Sleep-wake synchrony may be a novel mechanism by which romantic relationships are associated with long-term health outcomes, such as CVD.

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THE DANGER ZONE: MICRO SLEEP EPISODES PRIOR TO SLEEP ONSET IN MAINTENANCE OF WAKEFULNESS TESTS

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Introduction: Sleep onset is currently defined by the first appearance of at least 16 seconds of any sleep stage in a 30-second epoch of recording. Shorter segments of sleep (micro sleep) prior to sleep onset are ignored in objective assessments of daytime sleepiness such as the Maintenance of Wakefulness Tests (MWT). The Odds Ratio Product (ORP) is a new continuous index of sleep depth calculated in 3-sec epochs from the electroencephalogram. ORP values range from 0–2.5 with a value of 1.5 seen as cutoff between wake and sleep. We wanted to characterize the instability of vigilance during the sleep onset process in MWT and compare sleep onset times using the 3-sec ORP to Rechtshaffen & Kales (R&K).

Methods: The Polysomnograms from 8 subjects with EDS who previously underwent MWTs were re-scored for 3-sec ORP. Each subject had 4 nap opportunities separated by 2-hour intervals. Sleep onset latencies (SOLs) were determined by both R&K criteria and ORP criteria. An episode of micro sleep was defined as a 3-sec ORP value ≤ 1.5. Sleep onset per ORP criteria was defined as the onset of at least micro sleep episode with a 3-sec ORP value ≤ 1 or 2 episodes occurring within 9 seconds with ORP values ≤ 1.5.

Results: The average number of micro sleep episodes per minute prior to R&K sleep onset was 1.69 ± 1.51. Mean SOLs for the 8 MWTs using ORP criteria were on average shorter than those determined by R&K by 6.15 minutes (0.35–20.75). Six individual MWT nap opportunities and 2 full MWTs showed normal sleep latencies per R&K criteria despite frequent lapses in vigilance as suggested by ORP scores.

Conclusion: ORP scoring of sleep onset may provide a more accurate assessment of potentially dangerous vigilance lapses.

EFFECTS OF LONG SLEEP ON CRP LEVELS IN THE ‘MODELING THE EPIDEMIOLOGIC TRANSITION STUDY’

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Introduction: Clinical studies have indicated linkages between sleep duration and C-reactive protein (CRP), a stable inflammatory marker of cardiovascular disease. The present study explored effects of short (8 hours) sleep durations, referenced to healthy sleep (7–8 hours), on CRP levels among participants in the ‘Modeling the Epidemiologic Transition Study’ (METS).

Methods: We conducted a multi-site comparative study of communities representing a broad range of social and economic development, defined by the UN Human Development Index (HDI): Ghana as low middle HDI country, South Africa as middle, Jamaica and Seychelles as high, and U.S.A. as very high HDI. Participants were predominantly of African descent (n = 1,276; ages 25–44; 50% female). Sodiometricographic and anthropometric data were obtained at outpatient community-based clinics. Individuals were excluded if they had infectious diseases (e.g. HIV-positive), were pregnant/lactating, or had conditions preventing normal physical activities.

Results: Of the sample, 54.9% were overweight/obese; 11.7%, hypertension; 2.2%, diabetes; and 4.7, dyslipidemia. Prevalence of short and long sleep durations varied by site. Compared with individuals who reported sleeping 7–8 hours, the U.S. had the highest rate of short sleepers (43.5%), while South Africa had the highest rate of long sleepers (86.5%), X2 = 69.4; p < 0.001. Likewise, CRP levels varied by site (US = 5.9 ± 0.5, South Africa = 7.6 ± 0.7, Ghana = 4.7 ± 0.6, Jamaica = 4.1 ± 0.3, and Seychelles = 3.0 ± 0.2; F = 12.1, p < 0.001); values represent means and standard errors. GLM analysis, adjusting effects of age, sex, BMI and site, showed that short sleep did not have a significant effect on CRP. Rather, long sleep had a significant effect on CRP (F = 10.5, p < 0.001). CRP was also affected by sex (F = 11.3, p < 0.001), BMI, (F = 8.7, p < 0.001) and site (F = 9.8, p < 0.001), but not by age.
Conclusion: Findings are consistent with experimental studies showing effects of sleep on CRP, although long sleep, rather than, short sleep affected CRP concentrations. Site-specific differences in sleep durations and CRP levels are important, warranting further investigation.

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0975

EPIGENETIC, TRANSCRIPTOMIC AND PROTEOMIC CHANGES IN SKELETAL MUSCLE AND SUBCUTANEOUS ADIPOSE TISSUE FOLLOWING ACUTE SLEEP DEPRIVATION IN HEALTHY YOUNG MEN

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Introduction: To investigate the link between sleep loss and metabolic disruption, we conducted a study on the molecular effects of acute total sleep deprivation (TSD) on skeletal muscle (SM) and subcutaneous adipose tissue (SAT) in healthy young men.

Methods: In a two-session, crossover within-subject design, fifteen normal-weight male students were subjected to a night of TSD or normal sleep (8.5 hours), followed by SAT and SM biopsies under fasting conditions. Blood was collected before and after consumption of glucose. Epigenetic changes were analyzed with the Illumina HumanMethylation450 BeadChip; transcriptional changes with quantitative PCR and protein changes with western blotting.

Results: After TSD, circadian and metabolic genes (e.g. BMAL1 and PDK4; P < 0.05) were significantly hypermethylated in their promoter regions compared with sleep, with transcriptomic changes for the corresponding genes mainly apparent in SM (downregulated BMAL1 and CRY1; upregulated PDK4; P < 0.05). TSD did not cause altered cellular protein expression across tissues (e.g. phosphorylation of AS160), which might be attributed to the fact that biopsies were collected before and not after glucose consumption. Finally, following TSD, postprandial insulin sensitivity was 15% lower than after sleep (P < 0.05).

Conclusion: Overall, our results demonstrate that sleep loss influences various molecular switch points of pathways involved in circadian rhythmicity and glucose metabolism in peripheral tissues that essentially contribute to systemic glucose disposal. The extent by which sleep loss altered these molecular switch points differed between SM and SAT. This may suggest that the ability of peripheral tissues to synchronize their energy metabolism is diminished when sleep is lacking, thereby possibly contributing to impaired postprandial insulin sensitivity in non-diabetic men.

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0976

DIFFERENCES IN SLEEP DURATION AND QUALITY FROM ACTIGRAPHY AMONG HISPANIC/LATINO GROUPS: THE HISPANIC COMMUNITY HEALTH STUDY/STUDY OF LATINOS (HCHS/SOL) SUEÑO ANCILLARY STUDY

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Introduction: The sleep patterns of Hispanics/Latinos in the United States have not been well characterized. We sought to describe how aspects of sleep vary by ethnic background among a diverse population of U.S. Hispanics/Latino adults.

Methods: Participants aged 18–64 years were recruited from the probabilistic community-based HCHS/SOL cohort in four sites for an ancillary study focused on sleep. Subjects completed home sleep testing during the baseline exam. As part of the ancillary study, 2,252 adults underwent 1 week of wrist from which mean nightly sleep duration, sleep efficiency, and sleep fragmentation index were calculated. All analyses adjusted for age, gender, education, employment, body mass index, tobacco, alcohol, depression symptoms, sleep apnea severity, caffeine intake, use of sleep aid, and season.

Results: Overall, 93% had at least 5 days of valid actigraphy data and were included in this analysis. Mean ± SD age was 47.0 ± 11.6 years, 35.3% were male, and mean apnea-hypopnea index was 4.8 ± 7.7 events/hr. We found significant differences in nightly sleep duration across Hispanic backgrounds (p = 0.02 for global test). Nightly sleep (adjusted mean ± SD) was longest among Mexicans (6.8 ± 1.0 hrs) and shortest among South Americans (6.5 ± 1.0 hrs). Sleep quality was worst (highest sleep fragmentation index and lowest sleep efficiency) among Puerto Ricans and best among Mexicans (p < 0.01 for global test).

Conclusion: Significant differences in habitual sleep patterns exist across Hispanic/Latino backgrounds, even after adjustment for factors known to impact sleep duration and quality. These differences in sleep may explain differences in cardiovascular and other sleep-related disease risk across Hispanic/Latino groups. Further research is needed to understand the causes and consequences of these differences.

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ASSOCIATION OF SELF-REPORTED SLEEP DURATION AND MARKERS OF OBESITY AMONG YOUNG ADULTS FROM FIVE AFRICAN-ORIGIN POPULATIONS


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Introduction: Sleep duration has been inconsistently associated with elevated body mass index (BMI) in many populations. The modeling the Epidemiologic Transition Study (MET5), provides an excellent opportunity to assess these associations among populations of African origin at different levels of social and economic development.

Methods: MET5 enrolled 500 young adults, 25–45 years, from each of 5 study sites: rural Ghana, urban South Africa, Seychelles, urban Jamaica and suburban U.S. Anthropometrics and self-reported sleep duration data were collected. Multivariate regression models were used to assess associations between habitual sleep duration and markers of obesity (BMI > 30 kg/m²) using aggregated data (using dummy site variables; n = 2,500), as well as with data from each site individually (n = 500 per analysis).

Results: The mean (± SD) age was 34.7 (6.2) years. Among men, mean BMI ranged from 22.2 ± 2.7 to 29.7 ± 7.5 and among women it ranged from 25.5 ± 5.2 and 34.1 ± 8.8 in Ghana and the U.S., respectively. Percent body fat, fat mass, fat-free mass and waist and hip circumferences followed the same general pattern, lowest in Ghana and highest in the U.S. Mean sleep duration was shortest in the US (6.7 ± 1.4 hours), intermediate in Seychelles (7.2 ± 1.3), Jamaica (7.3 ± 1.8), and Ghana (7.9 ± 1.5) and longest in South Africa (10.3 ± 1.7; p < 0.001), for both men and women. In multivariate regressions, adjusting for sex, age and site, sleep was significantly inversely associated with BMI, fat mass, fat-free mass, waist circumference and hip circumference (all p < 0.001). When site-specific regressions were conducted, results remained statistically significant across all sites only for fat-free mass (all sites p < 0.05).

Conclusion: Sleep duration varied significantly between participants in South Africa and the other 4 MET5 study sites. In each and across all sites, fat-free mass was consistently more strongly associated with sleep duration than other indicators of obesity, warranting further investigation.

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THE EFFECTS OF SLEEP DISORDERS ON VISUAL EFFICIENCY

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Introduction: The effects of sleep deprivation on cognitive functions such as memory, reasoning and attention has been extensively investigated, whereas little is known about the effects of sleep disorders on visual perception. The aim of this research is to test the efficiency of visual processing in insomnia and Obstructive Sleep Apnoea (OSA) patients. Visual efficiency was tested by means of a visual search paradigm.

Methods: Participants had to detect the presence/absence of a target (letter T) embedded into a set of characters (letters Os, Xs, Ls, respectively). The test-stimuli were presented without time constraints and subjects were instructed to perform the two-alternative-forced-choice task as soon as possible. The saliency of the target with respect to the contextual letters (T vs. Os, Xs, or Ls, respectively) and the distractors’ number (15, 30, 60) were manipulated. As dependent variables, accuracy and reaction times were recorded. The results of 24 insomnia (mean age: 47 ± 14 years) and 22 OSA (mean age: 51 ± 11 years) patients were compared with the performance obtained by 22 control subjects (mean age: 45 ± 14 years).

Results: While no difference was observed in accuracy, an overall increase of response latency was found in both clinical groups compared to control subjects. However, while the difference in reaction times between OSA patients and controls was constant for all conditions, insomniacs showed a more remarkable impairment when visual search became more difficult.

Conclusion: Those results showed a general impairment of visual efficiency in populations suffering from sleep disorders and a specific impairment for insomniacs when the extraction of visual information from noise was more effortful. Those findings are consistent with the idea of a specific impairment of daytime cognitive functioning in insomniacs.
Conclusion: Increased visceral adipose tissue is associated with substantial sleep fragmentation in healthy non-obese men, independently of total body fat and subcutaneous fat. Whether visceral fat accumulation occurs as a consequence of poor sleep or, alternatively, whether sleep disruption is caused by enhanced visceral adiposity, remains to be determined.

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ALTERED AUTONOMIC METRICS IN PATIENTS WITH INSOMNIA SYMPTOMS
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Introduction: Patients with insomnia symptoms often under-estimate the amount of objectively measured sleep, a phenomenon known as misperception. However, the etiology of misperception remains uncertain. Recent work suggests that autonomic measures of sleep architecture may provide an alternative view of normal and pathological sleep. We tested the hypothesis that cardiopulmonary coupling metrics would correlate with total sleep time misperception and/or confidence in subjective sleep-wake time reporting.

Methods: We retrospectively analyzed n = 89 subjects studied in the MGH clinical laboratory who met the following criteria: AHI < 5, 1 or more insomnia symptoms, no hypnotics or neuro-active medications, no neurological disorders, and no missing post-sleep subjective reports of sleep-wake times and confidence of these estimations. Standard scoring was performed, as well as further analysis of PSG single-lead electrocardiograms (ECG) using CPC analysis by RemLogic software. This is a mathematical integration of heart rate variability and ECG R wave amplitude fluctuations driven by respiration to generate frequency maps of coupled autonomic respiratory oscillations. The resulting sleep spectrogram is able to categorize NREM sleep as “stable” or high-frequency coupling (HFC) and unstable or low-frequency coupling (LFC), independent of sleep stages. Very-low-frequency coupling is associated with wake and REM sleep. Elevated LEF (e-LFEC) is a subset of LFC that is associated with fragmented sleep of various etiologies.

Results: We found that the absolute and relative (percentage) amounts of LFC were inversely related to confidence in reporting subjective TST and subjective WASO. In addition, although sleep stage content (absolute and percentage) did not predict confidence in reporting, other standard measures of sleep fragmentation (# of wake transitions, WASO, and sleep efficiency) were inversely related to confidence in reporting.

Conclusion: Both EEG-based and EKG-based measures of sleep fragmentation are inversely related to confidence in reporting sleep-wake durations after laboratory PSG. Future work will test the hypothesis that misperception itself is linked to a combination of objective sleep physiology and subjective confidence in assessing ones state of awareness.

0981
SLEEP DURATION, TIMING OF SLEEP AND THE HUMAN METABOLOME
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Introduction: Sleep plays an important role in maintaining metabolic homeostasis. Circadian disruptions such as sleep deficit and late chronotype have been linked to metabolic disorders. It is important to understand the influence of sleep on human metabolomic signatures. However no previous study has investigated habitual sleep in relation to human metabolome.

Methods: The study population included 339 Chinese men and women (age 43–79). Participants reported the time they went to bed and got up in four 7-day activity logs during a one year period. We used this information to calculate sleep duration and midpoint of sleep. Participants donated plasma samples at the end of the study year. Metabolite levels were measured using liquid-phase chromatography and gas chromatography coupled with mass spectrometry. Linear regression was used to evaluate sleep-metabolite associations, adjusting for age, gender, BMI, and smoking.

Results: In total we detected 329 metabolites with known identity. We found that midpoint of sleep was associated (false discovery rate < 0.2) with 30 metabolites from a wide range of biochemical classes and metabolic pathways. Notably, late sleep midpoint was associated with higher levels of five amino acids in the branched-chain and aromatic amino acids metabolism pathways. In contrast, late sleep midpoints were associated with decreased levels of 13 carnitines and fatty acids that were involved in beta-oxidation. Some of these metabolites and pathways have been linked to metabolic dysfunction such as obesity and diabetes. Other metabolites associated with sleep midpoint included those from nucleotide sugar metabolism, Krebs cycle, purine metabolism and several tea and coffee metabolites. Sleep duration was not significantly associated with any metabolites.

Conclusion: Difference in timing of sleep is associated with alterations in the human metabolomic profile. Our study suggests new candidates for investigating the mechanisms underlying the important health effects of sleep.

Support (If Any): This research was supported by the Intramural Research Program of the National Institutes of Health, National Cancer Institute, National Institutes of Health, Department of Health and Human Services.
PROTEOMIC DETERMINATION OF CANDIDATE BIOMARKERS IN INDIVIDUALS RESISTANT AND SENSITIVE TO SLEEP LOSS
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Introduction: Sleep loss, a common problem in the American population, has serious behavioral consequences such as increased human error-related accidents and decreased cognitive performance. Epidemiological studies indicate an association between sleep loss and increased rates of obesity, type-2 diabetes and an increased risk of cardiovascular disease. It is known that there is a large difference between individuals in how affected they are by sleep loss; some individuals are relatively resistant while others are markedly affected. It is conceivable that changes in protein expression produced by sleep loss might be different in these two groups.

Methods: Blood samples were obtained every 4 hours during baseline during 38 hours of sleep deprivation (SD) and then recovery sleep from 10 individuals who had a low behavioral response (resistant) to sleep deprivation, and 10 individuals who had a high behavioral response to sleep deprivation (sensitive). We employed a high throughput 3-D label free proteomic discovery strategy to assess proteins changing expression across 12, 24 and 36 hr of sleep deprivation in pooled samples from both groups. High-priority sleep deprivation biomarkers were verified using label-free multiple reaction monitoring (MRM) quantitation using the plasma samples from each of the 5 most resistant or sensitive individuals.

Results: We identified 60 proteins that define susceptibility and 99 proteins that define resistance to sleep deprivation. There were 6 proteins in common between the high and low responders and may represent the universal biomarker for sleepiness. 17 potential biomarkers were verified by MRM assays. Levels of 12 of the 17 proteins across different classes were markedly increased in the resistant group but not the sensitive groups at 24 hr of SD. Proteins include cell adhesion, lysosomal trafficking, signaling, complement and cytoskeletal function.

Conclusion: The resistant group is able to mount a physiological response to sleep deprivation that may afford cognitive protection.

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A gene-level analysis was conducted by selecting only bases with a 10x coverage or fewer than 5 subjects in either group were excluded. Ten bases remained statistical significant after chromosome-level Bonferroni correction which were on or near the following genes/regions: HOXA5, FZD10-AS1, ITPK1-AS1, LINC01395, EDG4, and SOX1. The genes with the most differentially methylated bases, after normalizing to gene length, are TUBA3E (4 bases), GDF7 (5 bases), GABRD (4 bases), HMX1 (3 bases), and CASZ1 (4 bases). Methylkit also identified these significantly differentially methylated genes: ACAP3, SALL3, ADAP1, and AASDH.

**Conclusion:** SDB in adolescents is associated DNA methylation in otherwise healthy population-based individuals. Future analysis will focus on validating significant findings in the entire cohort.

**Support (If Any):** NIH R01 HL63772, R01 HL97165, UL1 RR033184, C06 RR16499

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**0984**

**IMPROVEMENTS IN PSYCHOSOCIAL FUNCTIONING IN PRESCHOOL CHILDREN FOLLOWING RESOLUTION OF SLEEP DISORDERED BREATHING ARE DEPENDENT ON DISEASE SEVERITY**


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**Introduction:** Sleep disordered breathing (SDB) in children carries a high psychosocial morbidity. Treatment efficacy studies show short-term improvements, yet it is unknown if this is sustained long-term, particularly considering a proportion of children have residual SDB following treatment. This study aimed to determine whether sustained resolution of SDB in preschool children, either due to treatment or spontaneous, predicted improvements in quality of life, family functioning and parental stress.

**Methods:** Three years following a baseline study, children originally diagnosed with SDB at 3–5 y (primary snoring N = 16, mild obstructive sleep apnea (mild OSA) N = 11, moderate-severe (MS) OSA N = 8), and healthy non-snorers controls (N = 25) underwent repeat polysomnography (PSG). Parents completed quality of life (OSA-18 & PedSQL™) and stress (Parental Stress Index) questionnaires at both time points. Resolution of SDB was determined as obstructive apnea hypopnea index (OAH1) < 1 event/h, absence of snoring during PSG, and a score of zero on the OSA-18 sleep disturbance scale. Linear mixed-model analyses determined the effects of time and resolution (control N = 25, resolved N = 18, unresolved N = 17) on psychosocial outcomes. OAH1 was entered as a covariate to determine the predictive value of changes in SDB severity on psychosocial outcomes.

**Results:** 50% of PS, 45% mild OSA, and 63% MS OSA resolved. 67% of all children who had resolved received treatment (PS N = 4 treated/8 resolved; Mild OSA N = 3/5; MS OSA N = 5/5). 47% of children who received treatment remained unresolved (PS N = 2 treated/8 unresolved; Mild OSA N = 3/6; MS OSA N = 3/3). Children originally diagnosed with SDB continued to show significant psychosocial impairments on all measures compared to non-snorers controls, irrespective of resolution. A reduction in OAH1 significantly predicted improvements in OSA-18 physical symptoms, PedSQL™ school functioning, family worry and family relationships, and stress related to a difficult child on the Parental Stress Index.

**Conclusion:** This study shows that treatment is more likely to result in resolution if symptoms are severe, and the greater the reduction in obstructive events, the greater the effect on psychosocial outcomes. However, as children with SDB, irrespective of resolution, continue to experience psychosocial dysfunction, alternate interventions, particularly for children with mild forms of SDB, are urgently required.

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**0985**

**PERINATAL RISKS FACTORS ASSOCIATED WITH OBSTRUCTIVE SLEEP APNEA SYNDROME IN SCHOOL-AGED CHILDREN BORN PREMATURELY**

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**Introduction:** The obstructive sleep apnea syndrome (OSAS) is common in ex-premature children, and associated with several complications when left untreated. However, it is unknown whether OSAS, in ex-prematures, is associated with specific perinatal risk factors, such as birth weight, Apgar at 5 minutes, maternal race, antenatal corticosteroids, chorioamnionitis, delivery route, gender, and multiple gestation. Considering OSAS is more common in African Americans, and linked with inflammatory markers, we hypothesized that OSAS was associated with maternal race and chorioamnionitis.

**Methods:** 197 ex-premature (500–1,250 g) children aged 5–12 years who participated as neonates in a double-blind, randomized clinical trial (Caffeine for Apnea of Prematurity [CAPP]) of caffeine versus placebo, underwent full ambulatory polysomnography. A negative binomial regression model was used to identify perinatal risk factors associated with OSAS, defined as obstructive apnea hypopnea index (AHI) ≥ 2 events per hour.
0987
VALIDITY OF HOME PORTABLE MONITORING IN THE DIAGNOSIS OF OBSTRUCTIVE SLEEP APNEA IN ADOLESCENTS
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Introduction: The purpose of this study was to examine the validity of portable home sleep testing (PHST) equipment, relative to in-lab polysomnography (PSG), in the diagnosis of obstructive sleep apnea (OSA) in a sample of adolescents.

Methods: Adolescents (N = 159; aged 12–19) were enrolled if presenting with habitual snoring (> 3 nights/week) during an office visit. Data was obtained simultaneously between PSG and Embletta Gold® (PHST). Data from both study types were scored using guidelines in the American Academy of Sleep Medicine Manual for Scoring Sleep (2012). PHST studies were scored independently and blinded from the PSG results to prevent any bias in scoring. Individual and sleep-related parameters were collected from the final set of participants with sufficient scorable data from portable testing (a total sleep period of at least four hours) (N = 38).

Results: Mean obstructive apnea-hypopnea index (AHI) from PSG testing (5.7 ± 8.6 events/hour) was significantly higher than that from home testing (2.8 ± 2.9 events/hour, p < 0.05). The mean apnea index (AI) was higher in PHST compared to PSG (4.2 ± 3.9 vs. 1.5 ± 4.0, p < 0.05), while the PSG hypopnea index (HI) was higher than the portable HI (5.1 ± 6.0 vs. 3.7 ± 4.7; p < 0.05). PHST consistently underestimated the severity of OSA when AHI values were classified into five standardized categories (χ² (12) = 26.8, p < 0.05). PSG AHI was categorized as primary snoring (n = 17), mild (n = 5), moderate (n = 10), moderate-severe (n = 4), and severe (n = 2). Applying the same groups to PHST AHI values yielded primary snoring (n = 20), mild (n = 12), moderate (n = 5), moderate-severe (n = 1), and severe (n = 0). Three children were incorrectly diagnosed as disease-free (AHI of < 2 events/hour) and two children with severe OSA were incorrectly categorized, based on PHST v. PSG classifications. The overall difference between PSG and portable AHI values did not correlate with either arousal index or sleep efficiency. For adolescent OSA defined as an AHI ≥ 2, portable monitoring exhibited a sensitivity value of 0.52 and a specificity value of 0.53. With a definition of AHI ≥ 5, the sensitivity remained consistent at a value of 0.50, but specificity increased to 0.90.

Conclusion: PHST monitoring was found to underestimate obstructive AHI, overestimate AI, and underestimate the HI in the adolescent sample, relative to PSG. PHST also consistently underdiagnosed severity of OSA compared to PSG, indicating that HST should not be used as an alternative to PSG in adolescents. Future studies should identify factors causing the disparities in respiratory indices and consider additional data from PHST.

0988
CEREBRAL BLOOD FLOW RESPONSE TO HYPERCAPNIA IN CHILDREN WITH OBSTRUCTIVE SLEEP APNEA SYNDROME
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Introduction: Children with obstructive sleep apnea syndrome (OSAS) routinely have their sleep interrupted by periods of hypercapnia, a potent stimulator of cerebral blood flow (CBF). Considering this chronic hypercapnia exposure during sleep, it is possible that children...
with OSAS have abnormal CBF regulation even during wakefulness. Therefore, we hypothesized that children with OSAS have blunted CBF response to induced hypercapnia during wakefulness, compared to snorers and controls.

**Methods:** CBF increases during hypercapneic ventilatory response (HCVR) were tested in age-matched children with OSAS, snorers, and healthy controls utilizing diffuse correlation spectroscopy (DCS). To isolate and quantify the effects of hypercapnia, we measured the peak of CBF change compared to a pre-hypercapnic baseline.

**Results:** 12 children with OSAS (aged 10.1 ± 2.5 years, obstructive apnea hypopnea index (AHI = 9.4 (5.1–15.4) events/hour), 8 snorers (11 ± 3 years, 0.5 (0–1.3) events/hour), and 10 controls (11.4 ± 2.6 years, 0.3 (0.2–0.4) events/hour) were studied. The fractional change in cerebral blood flow relative to a pre-hypercapnic baseline, normalized to the change in end-tidal CO2, was significantly higher in healthy controls (8.3 (8.1–10)%/mmHg) compared to children with OSAS (7.5 (5.9–8.1), p = 0.023). Snorers also had a trend reaching significance blunted response (6.2 (5.2–8.7), p = 0.068).

**Conclusion:** Children with OSAS have blunted CBF response to hypercapnia during wakefulness compared to controls. Noninvasive DCS measurements of hypercapnic reactivity provide significant insight into the physiopathology of OSAS in children. This technique could lead to further understanding of central nervous system complications of OSAS and potentially provide a screening tool to assess CNS complications of OSAS.

**Support (If Any):** ASMF 93-JF-13, RedCap

### 0989

**CHARACTERIZING CHRONIC RESPIRATORY DISEASES OF INFANCY**


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**Introduction:** Premature infants have risk of chronic respiratory diseases, apnea of prematurity (AOP) and chronic lung disease prematurity (CLD). We characterized their baseline characteristics and response to therapy.

**Methods:** We retrospectively reviewed infants < 1 year old evaluated at our sleep center (Kaiser Permanente, Fontana) and diagnosed with a chronic respiratory disease. Most underwent nap polysomnography (PSG), but occasionally overnight PSG. Repeat PSGs performed every 1–2 months until therapy weaned. Baseline clinical characteristics/history and response to therapy parameters were assessed.

**Results:** From January 2013 to September 2013, 24 (15 girls; 9 boys) infants were diagnosed with AOP and/or CLD. 4 infants (mean gestational age 25 ± 12 weeks) were diagnosed with CLD only: baseline AHI 8.1 ± 7.8, T90% 4.7 ± 4.3%, minimum oxygen saturation 81.0 ± 2.2%. Oxygen (median 0.1875 LPM; range 0.0625–0.25 LPM) improved AHI to 3.3 ± 3.9 and mean age of disease resolution (therapy weaned) was 11 ± 2.9 months. 8 infants (mean gestational age 35 ± 5.6 weeks) were diagnosed with AOP only: baseline AHI 87.71 ± 85.66, T90% 8.4 ± 11.3%, minimum oxygen saturation 76.6 ± 4.2. Oxygen (median 0.25 LPM; range 0.0625–0.25 LPM) improved AHI to 5.7 ± 3.3 (p < 0.05) and mean age of resolution was 5.4 ± 5.3 months. 12 infants (mean gestational age 26 ± 1.4 weeks) were diagnosed with both AOP and CLD: baseline AHI 34.2 ± 21.0, T90% 10.3 ± 18.8%, minimum oxygen saturation 81.1 ± 6.5. Oxygen (median 0.125 LPM; range 0.125–0.25 LPM) improved AHI to 12.6 ± 10.9 (p < 0.01) and mean age of resolution was 7.7 ± 4.6 months. 2 patients had ALTEs, both in the AOP group (none after initiating therapy). Mean and max sleep CO2 were normal in all patients.

**Conclusion:** While AOP and CLD commonly occurred together, AOP (compared to CLD) had higher baseline AHI (central apneas), similar hypoxemia, was less premature, and resolved at younger age. Oxygen was effective at stabilizing both central apneas and hypoxemia. Inclusion of additional patients is pending.

### 0990

**HOME MONITORING OF ASTHMA DURING SLEEP IN CHILDREN**

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**Introduction:** Little is known about the pattern of asthma-specific events during sleep after patients are discharged from hospital. We have shown that the Sonomat (our investigational device), previously validated against PSG for snoring and respiratory events in adults, also captures asthma respiratory signs in children (e.g., wheezes, coughs). This device has no attached sensors and is suitable for long-term recording at home. The aim of this study was to determine if asthma signs persist during sleep at home following hospital admission for acute asthma exacerbation.

**Methods:** Three asthmatic children (2 male) aged 6–11 (mean 9.3) years with active wheeze and cough were monitored in hospital using the investigational device and then at home on three consecutive nights. Overnight sound recordings were manually reviewed by audio replay, time-expanded waveform and Fast-Fourier analysis to determine the presence and frequency of pathological sounds at home.

**Results:** All children had persistent wheezing and cough during their in-hospital recordings. Following discharge, pathological sounds (wheezes, coughs, crackles) were detected overnight at home. On Night One all children wheezed (range: 1–53% of analysed time) but this improved by Night Three (range: 0–4%), including one wheeze-free child. Two-of-three children snored overnight (range: 4–44%); both showed significant night-to-night variability (20% cf. 44% in one child; 4% cf. 12% in the other). Initially, coughing overnight was detected in two children; by Night Three this was eliminated in one child and lessened in the other.

**Conclusion:** Home-based monitoring reveals that nocturnal wheeze and cough persist in some children after hospital therapy for an asthma exacerbation. Sleep-Disordered Breathing (SDB) is common in these children and varies night-to-night. Monitoring respiratory signs during sleep over multiple nights at home could assist the management of asthma and help unravel the link(s) between SDB and asthma.

### 0991

**MEASUREMENT OF ASTHMA RESPIRATORY SIGNS IN CHILDREN**

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**Introduction:** While the link between sleep and asthma exacerbations is well known, it is difficult to track changes in asthma severity without disturbing the subject’s sleep. The Sonomat (our investigational device), a thin mattress overlay with built-in vibration sensors, has been validated against PSG for snoring and respiratory events in adults. This system records breath/lung sounds and so has the potential to capture asthma-specific events (e.g., wheezes, crackles, coughs). It has no attached sensors and is suitable for long-term recording at home. The aim of this study was to validate lung sounds recorded by the investigational device with simultaneous physician auscultation in children with active asthma.
Methods: Five asthmatic children (3 male) aged 2–11 (mean 8) years with active wheeze and cough were examined by a chest physician in a hospital paediatric department. Pathological sounds were physician-confirmed and simultaneously recorded using an electronic stethoscope and the investigational device. Sound recordings were compared using time-expanded waveform and Fast-Fourier spectral analysis.

Results: Fifteen wheeze and ten cough samples were analysed. Time-expanded waveform comparisons demonstrated superimposable paired recordings, confirmed with Fast-Fourier analysis. Peak wheeze frequencies ranged between 150 Hz and 315 Hz. There was no significant difference (p = 0.87) between auscultation- and investigational device-derived wheeze frequencies (difference range: 0–9 Hz; mean: 3.5 Hz). Coughing saturated the available frequency spectrum (up to 2 kHz) and had no fundamental frequencies. All coughs were detected by the investigational device.

Conclusion: The investigational device records asthma-specific signs that are currently identified using a stethoscope. Monitoring nocturnal respiratory sounds could assist asthma diagnosis and management and help unravel the link(s) between asthma and sleep-disordered breathing.

0992 TRENDS AND LEARNING CURVE FOR THE PEDIATRIC HOME VENTILATION PROGRAMS IN ALBERTA: 2003-2014

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Introduction: Rates of non-invasive ventilation (NIV) in children have increased worldwide but there is no data available in Alberta. The aim of this study is to describe the longitudinal trends of the pediatric NIV programs in Alberta.

Methods: This is a retrospective chart review of outpatient medical charts and sleep laboratory records of all children receiving NIV for ≥ 3 months and cared for through one of the two NIV programs in Alberta. Data was subdivided into 4-year epochs, 2003–2006, 2007–2010, and 2011–2014 for trends analysis.

Results: We identified 345 children who commenced NIV during a 12-year period at first site. We have reviewed 89 charts to date. The mean number of children starting NIV each year increased significantly across epochs (Kruskal-Wallis, p < 0.05): Nine children started NIV in the first epoch, 32 in the second and 48 in the third. Mean age of initiation across epochs differed; Age was similar in the first and second epochs (7.9 ± 2.5 years, 10.7 ± 5.1 years) but lower in the third epoch compared to the second (7.2 ± 5.4 years; post-hoc ANOVA, p < 0.05). Children < 2 years of age were only represented in the third epoch (24 subjects). The reason for NIV initiation differed across epochs; For example, NIV was initiated after acute illness in 11%, 13% and 37% respectively across epochs (Chi-square 10.33, p < 0.05). Overall, 56% of children were started on continuous positive airway pressure (CPAP) versus 44% on Bi-level support. There was no difference on NIV type across epochs. The interface type changed significantly across epochs with a higher proportion of nasal versus full-face mask over time: 6%, 27%, 67% respectively (Chi-square 15.6, p < 0.001).

Conclusion: NIV use in children has increased over time in Alberta. More recently, younger children and infants are receiving NIV. While type of ventilation has not changed over time, more nasal mask interfaces have been used. This analysis supports our trends in NIV are similar to those reported worldwide.

Support (If Any): This project was awarded with the Deloitte and Stollery Foundation Clinical Research Fellowship Grant and received support from the Women and Children’s Health Research institute (WCHRI).

0993 OUTCOMES AND COMPLICATIONS OF LONG-TERM NON INVASIVE VENTILATION IN CHILDREN IN ALBERTA: 2003-2014

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Introduction: The use of non-invasive ventilation (NIV) in children has risen exponentially over the last decade. There is little data about outcomes and complications in Canada. The aim of this study is to examine the clinical course and outcomes for children started on NIV in Alberta.

Methods: A retrospective review was performed for children using NIV ≥ 3 months and cared for through one of the two pediatric NIV programs in Alberta over the last 12 years. Clinic charts and sleep laboratory records were reviewed. Subjects were divided into 4 categories according to their underlying condition: Upper airway (UA), central nervous system (CNS), musculoskeletal (MSK), or cardiopulmonary (C-RESP) diseases. Symptom improvements, complications and discontinuation rates were extracted from clinical reports.

Results: A total of 345 children using NIV were identified at the first site; Eighty-nine charts have been reviewed to date. The mean age of NIV initiation was 8.7 ± 5.6 years. UA was the predominant disease category with 57% of children, CNS 23%, MSK 12.8%, and C-RESP 7.0%. G-tube and supplemental oxygen were used by 23.3% and 22% of children respectively. At 6–12 month follow-up after NIV initiation, improvements in sleep (81%), nocturnal breathing (96%), mood/behaviour (92%), learning/school performance (92%), and quality of life (QOL; 88%) were reported; Data from the most recent visit showed the same pattern with no difference by disease category. Overall, complications were reported for 63% of children. There were no differences in the type of complications by disease category, except hospitalizations. Thirty-five percent of children have been discharged from the NIV program; 20% of discharges were because of discontinuing NIV. There were no significant differences by disease category for those who discontinued NIV therapy.

Conclusion: NIV use in children often subjectively improved sleep, breathing, learning and QOL. NIV was associated with frequent complications. Disease category did not seem to affect reported symptom improvements, complications or NIV discontinuation rates except hospitalizations.

Support (If Any): This project has been awarded with the Deloitte and Stollery Foundation Clinical Research Fellowship Grant and received support from the Women and Children’s Health Research institute (WCHRI).

0994 FREQUENCY OF SLEEP DISORDERS IN A HYPERTENSIVE PEDIATRIC POPULATION

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Introduction: There is a reported association between hypertension (HTN) and sleep disorders. The Academy of Pediatrics (AAP) rec-
ommends screening hypertensive children for sleep disorders since they may increase the risk for cardiovascular disease. We quantified the frequency and severity of sleep disorders within our institution’s hypertensive pediatric population and evaluated the effectiveness of screening and performing polysomnography (NPSG).

**Methods:** A retrospective chart review identified pediatric patients at Children’s of Alabama who had ambulatory blood pressure monitoring (ABPM), NPSG within 1 year of the ABPM, and symptoms concerning for obstructive sleep apnea (OSA). We compared the frequency of sleep disorders within this population to the reported diagnosis rates and the observed rates in our sleep center.

**Results:** Out of 54 patients identified with ABPM and NPSG, 33 (61%) had ABPM positive for HTN. Of these 33, 17 patients were male (51.5%), 21 (64%) were African American, and mean BMI was 33. Diastolic, systolic or both pressures decreased less than 10% during the nighttime in 61% (20/33). Eleven children (33%) had an Apnea-Hypopnea Index (AHI) > 5 and seven (21%) were found to have PLMD. In our sleep center, the overall frequency of children with an AHI > 5 is 20% and the rate of PLMD is 10%. Mean sleep efficiency was 88%.

**Conclusion:** In the hypertensive pediatric population referred for NPSG at UAB, 64% were diagnosed with a sleep disorder (OSA and/or PLMD). Thirty-three percent of hypertensive children had moderate to severe OSA (AHI > 5) whereas only 20% of children evaluated in our sleep center had moderate to severe OSA. Screening for sleep disorders and obtaining NPSG in hypertensive children increases the identification of comorbid sleep disorders (including more severe OSA and PLMD) and is an effective practice. These findings support the AAP’s recommendation to screen hypertensive children for sleep disorders.

### 0995
**RESOLUTION OF SLEEP DISORDERED BREATHING IN THREE CHILDREN WITH CHRONIC KIDNEY DISEASE POST RENAL TRANSPLANT**

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**Introduction:** There is an increased prevalence of sleep disordered breathing (SDB) in chronic kidney disease (CKD). Factors responsible for SDB in CKD include an increased apnic threshold secondary to uremia, uremic neuropathy causing decreased upper airway muscle tone, as well as metabolic alkalosis secondary to bicarbonate based dialysate fluids leading to hypoventilation and hypcapnia. The literature assessing SDB in pediatric CKD using polysomnogram (PSG), the gold standard to diagnose SDB is limited. Our aim was to describe the PSG features of children with paediatric CKD pre and post renal transplant.

**Methods:** We reviewed the results of three paediatric CKD patients. The baseline PSGs were performed as part of a larger research protocol approved by the Research Ethics Board (REB) at the Hospital for Sick Children (REB #1000031590).

**Results:** Patient 1 was a 5 year old girl with membranoproliferative glomerulonephritis who underwent bilateral nephrectomies for severe hypertension. Nocturnal intermittent peritoneal dialysis using Physioneal™ was started. Baseline PSG demonstrated hypoventilation with an end tidal carbon dioxide level being greater than 50 mmHg for 98.5% of the total sleep time. Patient 2 was a 7 year old boy with posterior urethral valves, renal dysplasia and stage 4 CKD. Baseline PSG was significant for a CAHI of 8.2/hr. Patient 3 had a diagnosis of Joubert’s syndrome, hypertension and stage 4 CKD. The baseline PSG was significant for a CAHI of 6.3/hr. All three patients underwent repeat PSGs three months post transplant. There was complete resolution of SDB in all patients.

**Conclusion:** Children with CKD are at risk for SDB and there should be a low threshold for screening with PSG. The resolution of SDB suggests that this was secondary to the underlying kidney disease. Further research is needed to identify the clinical characteristics that predict the development of SDB in children with CKD.

### 0996
**THE IMPACT OF ADENOTONSILLECTOMY ON SLEEP DISORDERED BREATHING IN CHILDREN WITH SICKLE CELL DISEASE**

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**Introduction:** Obstructive sleep apnea (OSA) is a common disorder in children estimated at 2–3% in the general pediatric population. The prevalence in patients with sickle cell disease (SCD) has been estimated to be higher at 30–70%. Intermittent nocturnal hypoxia, characteristic of OSA is thought to predispose to vaso-occlusive events in children with SCD. OSA in this population is believed to be related to adenotonsillar hypertrophy secondary to compensatory lymphoid hyperplasia. Adenotonsilsillectomy (AT) has been recognized as the first line treatment for moderate to severe OSA in children. The aim of this study was to review the polysomnogram (PSG) results of SCD patients with moderate to severe OSA pre and post AT.

**Methods:** We retrospectively reviewed PSG data in patients with SCD pre and post AT from 2003 to 2014. Moderate OSA was defined as an obstructive apnea-hypopnea index (OAHI) of > 5–10/hr and severe if OAHI of > 10/hr. Resolution of OSA was defined as an OAHI < 1.5 events per hour.

**Results:** The study included 17 patients with SCD and OSA with a median age of 6.8 years and a median BMI of 15 kg/m² at the time of the first PSG. The median OAHI was 11.6/hr pre-AT. 13/17 (76%) patients had severe OSA and 4/17 (24%) had moderate OSA. Post-AT, 12/17 (70.5%) of patients had PSG resolution of OSA, p < 0.001. However, 5/17 (29%) had persistent OSA with 2/5 were in the mild range, 2/5 in the moderate range and the one had severe OSA.

**Conclusion:** In this retrospective study we report the significant improvement of the OAHI post-AT in the majority of SCD children with moderate to severe OSA. However, 30% of children with SCD have persistent OSA despite AT and further work should evaluate the risk factors for persistent OSA in children with SCD.

### 0997
**EVALUATION OF THE PEDIATRIC SLEEP QUESTIONNAIRE (PSQ) TO SCREEN OSA IN SEVERELY OBSESE ADOLESCENTS ENROLLED IN THE TEEN-LABS STUDY**

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**Introduction:** Obstructive Sleep Apnea (OSA) is reported in up to 70% of adolescents who present for bariatric surgery. The Pediatric Sleep Questionnaire (PSQ) was developed to identify children at risk for OSA, but has not been validated in morbidly obese adolescents. Using polysomnographic results as the gold standard, the aims of this study were: (1) to assess the validity of PSQ to detect OSA and (2) determine correlation between physical exam findings and polysomnograph (PSG) parameters in this population.
Methods: We conducted a cross-sectional assessment of subjects recruited in the Teen-Longitudinal Assessment of Bariatric Surgery (Teen-LABS) study who were at high risk for OSA. Each underwent an overnight PSG and had a PSQ completed by a caregiver prior to bariatric surgery. Student’s t-test was used to compare groups and spearman correlation was used to evaluate the relationship between variables.

Results: Forty-five subjects were included in the analysis. Mean age was 16.7 ± 1.5 years; 84% were female, 78% were Caucasian. Mean BMI was 51.3 ± 7.7 kg/m². The mean obstructive apnea-hypopnea index (oAHI) was 6.1 ± 5.9 events per hour. Using the oAHI ≥ 5 for the diagnosis of OSA, the sensitivity, specificity, and positive predictive value (PPV) of PSQ total score were 86%, 38%, and 55%, respectively. The specificity and PPV of the question, “Do you snore,” were both 100%, although the sensitivity was only 18%. Sagittal abdominal diameter correlated with both the oAHI and O2 saturation nadir (rho 0.34, p = 0.027). Neck and waist circumference did not correlate with oAHI or saturation nadir.

Conclusion: The PSQ had low specificity and PPV for OSA in our cohort of severely obese adolescents. Inquires about snoring had high PPV, but poor sensitivity. Of the physical exam findings evaluated, sagittal abdominal diameter, but not neck or waist circumference, correlated with oAHI and oxygen saturation nadir.

0998

PHYSICAL ACTIVITY AMONG OBESE YOUTH WITH AND WITHOUT OBSTRUCTIVE SLEEP APNEA
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Introduction: Obstructive sleep apnea (OSA) is noted in ~25% of obese children. Obese children with OSA often report feeling tired, sleepy, and have an overall lack of energy during the day. This may contribute to low physical activity levels and subsequent lower energy expenditure, promoting further weight gain. This study aimed to identify factors associated with moderate-to-vigorous physical activity (MVPA) among obese youth with and without OSA.

Methods: This was a prospective study at the Hospital for Sick Children whereby obese youth were recruited from sleep clinic. Parental anthropometric measures included height, weight, BMI, and waist, hip and neck circumference. An overnight polysomnogram was performed to evaluate for OSA using the obstructive apnea-hypopnea index. Daytime sleepiness was measured using the modified Epworth Sleepiness Scale (ESS). Accelerometry assessed MVPA during waking hours over 7 consecutive days.

Results: Participants (n = 45; 56% male) (mean ± standard deviation; Age (14 ± 3 years); height (161 ± 13 cm), weight (95 ± 30 kg), BMI (36 ± 8 kg/m²), waist circumference (102 ± 19 cm), hip circumference (110 ± 24 cm), and neck circumference (37 ± 6 cm)) accumulated 11 minutes of MVPA per day. The mean ESS was not significantly different between those with (n = 15) and without (n = 30) OSA (9 ± 5 vs. 10 ± 5 points; p = 0.62). Participants with OSA engaged in fewer minutes of MVPA compared to participants without OSA (9 ± 3 vs. 13 ± 9 minutes per day; p = 0.05). The association between MVPA and ESS was not significantly different between those with and without OSA (parameter estimate[standard error]; p-value)(+0.6[0.4]; p = 0.14).

Conclusion: Obese youth with OSA accumulated less MVPA than those without OSA. However, the entire study population achieved only 11 minutes of MVPA per day despite the current physical activity recommendations for children to accumulate 60 minutes of MVPA per day. Efforts should focus on increasing MVPA to reduce obesity among youth, especially those with OSA. Additional research is needed to elucidate the relationship between MVPA, OSA and daytime sleepiness amongst obese youth.

0999

ACOUSTIC ANALYSIS OF BREATH SOUNDS FOR THE DIAGNOSIS OF SLEEP APNEA IN OBESE ADOLESCENTS
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Introduction: Significant increases in the demand for polysomnography (PSG) to diagnose sleep disorders in children is associated with an increase in the wait times to perform PSG. Of importance, PSG has modifiable risk factors and the lack of timely diagnosis of SDB limits the scope of potentially beneficial treatments in children. The identification and validation of new diagnostic modalities for SDB in ambulatory settings is urgently needed for children. The aim of this study was to evaluate one such tool, the ApneaDx monitor, in a pilot set of subjects. ApneaDx records breath sounds from which the apnea-hypopnea Index (AHI) is derived. In adults, there is a 95% correlation between the AHI derived from ApneaDx and from PSG.

Methods: In this prospective comparative study, obese patients were recruited during sleep clinic and underwent a full overnight PSG at which time an ApneaDx monitor was applied simultaneously. Scoring of AHI by PSG was done according to the American Academy of Sleep Medicine 2.1 standards. ApneaDx scoring was done automatically using previously developed and validated acoustic analysis algorithms.

Results: Eleven subjects (5 females) with a mean age of mean age of 14.6 (± 3.2) years and a mean body mass index (BMI) of 34.6 (± 6.4) kg/m² were studied. There was a significant correlation between ApneaDx AHI and PSG AHI (Spearman r = 0.8, p = 0.005, [95% CI 0.372–0.95]). Using an AHI cut-off of 5/hour, the ApneaDx had a sensitivity of 100% and specificity of 71% and a negative predictive value of 100% to detect SDB against simultaneous PSG.

Conclusion: These pilot data indicate that ApneaDx may be a useful diagnostic device for children and adolescents with SDB, given its high NPV. Future work is required to evaluate and validate this monitor in a larger paediatric population.

1000

FAMILIAR AGGREGATION OF HABITUAL SNORING USING CHILDREN PROBANDS
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Introduction: This study aimed to examine familial aggregation of habitual snoring (HS) using paediatric probands, and we hypothesized that first-degree relatives of children with HS were more likely to have HS.

Methods: Cases were attendants to our sleep disorder clinic aged between 6 and 18 years. Their parents completed a validated sleep symptoms questionnaire. Cases who snored for at least 3 nights per week in the past 12 months were considered as having HS. Controls without HS were recruited from a concurrent population-based epidemiological study. Parents and siblings of both cases and controls were also invited to complete a self-reported and a parent-reported questionnaire, respectively, to determine their snoring status. Generalized estimat-
ing equations were used to examine if first degree relatives of cases had higher odds of having HS when compared to controls. Separate analyses were performed for families of overweight and normal weight cases.

**Results:** A total of 62 cases with HS and 74 controls were recruited. A total of 295 first-degree relatives participated, of whom 133 (including 59 fathers, 62 mothers and 12 siblings) were of cases and 162 (including 70 fathers, 68 mothers and 24 siblings) were of controls. The results showed that first-degree relatives of cases had significantly higher odds of having HS [OR adjusted for age, gender and body size = 1.9 (95% CI: 1.1–3.4), p = 0.022]. Subgroup analysis revealed that the odds ratio was only significant in family members of normal weight cases [adjusted OR = 2.4 (95% CI: 1.2–4.8), p = 0.011] but not in those of overweight cases [adjusted OR = 1.6 (95% CI: 0.6–4.1), p = 0.31].

**Conclusion:** First-degree relatives of the only normal weight subjects had an increased odds of having HS.

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**1001 SYMPTOMS OF OBSTRUCTIVE SLEEP APNEA IN CHILDREN WITH A PARENT DIAGNOSED WITH OBSTRUCTIVE SLEEP APNEA**

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**Introduction:** Untreated paediatric obstructive sleep apnoea (OSA) is associated with a range of detrimental academic and health outcomes. Recognising the presence of OSA in children early so that they can receive timely treatment is therefore of the utmost importance. Known risk factors for paediatric OSA include enlarged tonsils and adenoids, craniofacial abnormalities, neuromuscular co-morbidities and obesity. Genetic predisposition has also been reported. We hypothesised that children of a parent diagnosed with OSA would be more likely to have symptoms and physical characteristics of OSA than age and gender matched controls. Aim: To document symptoms of OSA in children whose parents have been diagnosed with OSA and compare them to age and sex matched controls.

**Methods:** A case-control study. We recruited 25 children who had a parent diagnosed with OSA and 25 age and gender matched controls from the community whose parents scored as low risk for OSA (using adjusted Flemons score). The following measures were compared: OSA-18 questionnaire, measures of height and weight and mallampati score.

**Results:** There was a significant difference between the case and control groups on the OSA-18 questionnaire. Average score (SD) was 36.5 ± 18.1 for cases and 28.1 ± 9.1 for controls, resulting in an average difference of 8.4 (p = 0.018). Twenty percent (n = 5) of cases scored > 60 indicating a significant impact on quality of life. 56% of the cases group had a mallampati score of either III or IV compared to only 11% in the control group. There was a significant difference in BMIz between groups with the cases group averaging 0.56 ± 1.07 and the control group −0.15 ± 0.67 (p value = 0.002).

**Conclusion:** Children of parents with OSA are more likely than age matched controls to have symptoms of OSA and physical findings that are associated with an increased risk of obstruction. Further assessment will be required to determine whether a definite diagnosis of OSA can be made in these children and results will be compared to data obtained from children referred for sleep studies via a pediatric sleep service.

**Support (If Any):** Maurice and Phyllis Paykel Trust

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**1002 REM DEPENDENT OBSTRUCTIVE SLEEP APNEA IN CHILDREN**

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**Introduction:** The pathophysiology of the obstructive sleep apnea in children is still unclear. Therefore, indication criteria of the treatment are not clear. We compare the pathologic character of REM-dependent OSA with non-REM-dependent OSA.

**Methods:** We enroll consecutive 386 children who underwent PSG from June 2002 to May 2012 in Ota memorial sleep center retrospectively, we compare polygraphic parameters (total sleep time, sleep latency, sleep efficiency, sleep stage, oxygen desaturation index, PLM, Obstructive Apnea Index, respiratorily-related arousal index), cephalometric parameters (SNA, SNB, Fx, MPH, PAS, PNS-P), a parameter of rhinomanometry and so on.

**Results:** Obstructive Apnea Index and respiratory-related arousal index were significantly lower in the REM dependent case. As a result, REM dependent OSA was mild. Furthermore, we compare the children under 6 years old group with over 6 years old group. In a group of under six years respiratory-related arousal index were significantly lower in the REM dependent case (12.3 vs 7.3). On the other hand, in a group of over 6 years value of total nasal resistance in supine position was significantly higher in the REM dependent case (0.659 vs 0.796). Now, therefore we speculate association between nasal obstruction and severity of OSA in a elderly group.

**Conclusion:** REM-dependent OSA in children is mild as well as adults OSA. In child OSA, there are various pathophysiology according to age.

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**1003 INFANT FEEDING METHOD AND PEDIATRIC SLEEP-DISORDERED BREATHING**


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**Introduction:** Our previous work shows that children breastfed for longer durations as infants have reduced sleep-disordered breathing (SDB) severity. This makes conceptual sense: adenotonsillar hypertrophy is an inflammatory disorder and breast milk provides immunological protection. Additionally, breastfeeding alters infant upper airway morphology. Thus, two mechanisms may be responsible for proper development of the upper airway. Our goal is to determine whether immunological protection, morphological changes—or some combination of the two—provide this benefit.

**Methods:** We use a Siemens Verio 3 Tesla magnetic resonance imaging (MRI) to image children diagnosed with but not yet treated for SDB, who were or were not breastfed as infants. T2 sequences of both axial and sagittal scan planes will be used to image the airway. Upper airway quantification is used to determine whether breastfeeding’s effect is immunological (reduced upper airway lymphatic tissue volume), morphological (increased upper airway skeletal space), or both. A brief neurocognitive assessment battery is administered.

**Results:** Twenty children 4–8 years (m = 6.6, 40% female, 85% white non-Hispanic) with clinically significant SDB have completed the protocol. Following three additional participants and MRI processing, the investigators will be unblinded to feeding methods. Results available at the conference will address three hypotheses: (1) Breastfed children have smaller proportional adenotonsillar volume compared to non-breastfed children; (2) Breastfed children have larger proportional...
upper airway volume independent of adenotonsillar volume compared to non-breastfed children; and (3) Magnitude of airway differences is associated with reduced SDB severity and improved neurocognitive outcomes.

**Conclusion:** Our work holds the potential for SDB prevention. Knowledge from this research will enable us to direct prevention efforts toward either encouraging longer and exclusive breastfeeding durations for at-risk infants and/or improving existing artificial feeding methods that mimic breastfeeding’s positive effects on healthy infant airway development.

**Support (If Any):** Pilot Project Granting through NIH/NIGMS P30 GM103505 awarded to the West Virginia University Center for Neuroscience.

### 1004 IMPAIRED MEMORY CONSOLIDATION IN CHILDREN WITH MILD SLEEP DISORDERED BREATHING

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**Introduction:** Neuropsychological testing has yielded mixed results regarding the cognitive effects of sleep disordered breathing (SDB) in children. Memory consolidation has been shown to be sleep dependent in children and may be more susceptible to sleep disturbances from SDB. In this study, we compare memory consolidation across wake and sleep periods in children ages 5–9 years with SDB (RDI > 1/hour) compared to controls.

**Methods:** 14 otherwise healthy children with SDB and 7 controls matched for age, maternal education and gender were trained and tested on a 2D object location task prior to an overnight, in-lab polysomnogram (PSG) and retested approximately 10 hours later. At least 1 week before or after this test, subjects were tested across 10 hr of daytime wake with a different version of the task. Condition order and task versions were counterbalanced. Prior to all test and retesting phases, subjects completed a 3 minute psychomotor vigilance test (PVT). We compared memory consolidation (test-retest differences) across condition, PVT reaction times, Child Behavior Checklist total problems scores, and Conner ADHD T-scores between groups.

**Results:** We detected group differences in memory consolidation [SDB = −17.5 ± 5.5% (SEM), control: 7.9 ± 7.8%, F(1,19) = 7.1, p = 0.02], but found no main effect of condition (p = 0.82) or group x condition interaction on memory consolidation (p = 0.36). We found no differences in PVT reaction times based on time, group, and group x time interaction (all p’s > 0.2). CBCL total problems test and Conners ADHD test scores were not significantly different between groups (p = 0.19, p = 0.79, respectively), suggesting lack of confounding effects on memory performance results.

**Conclusion:** Memory consolidation is impaired in children with RDI > 1/hour compared to controls; however, we do not find an interaction with condition to suggest that these results are sleep dependent. These findings highlight the broader problem of impaired memory consolidation even in children with mild sleep disordered breathing.

**Support (If Any):** This study was sponsored by the American Sleep Medicine Foundation, Physician Scientist Training Award

### 1005 INFLAMMATORY CYTOKINES IN PEDIATRIC OBSTRUCTIVE SLEEP APNEA

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**Introduction:** Investigation: Pro-inflammatory cytokine IL 17, a pleiotropic cytokine produced by a unique CD4+ Th helper (Th) subset Th17 cells, and IL 23, an heterodimeric cytokine, crucial for production of pathogenic CD4+T cell population. Therefore, this study aims to find the specific interleukins in pediatric obstructive sleep apnea.

**Methods:** We collected 3–18 years children in this study. Inclusion criteria are based on polysomogram (PSG) findings and clinical symptoms. We divided these subjects into two groups (1)Controls: Individuals without symptoms, snoring, and AHI. All participants underwent an overnight PSG test followed by blood withdraw and neurocognitive function evaluations in the next morning. Plasma samples were analyzed of inflammatory cytokines including: high sensitivity C reactive protein (HS CRP), tumor necrosis factor alpha (TNF alpha), interleukins 1 (IL 1), 6 (IL 6), 10 (IL 10), 17 (IL 17) and 23 (IL 23).

**Results:** 84 non-obese children (F:M = 25:53, mean age = 7.86 ± 3.10 years, body mass index [BMI] = 18.26 ± 4.86 kg/m², BMI z score = 0.45 ± 0.31) were enrolled including: (1) 30 healthy control children (F:M = 9:21, mean age = 7.98 ± 2.68 y, [BMI] = 17.91 ± 2.10 kg/m², BMI z score = 0.28 ± 1.00) mean AHI = 0.54 ± 0.47/hour; (2) 52 OSA children (F:M = 20:32, mean age = 8.05 ± 3.33 y, [BMI] = 19.03 ± 5.26 kg/m², BMI z score = 0.68 ± 1.32) with clinical symptoms and mean AHI = 10.35 ± 13.80/hour. Serum analyses (controls versus OSA): HS CRP (mg/l): 0.40 ± 0.20 and 1.88 ± 3.26 p = 0.002 and IL-17 (pg/mL): 8.93 ± 5.55 and 14.08 ± 9.09, p = 0.029 were the only significant results. IL 23 had non significant trend: 12.14 ± 3.90 and 14.37 ± 4.56 p = 0.056. Post T&A analyses show significant reduction in HS CRP and interleukine 17 levels.

**Conclusion:** The high expression of Th 17 level may contribute to complications of untreated pediatric OSA.

### 1006 INFLAMMATION IS ASSOCIATED WITH OVERWEIGHT AND SLEEP DISORDERED BREATHING IN A DOSE-RESPONSE PATTERN IN ADOLESCENTS

Pennsylvania State University, Hershey, PA

**Introduction:** Many studies have established the association between overweight and sleep-disordered breathing (SDB) with elevated inflammation. No study to date, however, has examined the joint effect of these factors on inflammation in adolescents.

**Methods:** A sample of 421 adolescents (17.0 ± 2.3 y, 53.9% male) from the Penn State Child Cohort, a representative general population sample, underwent a single 9-hour polysomnography (PSG) recording and physical examination. Body mass index (BMI) percentile was ascertained in accordance with CDC standards. A single fasting blood draw was collected in the morning and assayed for IL-6, TNFa, and CRP via ELISA. “SDB” was defined as AHI ≥ 5, “mild SDB” as 2 ≤ AHI < 5, or “no SDB” as AHI < 2. “Overweight” was defined as BMI ≥ 85th percentile. ANCOVA assessed differences in three groups (lean without SDB, overweight without SDB, and overweight with SDB), adjusting for age, gender, and race.

**Results:** Elevated IL-6 was observed in overweight adolescents with SDB (2.32 ± 0.18 pg/mL) compared to lean without SDB (1.03 ± 0.07 pg/
mL) and overweight without SDB (1.05 ± 0.08 pg/mL, both p < 0.001). Similarly, TNFα was significantly elevated in those overweight with SDB (2.93 ± 0.26 pg/mL) compared to lean without SDB (1.76 ± 0.10 pg/mL) and overweight without SDB (1.88 ± 0.11 pg/mL, both p < 0.001). Finally, CRP was significantly elevated in overweight with SDB (2.64 ± 0.19 mg/L) compared to lean without SDB (0.58 ± 0.07 mg/L) and overweight without SDB (0.88 ± 0.08 mg/L, both P < 0.001); of those without SDB, overweight also had significantly higher CRP than lean adolescents (p = 0.007).

**Conclusion:** The joint effect of overweight and SDB is associated with elevated inflammation in a dose-response pattern in adolescents. Future studies should examine the role of systemic inflammation in predicting cardiometabolic abnormalities in children and adolescents with SDB.

**Support (If Any):** NIH R01 HL63772, R01 HL97165, UL1 RR033184, C06 RR16499

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### 1007

**THE ROLE OF INFLAMMATION IN THE ASSOCIATION BETWEEN SLEEP-DISORDERED BREATHING AND NEUROCOGNITIVE FUNCTIONING IN ADOLESCENTS**

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**Introduction:** Sleep-disordered breathing (SDB) has been associated with impaired neurocognitive functioning. However, the role of inflammation in predicting neurocognitive deficits in SDB is unclear. The aim of this study was to examine whether the inflammatory factor C-reactive protein (CRP) is associated with impaired neurocognition in adolescents with SDB.

**Methods:** A sample of 421 adolescents (17.0 ± 2.3 y, 53.9% male) from the Penn State Child Cohort, a representative general population sample, underwent a single 9-hour polysomnography (PSG) recording, anthropometric and blood pressure measures, and a dual-energy X-ray absorptiometry (DXA) scan. A single fasting blood draw was taken upon awakening (7:00) and assayed for CRP, glucose, insulin, and lipids. “SDB” was defined as AHI ≥ 5, whereas “mild SDB” was defined as 2 ≤ AHI < 5. Linear regression assessed the association of SDB and CRP on various neurocognitive outcomes, adjusting for age, gender, BMI percentile, and race.

**Results:** Overall, there was a marginal interaction between SDB and CRP on processing speed (B = −0.12, p = 0.15). While CRP was not associated with any neurocognitive outcomes within mild SDB (all p > 0.37), elevated CRP was significantly associated with deficits in processing speed in those with SDB (B = −0.38, p = 0.02).

**Conclusion:** Inflammation is associated with impaired processing speed in those with sleep apnea. These data offer a possible mechanism by which neurocognitive functioning is affected in subjects with SDB, suggesting that CRP may be a useful marker of sleep apnea severity in adolescents.

**Support (If Any):** NIH R01 HL63772, R01 HL97165, UL1 RR033184, C06 RR16499

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### 1008

**INFLAMMATION IS ASSOCIATED WITH CARDIOMETABOLIC ABNORMALITIES IN ADOLESCENTS WITH SLEEP-DISORDERED BREATHING**

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**Introduction:** Many studies have established a link between inflammation and sleep-disordered breathing (SDB). However, the role of inflammation in assessing the medical severity of SDB is unclear. The aim of this study was to examine whether the inflammatory factor C-reactive protein (CRP) is associated with cardiometabolic aberrations in adolescents with SDB.

**Methods:** A sample of 421 adolescents (17.0 ± 2.3 y, 53.9% male) from the Penn State Child Cohort, a representative general population sample, underwent a single 9-hour polysomnography (PSG) recording, anthropometric and blood pressure measures, and a dual-energy X-ray absorptiometry (DXA) scan. A single fasting blood draw was taken upon awakening (7:00) and assayed for CRP, glucose, insulin, and lipids. “SDB” was defined as AHI ≥ 5, whereas “mild SDB” was defined as 2 ≤ AHI < 5. Linear regression assessed the association of SDB and CRP on various neurocognitive outcomes, adjusting for age, gender, BMI percentile, and race.

**Results:** A significant interaction between SDB and CRP was observed for triglycerides (B = 0.23, p = 0.02), continuous metabolic syndrome score (cMetS; B = 0.22, p = 0.01), and a trend for insulin resistance (HOMA; B = 0.18, p = 0.07). Specifically, metabolic aberrations were associated with elevated CRP in an SDB-dose-response manner. Compared to mild SDB, CRP in SDB was more strongly associated with cMetS (B = 0.43, p = 0.001 vs. B = 0.18, p = 0.05, respectively), HOMA (B = 0.61, p < 0.001 vs. B = 0.21, p = 0.04), triglycerides (B = 0.55, p = 0.01 vs. B = 0.07, p = 0.47), and visceral fat area (B = 0.25, p = 0.08 vs. B = 0.03, p = 0.70).

**Conclusion:** Elevated plasma CRP is associated with metabolic abnormalities, suggesting that this biomarker may be a clinically useful predictor of the medical severity of SDB in adolescents. Future studies should examine how the association between inflammation and SDB severity on cardiovascular and metabolic aberrations progress during the transition into young adulthood and middle age.

**Support (If Any):** NIH R01 HL63772, R01 HL97165, UL1 RR033184, C06 RR16499

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### 1009

**ASSOCIATION BETWEEN SLEEP DISORDERED BREATHING WITH BODY MASS INDEX, GENDER AND MALOCCLUSION IN CHILDREN**

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**Introduction:** The aim of this study was to investigate the association of body mass index (BMI), gender and malocclusion with sleep disordered breathing (SDB) in children.

**Methods:** 1216 children (569 boys) aged 7 to 9 years that studied in municipal schools in Osasco/Brazil were selected through randomization. We excluded children with syndromes, cleft lip and/or palate, had undergone tonsil and/or adenoid surgery, were under or had a history of orthodontic treatment. The SDB was measured by Sleep Disturbance Scale for Children. Answers are given on Likert scale of 1 to 5: 1 point for “never”, 2 points for “occasionally” (once or twice per month), 3 points for “sometimes” (once or twice per week), 4 points for “often” (3 to 5 times per week), and 5 points for “always” (daily). Hence, the sum score for the three questions can be at least 3 and at most 15. The cutoff
point adopted was 8. The BMI were divided according to the National Center for Health - USA: Underweight, Healthy Weight, Overweight, Obese. A dentist assessed the occlusion by: Molar relationship (Angle’s classification), Crossbite, Open bite, Overjet, Overbite, and Crowding. We analyzed SDB by gender, BMI and occlusion.

Results: Of all children, 220 (18.09%) had SDB, there more SDB in boys (122; 21%) compared to girls (98; 15%), and there were more obese children with SDB (47; 29%) compared to the healthy weight children (139; 16%), p < 0.01. Among children with SDB, underweight children (35; 2.88%) and overweight children (176, 14.47%), there were no association among SDB and all malocclusion. For healthy weight children (843; 69.33%), there were more SDB children with: molar relationship class II/III (85; 19%) compared to class I (54; 13%), p = 0.01, overjet (46; 23%) compared to normal overjet (93; 15%; p < 0.01) and crowding (62; 21%) compared to no-crowding (77; 14%; p = 0.01). For obese children (162,13.32%) there was more SDB children with overbite (21; 39%) than compared to normal overbite (26; 24%; p = 0.05).

Conclusion: Boys and obese children had more SDB. SDB children with healthy weight seem to have more malocclusion associated.

Support (If Any): FAPESP (# 2010/02633-2)

1010 DEVELOPMENT OF A MODIFIED STOP-BANG TOOL FOR ADOLESCENT CHILDREN
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Introduction: There are a limited number of tools available to assess the risk of sleep-disordered breathing (SDB) in children, and screening rates in primary care are low. STOP-Bang is a frequently used tool to risk-stratify adults for SDB. We developed a modified STOP-Bang to assess the risk of SDB in adolescent children.

Methods: 312 children (age 9–17) from phase 2 of the Tucson Children’s Assessment of Sleep Apnea cohort study, with complete anthropomorphic data, parent questionnaires, and home polysomnograms were included. The following were included as an adolescent modification of STOP-Bang: snoring, tired, observed apnea, blood pressure ≥ 95th percentile (for height and age), BMI > 95th percentile for age, academic problems, neck circumference > 95th percentile for age, and male gender. An apnea-hypopnea index ≥ 1.5 events/hr was considered diagnostic of SDB.

Results: Receiver Operator Characteristic (ROC) curves for parent-reported STOP-Bang scores were generated for teenage and pre-teen children. The area under the curve (AUC) for teenage children was 0.77 (95% confidence interval [CI] 0.65–0.90) and was not different than that for preteen children (0.68; 95% CI 0.51–0.85, p = 0.42). A STOP-Bang score of ≥ 3 in teenage children was associated with a sensitivity of 64%, specificity of 82%, positive predictive value of 0.24 and negative predictive value of 0.96. To assess whether pubertal status influenced test characteristics, ROC curves were generated based on child-reported sexual maturity rating (SMR), available for 291 children. The AUC for children SMR ≥ 4 (0.83; 95% CI 0.71–0.95) was better than children with SMR < 4 (0.63; 95% CI 0.46–0.81) (p = 0.048).

Conclusion: Due to its high negative predictive value, this modified STOP-Bang may be useful in risk-stratifying the likelihood for SDB in adolescents. The improved test characteristics in children with a greater SMR are likely related to the changes in SDB phenotype in older compared to younger children.

Support (If Any): Arizona Respiratory Center

1011 A SIMPLIFIED DIAGNOSIS SCALE BASED ON THE ANALYSIS AND SCREENING OF CLINICAL PARAMETERS IN PEDIATRIC OBSTRUCTIVE SLEEP APNEA HYPOPNEA SYNDROME
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Introduction: To develop a simplified and accurate method to diagnose the pediatric obstructive sleep apnea hypopnea syndrome (OSAHS).

Methods: A total of 311 children with suspected pediatric OSAHS were included in the study and were divided into group A and group B. The clinical parameters, including gender, age, body mass index (BMI), history of snoring or gasping, history of nasal obstruction, history of running nose, palate tonsil size, adenoid/nasopharynx (A/N) ratio, and curve type based on acoustic immittance, were compared with polysomnography (PSG) result in group A using relevant correlation and regression analysis. Based on the established regression equation, the diagnostic coincidences between PSG result and dependent result in group A and B were calculated. Finally, a diagnostic scale was established according to the transformed equation.

Results: There was no significant difference in clinical data between group A and group B. Apnea-hypopnea index (AHI) had significant positive correlations with history of snoring or gasping, palate tonsil size, and curve type based on acoustic immittance. The stepwise logistic regression analysis revealed that there were significant correlations between PSG result and history of snoring or gasping, palate tonsil size and A/N ratio. The coincidence between dependant result and PSG result was 76.2% in group A and was 78.2% in group B

Conclusion: The diagnosis scale can be considered as a screening diagnostic tool to diagnose pediatric OSAHS for clinical application when PSG examination can not be accomplished. But it is not suitable for us to assess the severity of pediatric OSAHS separately.

1012 VALIDITY OF CLINICAL HISTORY IN DIAGNOSING SLEEP DISORDERED BREATHING IN CHILDREN: THE PENN STATE CHILD COHORT
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Introduction: The “gold standard” for the diagnosis of sleep disordered breathing (SDB) in children is a polysomnography (PSG) and is indicated when clinical diagnosis suggests SDB. However, the diagnosis of SDB is commonly based only on clinical history; thus, the aim of this study was to assess the validity of diagnosing SDB based solely on clinical assessment.

Methods: The Penn State Child Cohort is a representative random sample of elementary school children assessed using a two-phase strategy. During Phase I parents of elementary school children completed a brief questionnaire (N = 5,740) with a response rate of 78.5%. Phase II randomly-selected children spent a night in our sleep laboratory (N = 700) with a response rate of 70.0%. Each child underwent a 9-hour PSG, a clinical history and physical examination and a parent completed questionnaires.

Results: A ROC analysis was completed on several models predicting an outcome of AHI ≥ 2 which generated an optimal sensitivity and
specificity. The first model included ADHD, excessive daytime sleepiness, and snoring from parent report plus tonsil size based on ENT specialist assessment. The resulting sensitivity was 0.86 with a specificity of 0.22. In the 2nd model, we added parent report of sleep disturbance providing a sensitivity of 0.68 and specificity of 0.44. In the 3rd model, we added BMI percentile providing a sensitivity of 0.73 and specificity of 0.54. Age was added in model 4 and provided a sensitivity of 0.64 and specificity of 0.63. Finally, we included minority status providing a sensitivity of 0.76 and specificity of 0.57.

Conclusion: These data indicate that the diagnosis of childhood SDB based solely on clinical assessment is limited. These data are consistent with the recent CHAT study which reported that almost 50% of the recruited sample did not meet minimal objective criteria for SDB (AHI ≥ 2).

Support (If Any): NIH R01 HL 63772, R01 HL 97165, C06 RR 16499, ULI RR 33184

1013
DIAGNOSTIC UTILITY OF AN UNATTENDED SLEEP STUDY IN PEDIATRIC OBSTRUCTIVE SLEEP APNEA
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Introduction: Unattended polysomnograms (PSG) are accepted for the evaluation of obstructive sleep apnea (OSA) among adults, yet little data exists regarding their usefulness in pediatric populations. We present preliminary results of a study evaluating the diagnostic utility of a level 2 unattended PSG in a pediatric population for the detection of OSA.

Methods: 27 otherwise healthy children ages 4–15 years completed both an in-lab PSG (IPSG) at Boston Children’s Hospital and a home PSG (hPSG) between 2011–2014 for evaluation of OSA. The unattended, level II, hPSG (Xtek® Trex HD, Natus Medical Inc.) was performed within 2 months of the IPSG. A registered sleep technician set up the study prior to bedtime and removed leads in the morning at the patient’s home. Lead placement included 10 EEG leads, 3 chin EMG leads, 2 EOG leads, respiratory effort belts, oral nasal thermistor, EKG nasal airway pressure transducer, and oximeter. The hPSG and IPSG were scored by qualified scorers and interpreted by board certified sleep physicians, all blinded to patient information including IPSG results. Because AHI data were left skewed, we used nonparametric statistics for analysis.

Results: Subjects’ mean age was 8.9 years (2.6) and mean BMI was 22.1 (5.9); 68% were male and 50% were Caucasian. Based on lPSG, 18/27 subjects (66.7%) had AHI ≥ 1. While we found a correlation between hPSG and IPSG AHI values (r = 0.56, p = 0.002), the median AHI’s significantly differed between test conditions [hPSG: 0/hour (9.7), IPSG: 1.5/hour (0.146), p = 0.007]. The sensitivity of the hPSG in our sample to detect OSA (AHI ≥ 1) was 55.6% (95% CI: 30.7–78.4) and the specificity 100% (95% CI: 66.2–100).

Conclusion: This ongoing study shows that unattended hPSG has an overall low to moderate sensitivity for detecting OSA but has a moderate to high specificity in a clinical sample with mostly mild sleep disordered breathing.

Support (If Any): Dept. of Neurology and Dept. of Medicine, Boston Children’s Hospital

1014
SPLIT-NIGHT POLYSOMNOGRAPHY FOR SEVERE OBSTRUCTIVE SLEEP APNEA IN CHILDREN
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Introduction: Split night polysomnography (PSG) is an accepted practice in adults. It is not however, advocated in the pediatric population (age ≤ 14 years). The mainstay of treatment of obstructive sleep apnea (OSA) in children is adenotonsillectomy. Subsets of children with severe OSA however, arguably are more likely to eventually need positive airway pressure (PAP) and may benefit from early therapy.

Methods: We performed a retrospective review of polysomnograms performed between October 2004 and November 2014, selecting pediatric cases (≤ 14 years of age) that underwent a split night study. Demographic and polysomnographic data was collected and success of titration was assessed. The studies were staged and scored using the 2012 AASM manual.

Results: We identified 4 pediatric subjects that underwent a split night study. 2 were referred for witnessed apneas and 2 were evaluated post tonsillectomy or adenoidectomy. The mean age was 7.5 ± 4.65 (range 6–14 years) with a mean BMI of 29 ± 10.56 (range 16–41 kg/m²). The mean pretitration apnea index (AI) was 40.8 ± 54.4 (range 0–119) and apnea hypopnea index (AHI) was 67 ± 65.95 (range 15–162). All the patients had significant improvement in their obstructive indices: mean AHI 7.8 ± 2.1 (range 5.3–10), with one conversion to bi-level PAP therapy because of continued severe events on CPAP. PAP was tolerated well with no adverse events during any of the procedures.

Conclusion: Our data shows that split night studies can be successfully performed on pediatric patients. Often times, for example, in an older and/or obese pediatric patients, the adenotonsillar tissue is less likely to be the main contributing factor to the OSA and early PAP therapy may be of benefit. Split night studies should therefore, be considered in individualized pediatric cases, that have undergone evaluation and who will likely need PAP therapy.

1015
MEASUREMENT OF SNORING IN CHILDREN WITH SLEEP-DISORDERED BREATHING
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Introduction: Polysomnography (PSG) is used to diagnose sleep-disordered breathing (SDB) and involves the attachment of multiple sensors. The Somnomat (MAT) is a mattress-based device that requires no sensor attachment yet can identify respiratory events using breath sounds and movements; it has been validated in adults, with snoring detection superior to PSG methods. An apnea/hypopnea index (AHI) of 1 event/hr is the diagnostic threshold in children, yet their problem is primarily obstructed breathing/snoring which is rarely measured and not captured by the AHI metric. The aim was to examine the diagnostic accuracy of the investigational device and assess the suitability of snoring analysis in children.

Methods: We performed simultaneous recordings using PSG and the investigational device in 45 children (28 male, 5.6 ± 2.4 years, BMI = 18.7 ± 4.2 kg/m²) with clinical suspicion of SDB.

Results: Data presented as median and IQR. The AHI values correlated well (ICC = 0.9) and no significant difference was found (PSG = 1.0 (0.1, 2.9), MAT = 0.6 (0.3, 1.8) events/hr; p = 0.667 [mean difference = 0.1 events/hr]). PSG defined respiratory events were present for only 1% of sleep time, whereas snoring was present on the investigational device for 20% of the corresponding time. There were 272 (148, 719) runs of
snoring, occurring at a rate of 20 (10, 52) per hour [min = 0, max = 110]. In 22 children (49%) with an AHI < 1, runs of snoring occurred 21 (8, 47) times per hour [min = 0, max = 57].

**Conclusion:** Snoring was present for more time, occurred more frequently and had a greater spread than respiratory events. It varied extensively in children with a normal AHI. As pediatric SDB is dominated by obstructed breathing (rather than apneas and hypopneas), quantitative measurement of snoring may be an additional useful metric.

1016
**UTILITY OF A BRAIN MRI IN THE DIAGNOSIS AND MANAGEMENT OF SLEEP DISORDERED BREATHING IN CHILDREN**

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**Introduction:** Polysomnography is the gold standard test for the diagnosis of both obstructive (OSA) and central sleep apnea (CSA) in children. In children, neuro-anatomical causes may contribute to both CSA as well as persistent OSA post adenotonsillectomy. A brain MRI is often necessary to exclude additional etiologies of sleep disordered breathing. The objective of the study was to evaluate the utility of a brain MRI in the diagnosis and management of sleep-disordered breathing in children.

**Methods:** This was a retrospective analysis of the medical records, PSG results and brain MRI scan results of children at the Hospital for Sick Children in Toronto, Canada. These subjects were diagnosed with either 1) persistent OSA despite an adenotonsillectomy, 2) CSA of unclear etiology 3) OSA with co-existing CSA of unclear etiology and 4) unexplained nocturnal hypventilation. The brain MRI scan occurred after the abnormal PSG. The central and obstructive apnea-hypopnea index (CAI and OAIH respectively) were recorded for each subject.

**Results:** There were a total of 14 subjects selected between 2013–2014. The median (range) age was 10.7 years (1 to 15) and the body mass index (BMI) was calculated. The time of snoring was recorded. Measurements of soft tissue, bone structure, spatial structure of the upper airway by the adenoid and tonsillar hypertrophy and the enlarged soft palate. Sinusitis and lower hyoid bone position were leading to increased upper airway resistance.

**Conclusion:** The snoring children had airway obstruction of various degrees at the upper airway by the adenoid and tonsillar hypertrophy and the enlarged soft palate. Sinusitis and lower hyoid bone position were leading to increased upper airway resistance.

1018
**WHAT IS THE UTILITY OF ROUTINE POLYSOMNOGRAPHY IN CHILDREN USING POSITIVE AIRWAY PRESSURE?**

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**Introduction:** Children with sleep apnea are often prescribed positive airway pressure therapy. Routine repeat polysomnography testing is often performed to confirm the presence of ongoing sleep apnea and optimal device pressure settings. In order to review the utility of this practice, we compared the frequency of treatment changes following routine polysomnography to the frequency of changes resulting from an urgent study in this population.

**Methods:** Data from children on therapy who have undergone polysomnography at the Alberta Children’s Hospital in the past year was reviewed. Data collection included: Demographics, treatment device type, pressure setting and indication for repeat study. A difference in pressure setting of two or more centimeters of water and/or a pressure device type change were considered clinically significant changes. Comparison was made between two main groups of children—those undergoing routine study and those tested in response to a clinical concern.

**Results:** A total of 90 subjects (63 male) on positive airway pressure therapy have met inclusion criteria to date. Mean age is 9.4 years (range 2–18 years). 75/90 chart reviews have been completed to date. 25.3% of these had repeat polysomnography performed due to a clinical concern. Of these, 57% had a clinically significant change in treatment. In comparison, 44.6% of the studies performed on a routine basis resulted in a significant change in treatment. The odds of having a device change was highest amongst children under 5 years of age, undergoing non-routine polysomnography (OR 5.5).

**Conclusion:** Our data suggests polysomnography is most likely to result in changes in treatment when performed in response to clinical concerns in children under 5 years of age. However, routine polysom-
nography follow-up testing frequently results in clinically significant changes in therapy as well.

Support (If Any): Alberta Children’s Hospital Foundation

1019

PREDICTORS OF ADHERENCE TO PEDIATRIC OBSTRUCTIVE SLEEP APNEA THERAPY

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Introduction: Obstructive sleep apnea (OSA) is a common pediatric condition characterized by recurrent partial or complete cessation of airflow during sleep, typically due to inadequate upper airway patency. Continuous positive airway pressure (CPAP) is a therapeutic option that reduces morbidity. Despite efforts to promote use, CPAP adherence is poor. We sought to determine whether demographics, insurance status, OSA severity, therapeutic pressure, or comorbid conditions were associated with CPAP adherence.

Methods: After obtaining institutional review board approval (COMIRB#13-1439), chart review was performed on all patients who were monitored CPAP treatment over a one-year period. All patients had a therapeutic in-laboratory CPAP titration prior to CPAP prescription. Patients were grouped as either CPAP adherent or non-adherent, where adherence was defined as greater than 70% of nights and at least 4 h/night average usage. Differences between the groups regarding demographics, comorbidities, and polysomnography results were analyzed by Chi-square test.

Results: Overall CPAP adherence was poor at 49% (69/140). Of the demographic data collected (age, ethnicity, gender, insurance), only female gender was associated with adherence (60.9% adherence vs 39.5% for males, OR = 2.410, 95% CI = 1.196–4.854; p = 0.0114). Severity of OSA (represented by diagnostic apnea-hypopnea index [AHI] and degree of hypoxemia), therapeutic CPAP level, and residual AHI did not impact CPAP adherence (p > 0.05). Patients with cerebral palsy or developmental delay (CP/DD) were more likely to be adherent with CPAP than those without CP/DD (OR = 2.551, 95% CI = 1.271–5.128; p = 0.0069). Also, patients with any form of atopic illness (asthma, eczema, allergic rhinosinusitis) had increased adherence, but this did not reach statistical significance.

Conclusion: Our study suggests that, even in a large pediatric sleep medicine center with a robust CPAP desensitization program, adherence to CPAP therapy is poor. Females and those with cerebral palsy or developmental delay are more likely to be adherent to CPAP therapy for pediatric OSA.

1020

CLOSE FOLLOW-UP, ADHERENCE TO THERAPY AND SYMPTOMATIC IMPROVEMENT IN CHILDREN ON NONINVASIVE POSITIVE AIRWAY PRESSURE (PAP) TREATMENT FOR SLEEP-DISORDERED BREATHING (SDB)

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Introduction: Children with SDB can be successfully managed with noninvasive PAP. For SLEEP 2012, we evaluated our PAP program, symptomatic improvement and subjective adherence in our patients on noninvasive PAP. Since then, we have modified our follow-up protocol. After PAP set-up, a phone call is made within 1 week, an adherence download is requested within 1–2 weeks, and the 1st PAP follow-up visit is scheduled within 4–6 weeks. We hypothesized that close follow-up during the 1st month after set-up would result in improved adherence and subsequent symptomatic improvement.

Methods: A retrospective chart review was performed on 30 patients, a random sample of the 111 patients initiated on PAP between August 1, 2012 and August 25, 2014 at Children’s Hospital of Wisconsin. Statistical analysis was performed with chi-square tests and Pearson correlation.

Results: Sleep-related breathing diagnoses included obstructive sleep apnea (66.7%), hypoventilation (16.7%), altered respiratory mechanics (13.3%) and central sleep apnea (3.3%). PAP modes included CPAP (66.7%), bi-level PAP (30%), and ventilator (3.3%). At phone follow-up (N = 25), 72% reported improved daytime sleepiness, nighttime breathing and/or sleep quality. Adherence downloads within 14 days of PAP set-up (N = 17) showed a median usage > 4 hours of 80% of nights recorded. At the 1st PAP clinic visit (N = 23), 69.5% reported improved daytime symptoms, 2.6% reported improved nighttime symptoms, and median usage > 4 hours was 60% on adherence downloads (N = 20). At the 2nd PAP clinic visit (N = 14), 64.3% reported improved daytime symptoms, 71.4% reported improved nighttime symptoms, and median usage > 4 hours was 23% on adherence downloads (N = 10). Adherence and daytime symptom improvement at phone follow-up were predictive of adherence and daytime symptom improvement at the 1st PAP clinic, p < 0.02.

Conclusion: Good adherence and symptomatic improvement at phone follow-up carry over to the 1st PAP clinic. By the 2nd PAP clinic, symptomatic improvement continues, but adherence declines.

1021

IMPACT OF STANDARDIZED PHONE FOLLOW-UP ON PAP ADHERENCE IN OBESE ADOLESCENT PATIENTS WITH OBLSTRUCTIVE SLEEP APNEA

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Introduction: Obesity in children is increasing worldwide, and obstructive sleep apnea (OSA) is a common morbidity in obese adolescents. Importantly, untreated OSA carries a significant risk of long-term morbidity for cardio-metabolic disease. Since adenotonsillectomy does not cure OSA in a significant number of obese youth, positive airway pressure (PAP) therapy is required. Although PAP is an effective therapy, adherence rates are suboptimal in this population. This study prospectively evaluated PAP adherence rates in obese youth with OSA following a program of regular, standardized follow-up phone calls by a respiratory therapist (RT).

Methods: Obese youth were prospectively recruited from sleep clinic and were prescribed PAP after PAP initiation with simultaneous polysomnogram (PSG). Adherence was evaluated prospectively for 6 months by a respiratory therapist through PAP usage downloads as well as through a standardized questionnaire administered by telephone: weekly for the first month, bi-weekly for the second month, and then monthly until six months of PAP therapy. Issues described by patients and caregivers as barriers to PAP adherence were met with targeted resolution. PAP adherence at one month was compared to PAP adherence at 6 months.

Results: Nine obese subjects were prescribed PAP therapy for the treatment of moderate to severe OSA. The mean age and the mean BMI of the PAP treatment group were 14.3 years and 39.4 kg/m², respectively. The mean number of follow-up phone calls was nine. At one month, the average nocturnal PAP use over a 30-day period was 3.11
hours. The average hours of PAP used nightly during the sixth month was 3.70 hours.

**Conclusion:** Obese youth with OSA did not demonstrate improved PAP adherence over a six-month period despite regular phone follow-up by a RT. Persistent barriers to PAP adherence included poor mask tolerance, reluctance to use PAP while away from home, and late night schedules which rendered PAP use too taxing.

**1022**

**COMPARISON OF AUTO-ADJUSTING CPAP AND FIXED PRESSURE CPAP IN PEDIATRIC PATIENTS WITH OBSTRUCTIVE SLEEP APNEA: A RANDOMIZED CONTROLLED TRIAL**

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**Introduction:** CPAP is commonly used to treat adults and children with OSA. CPAP titration polysomnogram (TPSG) is the accepted method for determining the appropriate therapeutic pressure setting for children. Auto-adjusting CPAP (APAP) has commonly been used in adults with OSA; however, limited data exist on APAP in children. We hypothesize that APAP provides an accurate estimation of pressure compared to TPSG, and that APAP confers better treatment adherence and outcomes than fixed CPAP.

**Methods:** This prospective, double-blind, randomized crossover trial included children and adolescents with an AHI ≥ 5/hour. All subjects began therapy with APAP for 4–6 weeks, followed by TPSG. Subjects were then randomized to fixed CPAP or APAP, followed by a cross-over period, each of 4 weeks duration. Usage data was downloaded to determine APAP average 90% pressure (AV90) and to assess adherence. Subjects completed the Michigan Pediatric Sleep Questionnaire (PSQ), Epworth Sleepiness Scale (ESS), and Pediatric Quality of Life Inventory (PedsQL) at each visit. Non-parametric statistical testing was performed.

**Results:** Twenty one subjects were enrolled with mean age of 14.3 ± 2.7 years and mean AHI of 10.5 ± 5.8/hour. Eight subjects completed the study protocol and pressure comparison was made on 13 subjects. There was a trend towards lower AV90 compared to TPSG-derived pressure (7.7 ± 2.6 [AV90] vs. 9.8 ± 2.5 [TPSG], P = 0.07). During the randomization period there was no significant difference between APAP and CPAP percent days with device use (62.5 ± 27.2% [APAP] vs. 63.2 ± 26.9% [CPAP], P = 0.74). There was significant improvement in PSQ scores from baseline (B) to both APAP and CPAP periods (0.66 ± 0.2 [B], 0.48 ± 0.2 [APAP], 0.44 ± 0.2 [CPAP], P = 0.0087). There were no statistically significant differences in ESS (11.5 ± 6.3 [B], 8.8 ± 4.9 [APAP], 7.9 ± 4.4 [CPAP], P = 0.52) or PedsQL (59.5 ± 19.7 [B], 63.5 ± 22.1 [APAP], 67.4 ± 20.5 [CPAP], P = 0.25).

**Conclusion:** In the pediatric population, APAP does not provide an accurate pressure estimation compared to TPSG-derived pressure. APAP does not convey improvement in adherence over CPAP. Although PSQ improves with both APAP and CPAP use, APAP offers no clear benefit over CPAP in terms of daytime sleepiness and quality of life.

**Support (If Any):** Cincinnati Children’s Hospital Research Fund

**1023**

**THE RELATIONSHIP BETWEEN POSITIVE AIRWAY PRESSURE (PAP) ADHERENCE AND QUALITY OF LIFE IN CHILDREN WITH OBSTRUCTIVE SLEEP APNEA SYNDROME (OSAS)**

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**Introduction:** This study examined the quality of life (QoL) of children with OSAS before and after PAP therapy. Research has evidenced improvement in children’s QoL after tonsillectomy & adenotonsillectomy procedures for treatment of OSAS, however exploration of the impact of PAP treatment on QoL is minimal.

**Methods:** 40 subjects with OSAS diagnosis by polysomnography were evaluated at diagnosis and after 3 months of PAP therapy. Measures included: Obstructive Sleep Apnea-18 scores, measuring impact of OSAS on QoL and PAP adherence at 3 months. 20 participants completed the study. No significant differences were found between the participants who did and did not return for follow up on demographic, pre-PAP polysomnography, or paper measures.

**Results:** OSA-18 total QoL scores were significantly improved with the use of PAP (t(19) = 9.147, p < 0.001). Change in QoL and PAP adherence were significantly correlated (r = 0.597, p < 0.01). Individuals adherent with PAP therapy greater than 4 hours a night had significantly greater change in QoL than those who were less adherent (F(1,16) = 5.150, p < 0.05). Age and BMI were significant predictors of compliance (chi-square(2) = 7.377, p < 0.05). With a 1 unit increase in age, the odds of adherence decrease by 9%. Additionally, for each unit increase in BMI, the odds of adherence decrease by 12.3%.

**Conclusion:** Children with OSAS adherent with PAP showed improvements in QoL. This increase in QoL, positively correlated with greater adherence to therapy with a significant difference between the participants using at least 4 hours and those who did not. Increasing age and BMI were related to decreased adherence. Research has shown surgical treatments for OSAS result in improved QoL in children. This study provides support for the use of PAP therapy and its usefulness in improving QoL.

**Support (If Any):** In part by Resmed Foundation

**1024**

**EFFECT OF POSITIVE AIRWAY PRESSURE (PAP) THERAPY IN CHILDREN WITH OSAS: DOES PAP USE REDUCE PEDESTRIAN INJURY RISK?**

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**Introduction:** Studies document that treatment with Positive Airway Pressure (PAP) therapy in adults with OSAS reduces injury risk. However, the effect of PAP therapy on children’s injury risk is unknown. One notable domain where adults treated with PAP have reduced injury risk is motor vehicle crashes. Among children, diminished cognitive capacity is more prominent when engaged in traffic as pedestrians rather than drivers. Thus, we evaluated children’s pedestrian injury risk in a virtual reality pedestrian environment (VRPE). We hypothesized children with OSAS would have greater number of hits with a virtual vehicle when untreated than when treated with PAP therapy.

**Methods:** 23 children with OSAS between the ages of 8 and 16 upon diagnosis by polysomnography were enrolled. Children participated
in the VRPE, which is validated as an accurate measure of real-world pedestrian behavior, upon diagnosis and again after 3 months of PAP therapy. Children underwent sleep studies at both timepoints. 10 children were non-adherent and 13 children were adherent with PAP at 3 months, as verified by machine downloads.

**Results:** Children with OSAS treated with PAP therapy had a significant reduction in number of hits (p = 0.038) by a simulated vehicle in the VRPE. 87.5% of children adherent with PAP had a reduction in hits, while only 12.5% of children non-adherent to PAP had a reduction in number of hits. Among other aspects of pedestrian behavior, PAP therapy also significantly improved time to contact with oncoming traffic (t = −2.94, p = 0.01) but, as expected, no significant differences were found on attention to traffic (t = −0.50, p = 0.63).

**Conclusion:** The study provides initial evidence that PAP therapy reduces children’s pedestrian injury risk. The study offers a unique, real-world study of the consequences of pediatric OSAS and evaluates a potential applied benefit of this medically-based treatment.

**Support (If Any):** RESMED Foundation

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### 1025

**HIGH-FLOW AIR VIA NASAL CANNULA TREATS OBSTRUCTIVE SLEEP APNEA IN CPAP-INTOLERANT CHILDREN**

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**Introduction:** Obstructive sleep apnea (OSA) is characterized by partial or complete cessation of airflow during sleep. Pediatric OSA is common and comorbid with cardiovascular, neurodevelopmental, behavioral, and growth sequelae reported. Continuous positive airway pressure (CPAP) therapy is often considered for persistent OSA despite adenotonsillectomy, though non-adherence is common and an obstacle to prevention of morbidity. The use of high-flow, heated, humidified air via an open nasal cannula (HFNC) may be more tolerable and has been demonstrated to treat OSA in adults and neonates, but data regarding treatment in school-age children is scant. We present preliminary data of the efficacy of HFNC in children with CPAP intolerance.

**Methods:** Following approval from our local institutional review board (COMIBR#13-2469), we enrolled a convenience sample of pediatric patients with OSA diagnosed on polysomnogram by obstructive apnea-hypopnea index (OAHI) of greater than 1/h. Respiratory parameters obtained during polysomnography while undergoing HFNC treatment were compared to diagnostic polysomnography data by Student’s paired t-test.

**Results:** Four patients aged 4.1 to 9.3 y, with moderate to severe OSA (diagnostic OAHI of 9.4, 8.5, 10.8, and 19.1/h; mean 12.0/h) were treated with therapeutic HFNC ranging from 10 to 20 liters per minute. Underlying diagnoses were of severe cerebral palsy, hereditary osteodystrophy, trisomy 21, and VACTERL association. The OAHI was reduced to 2.5, 2.2, 2, and 2/h, respectively (mean 2.2/h, p = 0.007).

**Conclusion:** Our study suggests that HFNC is an effective therapy for moderate to severe OSA in CPAP-intolerant children. We plan to evaluate additional patients and to follow these patients prospectively to determine whether measures of behavior, mood, and sleep quality improve following initiation of HFNC therapy. We speculate that the partial obstruction (hypopnea) predominant nature of pediatric OSA lends itself to therapeutic response to HFNC and that this response may be explained by increased upper airway tone.

**Support (If Any):** This study is supported by the Department of Pediatrics at Children’s Hospital Colorado. Fisher & Paykel provided an Airvo2 high-flow air delivery device for clinical use.
of a health sciences librarian. Studies evaluating the effects of MAAs in children with OSA were sought.

**Results:** A total of 71 original articles were identified from the searches. Once selection criteria were applied, only 4 articles satisfied all inclusion criteria. Only one study was a quasi-randomized clinical trial. The remaining studies were of retrospective nature. All the included studies had high risk of bias. Absence of control groups and small sample sizes were the most limiting characteristics across selected studies. The limited available evidence may be suggestive that MAAs result in improvements in AHI scores; however they do not normalize AHI scores. A meta-analysis was not possible due to the heterogeneity in study designs and collected information.

**Conclusion:** Based on current limited evidence, it is questionable to strongly imply that MMAs are effective to treat POSA. There are significant weaknesses in the existing evidence due primarily to absence of control groups, small sample sizes, lack of randomization and short-term results.

### 1028

**MAXILLARY EXPANSION FOR THE TREATMENT OF PEDIATRIC OBSTRUCTIVE SLEEP APNEA: A SYSTEMATIC REVIEW**

**Introduction:** Maxillary expansion (ME) is a relatively common orthodontic treatment. Some studies have claimed that ME procedures do improve some sleep parameters in pediatric patients with obstructive sleep apnea (OSA).

**Methods:** A systematic search of five electronic databases, available grey literature, and manual searches were performed following PRISMA guidelines. Studies evaluating ME in OSA children age 3–16 with before and after polysomnography (PSG) (PSG) were included.

**Results:** Seven studies in eight publications met the inclusion criteria. Methodologic quality of these included studies ranged from poor to good. Small sample size, absence of control groups, and variable PSG methods not conforming to AASM guidelines were common weaknesses. Most included subjects had mild to moderate POSA, and all had maxillary constriction. All studies employed rapid ME (RME) and demonstrated mild to moderate improvements in apnea-hypopnea index (AHI) or respiratory distress index (RDI). For children with combined maxillary constriction and adenoid hypertrophy, RME appeared equally effective as adenotonsillectomy (A&T). Subjects responded more favorably to combined RME plus A&T than either individual therapy.

**Conclusion:** Based on currently available evidence, RME in children with OSA resulted in mild to moderate improvements in AHI and RDI, but appeared to be more effective when combined with A&T. For children with adenotonsil hypertrophy and concurrent maxillary constriction, combined RME and AT therapy may be recommended.

### 1029

**PREDICTORS OF OBTAINING PREOPERATIVE POLYSOMNOGRAPHY AMONG PEDIATRIC TONSILLECTOMY PATIENTS AND ITS RELATIONSHIP WITH PERIOPERATIVE MANAGEMENT**

**Introduction:** Several guidelines offer conflicting recommendations regarding who should undergo preoperative polysomnography when considering adenotonsillectomy for treatment of pediatric obstructive sleep apnea. The objectives of this study were to 1) determine predictors for obtaining polysomnography (PSG) before tonsillectomy in a tertiary care children’s hospital, 2) assess whether preoperative PSG affected the likelihood of overnight observation and respiratory interventions.

**Methods:** This was a retrospective cohort study of patients aged 0–18 who underwent tonsillectomy from Sept 2011–Sept 2012. Potential predictors of PSG and perioperative outcomes included age, gender, insurance type, income quartile, obesity, neurologic condition, craniofacial anomaly, and syndromic diagnosis. Outcomes included need for perioperative respiratory interventions (oxygen supplementation for > 30 minutes, nasopharyngeal airway, or unplanned ICU admission). Multivariable logistic regression was used to test the independent associations between potential predictors and outcomes of interest.

**Results:** 172 (38%) of 455 patients in the cohort had preoperative PSG with a mean AHI 11.2 (SD 13.7). In multivariable analysis, preoperative PSG was significantly associated with age < 3 yrs (OR 2.3), Medicaid insurance (OR 2.1), and having a syndromic diagnosis (OR 2.3). 130 (29%) pts were observed overnight. Perioperative respiratory interventions occurred in 27% (47/173) with and 21% (60/282) without preoperative PSG (p = 0.17). The need for respiratory intervention was associated with age < 3 yrs (OR 2.5), obesity (OR 1.8), and neuromuscular disorder (OR 4.6) but not preoperative PSG (OR 0.99). In patients with preoperative PSG, overnight observation was associated with age 10 (OR 3.7).

**Conclusion:** Despite strong associations between high-risk comorbidities and pre-tonsillectomy PSG, having this test was not independently associated with the need for perioperative respiratory intervention. Pre-tonsillectomy PSG does influence the decision to observe overnight, but may not impact other perioperative outcomes.

### 1030

**IMPACT OF SLEEP DISORDERED BREATHING ON OPERATIVE OUTCOMES OF CHILDREN FOLLOWING ADENOTONSILLECTOMY: ANALYSIS FROM THE MARKETSCAN DATABASE**

**Introduction:** Adenotonsillectomy (AT) is the second most common surgical procedure in children. The high incidence of AT is secondary to a heightened awareness and recognition of sleep disordered breathing (SDB) in children. SDB has been shown to pose an operative risk in adults, however little is understood whether SDB specifically confers a greater operative risk in children undergoing AT.

**Methods:** The Marketscan Database provides access to all children with privatized health insurance and identifies outcomes using specific diagnostic billing codes. All children undergoing AT from 2003–2012 were identified. Using diagnostic codes, children were stratified into three groups: 1) SDB codes (excluding recurrent infection (RI) or adenotonsillar hypertrophy (ATH) codes) 2) RI codes (excluding SDB or
1031 POSTERIOR MIDLINE GLOSSECTOMY FOR TREATMENT OF POST-ADENOTONSILLECTOMY OBSTRUCTIVE SLEEP APNEA IN CHILDREN WITH DOWN SYNDROME
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Introduction: Persistent obstructive sleep apnea (OSA) after adenotonsillectomy (T&A) in children with Down syndrome (DS) occurs in almost 50% and may involve multiple levels of obstruction. We hypothesize that Posterior Midline Glossectomy (PMG) effectively treats persistent OSA in patients with DS who have base of tongue obstruction. This study evaluates the success of the PMG in children with DS and identifies risk factors for failure.

Methods: Retrospective chart review of children with Down syndrome who had previously undergone T&A with persistent OSA at a tertiary care facility. Persistent obstruction at the level of the base of tongue was identified by sleep cine MRI’s. All patients underwent PMG by the senior author and underwent pre and post-operative polysomnographies (PSG). Changes in apnea-hypopnea index (AHI) pre and post-surgery were tested using a paired t-test, and logistic regression was used to determine factors associated with failure.

Results: Thirty subjects were included in the analysis. Mean age at time of PMG was 10.3 ± 10 years; 30% were female, 73% were Caucasian. Mean BMI was 24.4 ± 34.3. The mean AHI pre-operatively was 8.9 ± 43.7 events per hour, and the mean post-operative AHI was 5.8 ± 26.6 (p = 0.01). Using an AHI < 6 and SpO2 ≥ 90% for 98% of the PSG as criteria for surgical success, 43% of patients were deemed surgical successes. BMI and age at time of PMG correlated with surgical failure, OR 2.57 and 1.22, respectively. BMI percentile and non-White race did not correlate with surgical failure.

Conclusion: PMG is an effective treatment for specific patient populations, including children with Down syndrome with persistent OSA after T&A who have base of tongue obstruction. Surgical success is likely related to reduction of tongue volume and increased fibrosis at the base of the tongue. Increasing age and obesity are risk factors for failure after PMG in this population.
ACTIGRAPH-MEASURED SLEEP PARAMETERS IN PATAGONIAN ADOLESCENTS WITH AUTISM AND OTHER DISABILITIES
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Introduction: To characterize actigraphy-measured sleep parameters among adolescents with disabilities, and to examine whether adolescents’ sleep parameters were associated with adolescents’ age, sex, disability diagnosis, caregiver-adolescent relationship, and caregiver education.

Methods: This cross-sectional study was conducted between April and July 2013 among 54 adolescents aged 13–18 years diagnosed with autism and other disabilities and their primary caregivers. Adolescents wore ActiSleep monitors for eight consecutive days, while caregivers completed sleep logs for adolescents. Interviewer-administered questionnaires were used to collect sociodemographic information from caregivers. Log-transformed sleep latency and awakening length were included in linear regression models. Multivariable logistic regression models were conducted to evaluate associations between risk factors and sleep parameters.

Results: The mean wake after sleep onset was 92.5 minutes (standard deviation [SD] = 41.9), number of awakenings 19.7 (SD = 7.2), sleep duration 7.5 hours (SD = 1.2), and sleep efficiency 79.4% (SD = 8.5). The median sleep latency was 20.3 minutes (interquartile range [IQR] = 8.1–40.7) and awakening length was 6.3 minutes (IQR = 4.4–9.6). 31.5% of adolescents had longer sleep latency ≥ 30 minutes and 33.3% had short sleep < 7 hours. Compared to adolescents of caregivers with higher education (> high school), adolescents of caregivers with low education (< high school) had longer sleep latency (P = 0.036) and awakening length (P = 0.013). Girls were less likely to have long sleep latency (odds ratio [OR] = 0.20; 95% confidence interval [CI] = 0.05–0.88) and short sleep duration < 7 hours (OR = 0.10; 95% CI = 0.02–0.53) than boys. There were no such significant associations for other sleep parameters. Overall, adolescents’ age, disability diagnosis, caregiver-child relationship, and caregivers’ age were not significantly associated with adolescents’ sleep parameters.

Conclusions: Adolescents with disabilities had long sleep latency, long wake after sleep onset, frequent nocturnal awakenings, short sleep, and poor sleep. Male adolescents and caregivers’ low education were associated with adolescents’ sleep disturbances. These findings underscore the importance of developing effective sleep education interventions for adolescents and caregivers.

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1034 ITEM ANALYSIS OF THE CHILDREN’S SLEEP HABITS QUESTIONNAIRE IN THE AUTISM SPEAKS-AUTISM TREATMENT NETWORK REGISTRY DATA
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Introduction: Sleep difficulties are a common problem in children with autism spectrum disorder (ASD). Parents within the Autism Speaks-Autism Treatment Network (AS-ATN) complete the Child Sleep Habits Questionnaire (CSHQ), along with a parent survey sleep problems question. An item analysis for reliability of the CSHQ has not been performed in a sample of children with ASD.

Methods: 1220 parents of children ages 2–3 and 2118 of children ages 4–10 completed the CSHQ and parent survey forms. A Cronbach’s alpha item analysis was conducted on each subscale of the CSHQ by age group. If deletion of an item resulted in an increase in standardized alpha of at least 0.01, then the item was deleted from the CSHQ total score. Using the parent survey sleep problems question as the “gold standard”, receiver operating characteristics (ROC) of the shortened CSHQ were used to determine an optimal range of cut-points to indicate sleep problems. Using these cut-points, the sensitivity, specificity, positive predictive value (PPV), and negative predictive value (NPV) of the shortened CSHQ were compared to those of the full CSHQ.

Results: ROC analysis of the shortened CSHQ indicated a range of cut-points from 38–42 for ages 2–3 and 38–40 for ages 4–10. Using these cut-points, the shortened CSHQ score improved specificity and PPV but worsened sensitivity and NPV. When using the cut-point that resulted in the smallest change in sensitivity, the changes in percentage points range from +26.6 to +26.8 for specificity, +10.8 to +12.0 for PPV, −11.9 to −17.9 for sensitivity, and −6.7 to −9.4 for NPV.

Conclusion: Comparing the shortened CSHQ to the full CSHQ, the total improvements in specificity and PPV are greater than the total losses in sensitivity and NPV. This analysis is a preliminary step for future work on refining the CSHQ among children with ASD.

Support (If Any): This research was conducted as part of the Autism Speaks Autism Treatment Network. Further support came from a cooperative agreement (UA3 MC 11054) from the U.S. Department of Health and Human Services, Health Resources and Services Administration, Maternal and Child Health Research Program, to the Massachusetts General Hospital. The views expressed in this publication do not necessarily reflect the views of Autism Speaks, Inc.

1035 BEHAVIORAL PROFILES OF CHILDHOOD-ONSET AND ADOLESCENCE-ONSET INSOMNIA
Pennsylvania State University, Hershey, PA

Introduction: Sleep disorders have been associated with behavioral problems in children and adolescents. However, no study to date has examined the impact of insomnia on behavior while taking into account whether the disorder persisted since childhood or developed in adolescence.

Methods: The Penn State Child Cohort is a random sample of 700 children aged 5–12 years (8.6 ± 1.7 y) at baseline of whom 421 (53.9% male) were followed-up 8 years later during adolescence (17.0 ± 2.3 y). Childhood-onset insomnia was defined as a parent-report of difficulty falling (DFA) and/or staying (DSA) asleep at baseline and self-report of DFA and/or DSA at follow-up, while adolescence-onset insomnia was
defined as a self-report of DFA and/or DSA at follow-up in the absence of a parent-report of DFA and/or DSA at baseline. Controls did not have any history of DFA or DSA either at baseline or follow-up. All subjects underwent a 9-h polysomnography and Child/Adult Behavior Check List testing at follow-up.

Results: We found a significant effect of insomnia groups on all domains of behavioral functioning (p = 0.027–0.0001) after adjusting for sex, age, race, body mass index, and sleep disordered breathing, with the exception of anxious-depressed and anxious problems that were only marginally significant (p = 0.104 and p = 0.092, respectively). Specifically, both adolescent-onset and childhood-onset insomnia were significantly associated with externalizing behaviors (p = 0.008 and p = 0.0001, respectively) and childhood-onset insomnia was significantly associated with internalizing behaviors (p = 0.015), while adolescent-onset was only marginally associated (p = 0.096).

Conclusion: Insomnia in adolescence appears to be associated with internalizing and externalizing behavioral problems. Interestingly, childhood-onset insomnia is associated with higher scores in internalizing behaviors, which are primarily driven by somatic problems. These data suggest that childhood-onset insomnia may represent a more severe form of the disorder.

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1036
IMPACT OF CHILDHOOD-ONSET AND ADOLESCENCE-ONSET INSOMNIA ON NEUROCOGNITIVE FUNCTIONING
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Introduction: Sleep disorders have been associated with impaired neurocognitive functioning in children and adolescents. However, no study to date has examined the impact of insomnia on neurocognition taking into account whether the disorder persisted since childhood or developed in adolescence.

Methods: The Penn State Child Cohort is a random sample of 700 children aged 5–12 years (8.6 ± 1.7 y) at baseline of whom 421 (53.9% male) were followed-up 8 years later during adolescence (17.0 ± 2.3 y). Childhood-onset insomnia was defined as a parent-report of difficulty falling (DFA) and/or staying (DSA) asleep at baseline and self-report of DFA and/or DSA at follow-up, while adolescence-onset insomnia was defined as a self-report of DFA and/or DSA at follow-up in the absence of a parent-report of DFA and/or DSA at baseline. Controls did not have any history of DFA or DSA either at baseline or follow-up. All subjects underwent a 9-h polysomnography and neurocognitive testing at follow-up.

Results: We found a significant effect of insomnia groups on domains of general ability (p = 0.001), processing speed (p = 0.004), math achievement (p = 0.004), and response interference (p = 0.041), after adjusting for sex, age, race, body mass index, and sleep disordered breathing. Specifically, both adolescent-onset and childhood-onset insomnia were associated with impaired general ability (p = 0.033 and p = 0.003, respectively), while only childhood-onset insomnia was associated with impaired processing speed (p < 0.0001), math achievement (p = 0.004), and response interference (p = 0.041) as compared to controls. No significant differences on vigilance or working memory were found.

Conclusion: Insomnia in adolescence appears to be associated with impaired cognition. Interestingly, childhood-onset insomnia is associated with more pervasive deficits in neurocognitive functioning. These data suggest that childhood-onset insomnia may represent a more severe form of the disorder.

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1037
SECOND-HAND SMOKE EXPOSURE, SLEEP-DISORDERED BREATHING, AND INSOMNIA SYMPTOMS IN CHILDREN AND ADOLESCENTS
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Introduction: Second-hand smoke (SHS) exposure has been associated with a number of sleep problems in pediatric populations, such as increased sleep-disordered breathing, longer sleep onset latency, and parasomnia. Prior investigations, however, have relied on subjective report of either SHS exposure or sleep variables. The current study uses objective measures to examine associations between SHS exposure and indices of sleep patterns and sleep-disordered breathing (SDB).

Methods: N = 70 children and adolescents (ages 3–17) referred to a Pediatric Sleep Medicine Center for snoring underwent an overnight polysomnogram (PSG). SHS exposure was measured via urinary cotinine levels from a single sample collected the evening before the PSG. Parents completed a self-report questionnaire describing their child’s sleep.

Results: Participants were 62.9% male and 50% Caucasian with a mean age of 8.62 years (SD = 2.86), mean cotinine level of 6.00 ng/mL (SD = 8.06), and mean obstructive apnea hypopnea index (oAHI) of 8.45 events per hour (SD = 13.01). After adjusting for median household income, gender and weight at the time of PSG, patients with urinary cotinine levels suggestive of SHS exposure (> 10 ng/mL) had significantly higher mean oAHI (p < 0.01) and respiratory disturbance index (RDI; p < 0.01) values. Those exposed to SHS also had less total sleep time (p < 0.01), lower sleep efficiency (p < 0.05), and more wake after sleep onset (p < 0.01) during the PSG. No differences in sleep onset latency, sleep architecture, or parental report of parasomnia were found.

Conclusion: In a population of children and adolescents referred for snoring, those exposed to SHS had more problematic sleep indices in the domains of sleep-disordered breathing and insomnia symptoms. Disrupted sleep in youth constitutes another adverse health effect associated with SHS exposure.

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EFFECT OF INFANT SLEEP ARRANGEMENT ON SLEEP PATTERN, FEEDING METHODS, AND PARENTAL SLEEP QUALITY
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Introduction: Different sleep arrangements in infancy might affect infant sleep development, feeding pattern, and parental sleep quality; however, the association among these is rarely studied. The aim of this study was to compare infant sleep pattern, feeding methods, and parental sleep quality between bed-sharing and room-sharing infants of 1-month age.
Methods: This is a preliminary study of one longitudinal research that investigates the effect of infant sleep arrangement on infant sleep, body weight development, parental psychological well-being, and parental sleep quality from birth to 2 years. Eighty-six eligible healthy mother-newborn pairs were recruited during 1st week after birth, and they were followed for 1 month. Newborns were match paired for maternal age, family economic status, and gender after they were classified into bed-sharing (n = 40) and room-sharing (n = 46) groups based on their sleep arrangement reported by the parents. Parents completed a 3-day infant sleep-feeding diary, weighed their infant, and completed the Pittsburgh Sleep Quality Index (PSQI) weekly.

Results: When the infants reached their first month of age, bed-sharers gained more weight (+232 gm) than room-sharers. In addition, more bed-sharers were exclusive breastfed (100%) than the room-sharers (92%). Bed-sharers comparing to room-sharers showed longer sleep latency and longer wake time after sleep onset. In addition, bed-shares kept lower sleep efficiency comparing to room-sharers. Parental sleep quality was not associated with infant sleep arrangement.

Conclusion: Bed-sharers had a higher breastfeeding rate and gained more body weight than the room-sharers. However, room-sharers slept better than the bed-sharers. Parental sleep quality was not affected by infant sleep arrangement.

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POSITIVE AND NEGATIVE ROLE MODELING OF CHILD AND PARENT SLEEP BEHAVIORS IN PICTURE BOOKS

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Introduction: Children’s picture books can be a powerful tool in shaping parent and child norms around bedtime and sleep. Although entertaining, books may be normalizing bedtime resistance, poor sleep hygiene, and inconsistent limit setting.

Methods: An initial list of themes about bedtime and sleep was developed from a review of healthy and problematic bedtime and sleep behaviors in preschool-aged children from existing research. Using this list of themes, we then quantified the degree and frequency to which they occur in currently available children’s picture books. Books were reviewed by at least two trained reviewers, who met periodically to review discrepancies and maintain agreement levels. Books were eligible for inclusion if title or keyword searches included sleep, bedtime, or related topics on library databases or Amazon.com. This undergraduate project will review at least 50 picture books; 17 books have been reviewed and coded to date.

Results: Of books coded, 65% contained at least some elements of a bedtime routine, although 41% depicted significant bedtime resistance and 31% showed the child staying up considerably past the bedtime stated in the book. Other negative themes commonly shown included the child calling out to the parent after bedtime (53%), poor parent enforcement of limit setting at bedtime (56%), child insistence that they are not tired (76%), and night wakings (23%). On the other hand, positive themes were also shown, including having calming activities as part of the bedtime routine (18%), using self-soothing or relaxation skills to help the child fall asleep (18%), and making a point of feeling refreshed or more ready for fun in the morning after a good night’s sleep (12%). Overall, there was a trend towards a greater proportion of pages depicting negative sleep behaviors (46% of the book, on average) than positive (34%).

Conclusion: Although valuable examples were observed of positive parent and child role modeling, negative bedtime and sleep behaviors were very common. This may contribute to parent and child norms and expectations about bedtime and sleep, especially when picture books like these are read to the child as part of the bedtime routine. Among families struggling with bedtime resistance, it may be advisable to search out books with positive presentations of bedtime and sleep behaviors. Future research will address whether picture book selection is associated with differences in parent and child attitudes and behaviors around bedtime and sleep.

1040

AN IPHONE APPLICATION FOR YOUNG CHILDREN’S SLEEP: CAREGIVERS’ CONCERNS

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Introduction: The aim of this study was to assess the types of questions asked through an Ask the Expert feature of a smartphone application for sleep in infants and toddlers and their relationship to sleep patterns.

Methods: Data were collected from 21 users of a free publicly-available smartphone app who (1) logged data for a minimum of 450 sleep sessions and (2) asked a question via Ask the Expert feature. This study was IRB approved and all users provided consent.

Results: Of these 21 users, 15 had children who were identified as consolidated sleepers (71.4%) and 6 were not consolidated (28.6%). There was no difference in median child age (130 vs 118 days) at the time of the initial question or in number of total questions asked (2.7 vs 2.8 questions). However, there were differences in types of questions asked, with users of children whose sleep was not consolidated being much more likely to ask questions regarding night wakings (27% vs 67%) and more likely to indicate that they believed that their child had a sleep problem (47% vs 100%). In contrast, the caregivers of consolidated sleepers were more likely to ask questions about naps, sleep onset, and sleep safety.

Conclusion: Overall, these preliminary results indicate that caregivers seem to appropriately identify when their child has a sleep problem and seek advice for such issues. Caregivers of children whose sleep had not yet consolidated are much more likely to ask questions about night wakings, whereas caregivers of children whose sleep had already consolidated are much more likely to ask about other issues, such as naps and sleep safety. These findings indicate that parents appear to seek appropriate sleep-related advice and are willing to do so through an accessible means of obtaining information.

Support (If Any): This study was supported by Johnson & Johnson Consumer Products Company, Division of Johnson & Johnson Consumer Companies, Inc.

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SLEEP IN CHILDREN RAISED BY GRANDPARENTS COMPARED TO OTHER FAMILY STRUCTURES: ANALYSIS OF FACES SURVEY

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Introduction: One in ten grandparents live with their grandchildren. 1 in 11 children and 1 in 5 black children live with a grandparent or other relative at some point before age 18, little is known about these children

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and how they compare to children raised in other settings, particularly about their sleep behavior. This study uses a nationally representative dataset to examine a sleep profile for children raised by grandparents.

**Methods:** 2009 Head Start Family and Child Experiences Survey (FACES), (mean age: 3.6 ± 0.6 years; 47% boys) a periodic, ongoing longitudinal study of program performance with successive nationally representative samples of Head Start children was investigated. Subset of 328 child-level cases was created by stratifying subjects into four groups (82 in each group) based on family structure including: mother and father, biological mother only, biological mother with non-biological father, and grandparent headed households and randomized into groups. Descriptive statistics and one-way between subjects ANOVA were conducted to compare means.

**Results:** Children slept an average of 10.4 ± 0.9 hours. Among the children raised by grandparents, 94% have regular bedtime at least 4 weekdays in past week, most sleep (66%) 10–11 hours per night, 22% seem sleepy or tired in class, 23% wake up at night at least once, 46% have restless sleep, 10% do not wake up full of energy. Grandparent caregivers were more likely than other parents or caregivers to report that their children have a safe place to sleep at night \( F(3,323) = 3.67, p = 0.01 \). Children raised by grandparents were more likely to appear very restless and fidgety during the daytime \( F(3,283) = 3.82, p = 0.01 \) and less likely to wake up full of energy than children raised by biological mothers only \( F(3,323) = 2.98, p = 0.03 \).

**Conclusion:** Limited information exists about children raised by grandparents, these results suggest children raised by grandparents have restless sleep, despite maintaining a regular bedtime. More research is needed to better understand sleep behavior and develop interventions specifically for grandparents to promote healthy sleep for the children in their care.


**1042**

**SLEEP ONSET DIFFICULTIES IN CHILDREN LIVING WITH NEGLECT ARE LINKED TO MATERNAL’S EMOTIONAL NEGLECT AND DEPRESSION SYMPTOMS**

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**Introduction:** Previous research has indicated the parent-child relationship and parenting quality to be important modulators of children’s sleep. Considering that parenting stress is an important predictor of neglect, and that parenting impacts on children’s sleep in neglect context have never been studied, this study examines the relationship between sleep problems of children living with neglect and various parental variables.

**Methods:** Participants were 43 mothers (from 20 to 43 years old) and one of their children, aged from 12 to 59 months, taking part in a national government parental neglect intervention program. Mothers completed questionnaires on their level of parenting stress (PSI), depression symptoms and their child’s sleep habits. An observational measure of parental emotional neglect was also completed. Multiple linear regression analyses were performed to examine child’s sleep onset difficulties’ association with parenting stress, depression symptoms of the mother and the level of emotional neglect.

**Results:** Children’s sleep onset difficulties showed significant correlations with the PSI parent-child dysfunctional interaction subscale \( r = -0.31^* \), PSI difficult child subscale \( r = -0.25^* \), depression symptoms \( r = 0.26^* \) and emotional neglect \( r = 0.33^* \). Stepwise multiple linear regression modeling demonstrated mothers’ depression symptoms and emotional neglect explained together 17.1% of sleep difficulties in children living with neglect \( p = 0.03 \). Emotional neglect was the largest predictor \( \beta = 0.39^* \), followed by depression \( \beta = 0.32^* \). However, parenting stress was not a significant predictor in the model. Further analyses indicated that children’s sleep onset difficulties were not a predictor of the parenting stress either.

**Conclusion:** Those results highlight the importance of targeting emotional neglect and mothers’ depression symptoms in addition to parenting stress, which is usually the main objective in neglect intervention programs, when trying to protect children’s sleep. In light of our results, the potential and risks of developing long term sleep problems in children living with neglect need to be addressed.

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**1043**

**SLEEP WELL!; IMPROVING SLEEP OF DISADVANTAGED CHILDREN**

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**Introduction:** The aim of this study was to assess the efficacy of the Sleep Well! Project, a simple 3-message parent-based sleep health education endeavor that supplemented the Beds for Kids program, a program that provides beds to disadvantaged children.

**Methods:** 77 families of children (ages 2–12 years; mean age = 5.62; 43 boys) were randomly assigned to a sleep education (3 messages: bedtime before 9:00; no caffeine; keep electronics out of the bedroom) or control (dental hygiene education) group. All education was provided at the time of delivery of a bed to each child. Sleep data were collected at baseline and at 1-month follow-up.

**Results:** Provision of beds was found to significantly reduce technology in the bedroom for all children (baseline: 1.71 items control; 1.95 items intervention) but more so for those who received sleep education (follow-up: 1.29 items vs 0.74 items), \( P = 0.003 \). Although not significant, there was a reduction of 0.46 caffeinated beverages in the intervention group, with an increase of 0.05 drinks in the control group, \( P = 0.126 \). No change was observed in bedtimes, which may have been the result of early bedtimes at baseline (9:12 control, 8:54 intervention), \( P = 0.624 \). Furthermore, a trend was observed for an increase in total sleep time from baseline (9.85 hours) to follow-up (10.21) for all participants, \( P = 0.055 \), with no group differences, \( P = 0.670 \).

**Conclusion:** A simple parent-based 3-message educational program resulted in significant reductions in electronics in the bedroom for disadvantaged children. Although not significant, there was also a reduction of half a caffeinated beverage following sleep education. No change in bedtime was observed, although this may be the result of already early bedtimes at baseline. Finally, it should be noted that there was an overall increase of 22 minutes in total sleep time and decrease of electronics in the bedroom for all children, which may be a result of the provision of beds for these disadvantaged children.

**Support (If Any):** This study was supported by the non-profit organization Beds for Kids.
1044
RELATIONSHIPS AND MECHANISMS BETWEEN PRE-BEDTIME BEHAVIORS AND ACTIGRAPH MEASURED SLEEP IN ADOLESCENTS
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Introduction: Computer and technology use before bedtime is associated with poorer and shorter sleep in adolescents. However, little is known about non-technology related behaviors like school-work. This study characterised both adolescent’s technology and non-technology related behaviours in the hour before bed (i.e., pre-bedtime behaviors; PBB) and examined their relationship with sleep timing, duration and onset latency. Pre-sleep arousal was examined as a mediator of the relationships between technological PBBs and sleep onset latency.

Methods: During the last week of a school-term and throughout a two-week vacation, 146 adolescents (47.26% male, age M ± SD = 16.2 ± 1.0 years) from the general community wore actigraphs continuously, which measured bedtime, risetime, sleep duration and sleep onset latency. During school and vacation periods participants completed a Pre-bedtime Behaviour Questionnaire that assessed the frequency of weekly engagement in PBBs, Morningness-Eveningness Questionnaire that assessed chronotype and the Pre-Sleep Arousal Scale that assessed cognitive pre-sleep arousal.

Results: During school and vacation periods, adolescents engaged in a range of technological and non-technological PBBs that shared varying relationships with sleep outcomes. Notably, playing video-games was associated with significantly later school-term and vacation bedtime (controlling for chronotype), and shorter school-term sleep duration. During vacation, online social-media behaviors were significantly associated with longer SOL, and this relationship was mediated by higher cognitive pre-sleep arousal. In contrast, during the school term spending time with family related to significantly earlier bedtime and longer sleep duration.

Conclusion: Some pre-sleep behaviors were associated with adolescents’ sleep timing, duration, and onset latency. Playing video-games might delay bedtime and has the potential to shorten sleep duration when sleep opportunity is constrained. In the context of relatively unconstrained sleep opportunity and lowered sleep drive, the use of online social media might increase sleep onset latency via increased pre-sleep arousal. Conversely spending time with family may encourage an earlier bedtime and longer sleep duration. Findings in this study help better understand not just whether but also how PBBs relate to adolescents’ sleep and have practical implications for adolescents’ health and wellbeing.

1046
INFLAMMATION AND VASCULAR STIFFNESS IN CHILDREN WITH OBSTRUCTIVE SLEEP APNEA
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Introduction: The cardiovascular outcomes of obstructive sleep apnea (OSA) in children are not clearly defined as they are in adults. We hypothesize that children with OSA have a systemic inflammatory response coupled to vascular stiffness. The aim of this study was to compare, in children with OSA and healthy controls, plasma levels of CD40 ligand (CD40L), adiponectin and IL-6, and measure their relationship to pulse wave velocities (PWV), a marker for vessel stiffness.

Methods: Prospective cohort study at an academic tertiary care center. Children with OSA and healthy matched controls (age, BMI, gender) aged 5–13 years were recruited. Plasma samples, blood pressures and PWV were obtained both before and after an overnight polysomnogram.

Results: 85 children with OSA and 105 controls were recruited. Children with OSA were more likely to be older (p = 0.01), obese (p = 0.02) and African American (p = 0.0006). Morning adiponectin levels were lower in OSA patients compared to controls (p = 0.04), and adiponectin negatively correlated with PWV (p = 0.02). While there were no group differences in pm or am IL-6 levels, IL-6 positively correlated with PWV (p ≤ 0.03). Serum CD40L was significantly higher in OSA versus control patients in the pm (p ≤ 0.0001) and am (p ≤ 0.0001) but did not correlate with PWV. There was no significant difference in PWV between control and OSA patients (345.5 versus 338.1, p = 0.10).

Conclusion: IL-6 and adiponectin were associated with increased vessel stiffness in children with OSA. While CD40L, a biomarker of atherosclerosis in adults, was significantly higher in children with OSA compared to controls, it was not a predictor of vessel stiffness. These findings suggest that the effect of upregulated inflammatory mediators on vascular function might not all manifest at the same stage of the disease and that longer exposure to OSA and elevated CD40L is required before structural and functional vascular changes are observed.

1045
IMPACT OF TECHNOLOGY USE BEFORE SLEEP ON DAYTIME FUNCTION IN ADOLESCENCE
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Introduction: Particularly among adolescents, technology (cell phones, computers, and video games), has become pervasive in American culture. The purpose of this study is to examine associations between the use of technology, nighttime sleep, and daytime function in adolescents.

Methods: This study is a secondary analysis of a subsample of respondents ages 13 to 21 years from the 2010 National Sleep Foundation’s Sleep in America Poll. The survey includes questions on demographics, sleep duration, frequency of waking unrefreshed, daytime sleepiness (questions from the Epworth Sleepiness Scale [ESS]), and frequency of technology use during the hour before bedtime. Descriptive and inferential statistics were performed. Statistical significance was set at p < 0.05.

Results: Adolescents (N = 259, 17.1 ± 2.6-years, 52% male, 32% minority) had a mean sleep duration of 7.7 hours ± 1.2 (range: 2.9–11.9); 60% report 8+ hours a night required “function at best.” There was no statistical difference in sleep duration by gender; Those under age 16 had an average of 30 minutes more nighttime sleep. Use of technology before bedtime was almost universal; Social media, internet, and/or texting nightly/every night were done by > 50% of the sample. Females were more likely to text message; Males more likely to play video games (p values < 0.05). Frequent use of technology (internet, social media, games with crude humor and/or violence, videos on mobile devices) was significantly associated with increased daytime sleepiness (p values < 0.05). Less than 10% of adolescents turn off their cellphone at night; Almost 30% report they were awakened a “few nights a week” to “every night” with phone calls/text messages and/or emails. The frequency of being awoken by a cell phone was associated with increased daytime sleepiness and waking unrefreshed (p values < 0.05).

Conclusion: Use of technology before sleep, ubiquitous among American adolescents, may have negative consequences on nighttime sleep and next day function.

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ASSOCIATION BETWEEN OBSTRUCTIVE SLEEP APNEA AND OBESITY IN A PEDIATRIC POPULATION
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Introduction: In adult populations, the pathology of obstructive sleep apnea syndrome (OSAS) is mainly related to obesity. In contrast, early studies in pediatric populations suggested adenoid and tonsillar hypertrophy (ATH) to be the main causes of OSAS in children, making adenotonsillectomy the main treatment. Early consensus was that, in contrast to adults, pediatric OSAS patients often present with inadequate weight gain and even failure to thrive. In fact, the past three decades have witnessed a 2–3-fold increase in the prevalence of childhood obesity. This fact sparked a shift in the pediatric OSAS paradigm towards combing obesity and ATH as the main causes of the disease. This represents a major change from the traditional view that ATH alone was the primary cause. Thus, further research on the pathology and outcomes of pediatric OSAS is needed. Especially given the increased prevalence of childhood obesity.

Methods: Correlations between patients’ sleep apnea severity, indicated by apnea hypopnea index (AHI) score, and patients’ body weight, indicated by the body mass index Z-score (BMI Z-score) were studied in a pediatric population from Seattle Children’s Hospital Sleep Center (n = 500). Analysis was carried out in the overall group and then stratified by body weight.

Results: Nearly half of the study subjects were overweight or obese. There was a significant association between AHI scores and the BMI Z-scores in the non-underweight group (n = 480). This association remained significant after adjusting for sociodemographic and comorbidity factors. No significant association was found between AHI scores and the BMI Z-scores in the all-subject group (n = 500) or in the underweight group (n = 20).

Conclusion: Obesity has become another major risk factor and potential cause for OSAS in the pediatric population. Weight management should become an important first line of treatments for OSAS patients in addition to the traditional surgical approach.

ESTABLISHING A ROLE FOR POLYSOMNOGRAPHY IN HOSPITALIZED CHILDREN
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Introduction: Children with neuromuscular disorders, intellectual & developmental disabilities, and chronic respiratory diseases have a high prevalence of sleep disorders. Outpatient polysomnography (PSG) may be difficult to perform due to lack of skilled nursing care. Recently, a case series on inpatient PSGs in adults was published, but similar studies are lacking in children. The aim of this study was to explore PSG indications in hospitalized children and assess its impact on patient care.

Methods: Data (demographics, clinical diagnosis, PSG indications, findings, and interventions) from 58 inpatient PSGs of 49 children hospitalized between March and August 2014 on the pediatric inpatient unit, ICU, & neonatal ICU of a single medical center was retrospectively collected. All patients underwent PSGs according to established AASM guidelines.

Results: 61% of patients were boys with ages 6.5 ± 6 years. Chronic respiratory failure was present in 55%, upper and lower airway obstruction due to congenital defects of the tracheobronchial tree & craniofacial abnormalities in 49%, hypoxic-ischemic encephalopathy (cerebral palsy, hydrocephalus) in 26.5%, genetic syndromes and neurodegenerative disorders in 18.4%, congenital myopathies in 10.2%, metabolic diseases in 6.1%, OSA in 6.1%, congenital cyanotic heart defects in 4.1%, acute life threatening events (ALTE) in 4.1%, and unexplained tachypnea and desaturations in the newborn in 4.1% patients. Indications for PSG were chronic pulmonary disease with upper/ lower airway obstruction in 62.8%, assessment of ventilator requirements in 37.9%, apnea and desaturation in 17.2%, and ALTE in 1.7% patients. Abnormal PSG results were found in 96.6% patients. The observed PSG diagnosis was: OSA in 67.9% (mild 23.7%, moderate 39.5%, severe 36.8%), hypoventilation in 8.9%, signs of chronic lung disease (tachypnea, desaturation, hypercapnia) in 39.3%, hypoventilation in 8.9%, periodic breathing in 5.4%, and periodic limb movement of sleep in 3.6% patients. The following interventions were performed based on PSG findings: adjustment of ventilator parameters in 37.9% of patients, initiation of positive airway pressure ventilator support in 41.4%, otolaryngology referral for upper airway assessment in 27.6%, supraglottoplasty in 1.7%, decannulation of tracheostomy in 3.4% patients, and performing tracheostomy as a temporary measure prior to corrective craniofacial surgery in 6%.

Conclusion: In a select group of patients, inpatient PSGs give invaluable information leading to appropriate intervention, and should be performed when indicated.

SLEEP CONCUSSION REVIEW AND EVALUATION (SCORE): SLEEP DISORDERS IN PEDIATRIC SPORTS-RELATED CONCUSSIONS
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Introduction: There is mounting evidence of sleep disturbance related to sports-related concussions in adults, including diminished sleep efficiency, insomnia, daytime sleepiness, and circadian rhythm abnormalities. However, there is little published data specifically characterizing the sleep disturbances in children due to sports-related concussions.

Methods: Retrospective cohort study. Participants who were evaluated for a physician-confirmed sports-related concussion March–November 2014 in the Sports Medicine Clinic at Seattle Children’s Hospital completed a questionnaire at their initial post-concussion visit regarding sleep schedule, modified pediatric Epworth sleepiness scale (ESS), daytime napping habits, and other sleep habits prior to and after concussion.

Results: 84 questionnaires were reviewed. Mean age 14.4 ± 2.4 years, 50% male, 83% Caucasian. Mean concussion symptom checklist score was 12.3 ± 6.5, indicating a broad range of subjective complaints. Mean time from concussion to clinic was 16.3 ± 13.9 days. Mean ESS score worsened post-concussion (5.0 ± 3.9 vs 8.2 ± 5.1, p < 0.001). 88% had increased reported daytime nap frequency post-concussion. Compared to pre-concussion: post-concussion bedtime on weekdays was earlier
1050 SLEEP AFTER PEDIATRIC TRAUMATIC BRAIN INJURY: A SURVEY STUDY
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Introduction: The purpose of this study was to compare sleep disturbances, daytime sleepiness, and sleep quality among children with traumatic brain injuries (TBI) to healthy matched control children. We hypothesized that children with TBI would have poorer sleep quality, greater daytime sleepiness, and more sleep disturbances compared to healthy matched control children based on parental report survey scales.

Methods: Information about the study and the study link was placed on pediatric hospitals, brain injury organizations, and health promotion internet sites for 2 months. Parents of children with TBI and parents of healthy children completed three surveys related to their child’s sleep behaviors and sleep quality: Children’s Sleep Habits Questionnaire (CSHQ), Child Sleep Wake Scale (CSWS), and the modified Epworth Sleepiness Scale (ESS). Children with TBI were then matched with healthy children based on age, race, and maternal education level. Children with TBI and healthy children were then compared using one-tailed directional t-tests based on a priori hypotheses.

Results: A total of 15 children with TBI along with 15 healthy children matched on age, race, and maternal education level. Children with TBI had significantly poorer sleep quality, measured by the CSWS, compared to healthy controls. The children with TBI also had significantly more daytime sleepiness, measured by the ESS, compared to healthy controls. However, no difference was found between groups on sleep disturbances, as measured by the CSHQ.

Conclusions: Children with TBI have poorer parent report sleep quality and daytime sleepiness, when compared to children with similar demographic characteristics.

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1051 LOW HEART RATE VARIABILITY DURING SLEEP IN YOUTH WITH CHRONIC PAIN
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Introduction: Idiopathic juvenile arthritis (JIA) is a chronic inflammatory syndrome associated with chronic pain status in youth population. The presence of sleep fragmentation has been described in children with JIA. However, the arousal is an insensitive marker of sleep fragmentation in young patients. Changes in heart rate variability (HRV) have been associated with sleep disruption, and it may be an important marker of less favorable health in all ages. Moreover, low HRV may be an indicator of increase in cardiovascular risks, including sudden death. The aim of this study was to examine HRV during sleep in pediatric patients with JIA.

Methods: We studied 10 patients with JIA that were compared with 10 healthy subjects matched for age, gender and Tanner stage. The HRV Standard Time and Frequency Domain were calculated for 5-minute periods in all sleep stages. The frequency components were subdivided in low and high frequency, and the time domain analyses were calculated by determination of the ratio of the standard deviation of the RR intervals. The Mann-Whitney U-test was used for identifying differences in HRV parameters, with a significance level set at 5%.

Results: We found that JIA patients had more arousals than controls. They also presented a reduction of NREM sleep, and a significantly longer total sleep time and wake time after sleep onset (WASO). Average normal-to-normal interval (SDNN) during slow wake sleep (SWS) was higher compared to stage 2 [94.6 ± 75.2 vs 47.0 ± 38.5, p = 0.02, respectively]. The total power of the HRV was lower in patients in all sleep stages (p < 0.05). Increased number of joints with impairment was positively related to pNN50 parameter (rs = 0.45; p < 0.05).

Conclusion: Patients with JIA suffer sleep fragmentation with concomitantly changes in their cardiovascular autonomic function during sleep. Change in parasympathetic process since childhood may lead to unfavorable cardio-vascular prognostic in this population.

1052 SLEEP DISORDERS IN CHILDREN WITH ASTHMA
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Introduction: Previous studies have shown that sleep complaints are common in patients with Asthma. However, there is very little data on sleep in children with asthma and the association with severity of lung disease.

Methods: A prospective study was conducted in asthma children. Total Sixty-four children with asthma were enrolled in the study. Subjects were questioned for daytime sleepiness using the Paediatric Daytime Sleepiness Scale (Epworth Scale), and sleep complaints using Michigan Scale. Enrolled asthma children finished lung function (FVC, FEV1, PEF as a percent predict). Complete overnight polysomnography techniques were performed on all subjects before and after asthma controlled, to evaluate the association between sleep disorder and asthma control.

Results: 1. Studies have shown decreased quality of sleep defined as reduced sleep time, reduced sleep quality, snoring, difficulty in maintaining sleep, and daytime sleepiness in asthma children, especially
in non-well controlled asthmatics. Non-well controlled asthmatic children had a significant decrease in sleep efficiency (SE; 76.3% (N) vs 79.1% (W); P < 0.05), prolonged rapid eye movement (REM) latency [150.5 min (N) vs 88 min (W); P < 0.05], and reduction in percentage of REM sleep [12.7 (N) vs 18.3 (W); P < 0.05]. The data suggest that the prevalence of pediatric sleep-disordered breathing and sleep fragmentation could be very high among children with asthma, no matter well-controlled or non-well controlled. 2. Non-well controlled asthmatic children had a higher apnea-hypopnea index (P < 0.05) and apnea-hypopnea-related arousal index (P < 0.05) as compared with well-controlled asthmatics. 3. SE, indicated the degree of sleep disruption, was correlated with FEV1. However, there was no significant correlation between SE and oxygen desaturation or SE and end-tidal pCO2.

Conclusions: It is concluded that asthmatic children have significant sleep fragmentation. OSA may coexist with asthma. Sleep disruption is associated with severity of lung disease, but is not directly correlated with the degree of nocturnal hypoxemia or hypoventilation.

1053 SUBJECTIVE BEDTIME VARIABILITY PREDICTS OBJECTIVE SLEEP ONSET LATENCY AMONG YOUTH WITH ASTHMA
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Introduction: The relationship between pediatric asthma and sleep is bidirectional; youth with asthma exhibit altered sleep architecture, and sleep disturbance exacerbates asthma symptoms. Compared to healthy peers, youth with asthma also exhibit more maladaptive sleep-related behaviors, including poor sleep hygiene and greater variability in week-to-weekend bedtimes, which may indirectly influence sleep architecture. This study examined the relationship between subjective parent-reported week-to-weekend variability in average bedtime and objective PSG-determined sleep onset latency (SOL) among youth with asthma. We hypothesized that greater at-home bedtime variability would predict longer PSG-determined SOL.

Methods: Data from 41 youth (3–16 yrs) with asthma (confirmed by parent-reported use of asthma controller or bronchodilator medication) were obtained from medical records from one overnight polysomnography (PSG) study. All data were collected at the University of Florida Health Sleep Disorders Center, and included subjective questionnaire data and technician-scored PSG outcomes. Variables of interest included: lights off = time of lights off during overnight PSG; bedtime variability = absolute value of the difference score between parent-reported average weeknight bedtime and average weekend bedtime; SOL = minutes to sleep onset during overnight PSG.

Results: Average parent-reported bedtime variability was 47.5 mins (SD = 32.5 mins); average PSG light’s out was 10:00 pm (SD = 36.5 mins); average PSG SOL was 23.3 mins (SD = 23.1 mins). Hierarchical linear regression (block 1 = child age and lights out; block 2 = bedtime variability) revealed that greater at-home week-to-weekend bedtime variability significantly predicted longer SOL (F(2,39) = 4.44, p = 0.009, b-weight = 0.28, R² = 0.26) during the overnight PSG, even after controlling for age and lights off.

Conclusion: This study found that greater variability in average week-to-weekend bedtimes independently predicted longer PSG-determined SOL in children with asthma. Specifically, each 3-minute increase in average week-to-weekend bedtime variability corresponded to 1 minute greater PSG-determined sleep onset latency. Findings suggest that promoting consistent bedtimes in youth with asthma may be an effective way to shorten overall SOL, thereby indirectly increasing TST and possibly improving overall sleep architecture.

1054 OBJECTIVE AND SUBJECTIVE REPORT OF SLEEP PROBLEMS IN CHILDREN WITH EOSINOPHILIC ESOPHAGITIS
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Introduction: This preliminary study examined the sleep patterns and problems of children with Eosinophilic Esophagitis (EoE) compared to healthy peers. EoE is a chronic inflammatory gastrointestinal disorder with symptoms of upper gastrointestinal distress and increased eosinophils in the esophagus. Research has illustrated the negative impact EoE has on the child’s quality of life (QOL). Sleep is an important, yet to be examined, factor that may impact the QOL of children with EoE.

Methods: Fourteen children with EoE and 12 healthy children ages 4–12 years participated. Parents completed the Children’s Sleep Habits Questionnaires (CSHQ), a QOL questionnaire, and a sleep diary for their child. The child wore an actigraph watch for 12 days for objective report on sleep.

Results: Based on on actigraphy, an objective measure, sleep efficiency of children with EoE (80.2%) was significantly poorer than the healthy children (87%; t(1) = −2.94, p < 0.05. However, children’s scores on the CSHQ, by parent report, were equivalent across groups with no significant differences on subscales or total scores. Parents reported children with EoE had poorer QOL than healthy peers (t(1) = −3.04, p < 0.05).

Conclusion: Objective reports of sleep in children with EoE provide evidence of significantly poor sleep compared to healthy controls which may be under-reported or unrecognized. Subjective reports via caregivers were incongruent with actigraph data, indicating limited awareness of the nighttime problems. The child may not alert the parent to sleep problems, or the focus of attention with EoE in families may be on the quality of life daytime changes rather than the nighttime problems. Assessment of sleep problems and daytime consequences that may indicate sleep problem is needed.

1055 SENSITIVITY AND SPECIFICITY OF THE MODIFIED EPWORTH SLEEPINESS SCALE IN CHILDREN WITH CRANIOPHYNGIOMA
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Introduction: The modified Epworth Sleepiness Scale (ESS) has been demonstrated to be an effective measure of sleepiness in children with sleep-disordered breathing (SDB). Pediatric craniopharyngioma patients are at increased risk for excessive daytime sleepiness (EDS) with different pathophysiology leading to EDS than is seen in children with SDB. Because no prior work has examined the appropriateness of self-reported sleepiness tools in this population, we sought to explore the sensitivity and specificity of the modified ESS in a sample of children with craniopharyngioma.

Methods: After surgery and prior to proton therapy, 40 patients with craniopharyngioma ages 7–20 (M = 11.5 ± 3.9) underwent overnight...
polysomnography and multiple sleep latency testing (MSLT) and completed the modified ESS. Participants were 55% female and 65% Caucasian. McNemar’s tests were used to compare the proportion of patients identified with sleepiness by the modified ESS in relation to MSLT.

**Results:** 68% of the sample had mean sleep onset latency (SOL) of ≤ 10 minutes, while 38% had modified ESS ≥ 10 (McNemar’s p = 0.008). The modified ESS demonstrated 44% sensitivity and 77% specificity in relation to mean SOL. 38% of the sample had ≥ 2 sleep-onset REM episodes (SOREM) on MSLT. The modified ESS demonstrated 27% sensitivity and 56% specificity in relation to SOREM.

**Conclusion:** Preliminary data in children with craniopharyngioma evaluated prior to proton therapy reveal that approximately two-thirds present with objectively documented EDS, and one third demonstrate significant SOREM. On the other hand, nearly twice as many children had objective sleepiness than subjectively reported sleepiness. Given the significant risk for EDS in children with craniopharyngioma, the poor sensitivity of the modified ESS points to the importance of objectively measuring sleepiness in this high-risk population.

**1056**  
**SLEEP IN ADOLESCENTS AND YOUNG ADULTS IN THE YEAR POST CANCER TREATMENT**  
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**Introduction:** Adolescents and young adults with cancer (AYA) are a vulnerable group facing more intense treatments, higher symptom burden (sleep disturbance, fatigue, pain, depression), and poorer treatment outcomes relative to younger children. Sleep disruption is common during cancer treatment and sleep problems persist into adulthood for some survivors. Furthermore, the developmental period of adolescence/emerging adulthood confers greater biological and behavioral risk for insufficient sleep relative to older or younger ages. Thus, understanding the frequency and characteristics of AYA sleep disturbances shortly after completing treatment is important for informing targets of intervention to manage cancer-related symptoms and improve quality of life.

**Methods:** The data is from baseline assessments of an ongoing randomized controlled trial testing a texting health-promoting intervention with AYA in the first year after completing treatment. Forty AYA completed the Pittsburg Sleep Quality Index (PSQI) as part of the baseline visit.

**Results:** AYA ranged in age from 12–24 (M = 17.05, SD = 2.98) and they were 6.53 months (SD = 3.20) off treatment. On average, AYA reported sleeping 7.85 hours (SD = 1.73), taking 37.96 minutes (SD = 54.38) to fall asleep, and sleep efficiency of 91% (SD = 18.85). However, 30% of the sample reported sleep efficiency below 85%. The average total PSQI score was 5.50 (SD = 2.64) and 47% (n = 19) were above the clinical cut-point of 5 indicating that they were “poor sleepers.”

**Conclusion:** On average, AYA report less sleep than age recommendations and take longer to fall asleep than clinical cut-points for insomnia diagnoses. Similar to research in adult childhood cancer survivors, almost one-third of this sample reported suboptimal sleep efficiency suggestive of insomnia. That almost half of AYA were above the clinical cut-point of the PSQI indicates the importance of assessing and treating sleep problems as an essential component of improving quality of life during and after cancer treatment.

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**1057**  
**SLEEP AND BEHAVIORAL FUNCTIONING IN SURVIVORS OF CHILDHOOD HEMATOPOIETIC STEM CELL TRANSPLANT**  
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**Introduction:** As survival rates in pediatric hematopoietic stem cell transplantation (HSCT) increase, attention to long-term psychosocial outcomes becomes increasingly important. Past studies have demonstrated that a subset of pediatric HSCT survivors have increased rates of depression and anxiety. No attention has been paid, however, to sleep in HSCT survivors or to the relation between sleep and behavioral outcomes. The aim of this study is to examine parent-proxy and self-reported sleepiness as a predictor of behavioral and executive functioning in childhood HSCT survivors.

**Methods:** Seventy-six HSCT survivors (age 8–29 years; M = 17.84 ± 6.04 years) were assessed 5–14 years post-transplant (M = 7.8 ± 1.87 years). Parent-proxy report was obtained for participants younger than 18 years. Two sample t-tests were conducted to compare the presence of excessive daytime sleepiness (EDS; Epworth Sleepiness Scale ≥ 10) to emotional/behavioral functioning (Behavior Assessment System in Children-BASC-2) and executive functioning (Behavior Rating Inventory of Executive Function-BRIEF).

**Results:** EDS was reported by approximately 21–28% of parents and survivors. Self-reported EDS was associated with significantly more self-reported behavioral and emotional difficulties across most domains (Mean BASC-2 T-score differences = 6–11 points; all p’s < 0.05). Parent-reported EDS was significantly associated with more parent-reported difficulties in global behavioral symptoms, aggression, anxiety, atypicality, and withdrawal (Mean BASC-2 T-score differences = 8–15 points; all p’s < 0.05). Parent-reported EDS was also significantly associated with more parent-reported executive dysfunction (Mean BRIEF T-score differences = 10–12 points; all p’s < 0.05).

**Conclusion:** This study is the first to examine the role of sleepiness in behavioral and executive functioning of long-term survivors of pediatric HSCT. Survivors with EDS exhibited both statistically and clinically more behavioral and executive functioning difficulties by both self- and parent-report. These findings illustrate the importance of examining EDS in pediatric HSCT survivors and considering the development of interventions to improve alertness, which may have a broader impact on daytime function.

**Support (If Any):** St. Baldrick’s Foundation

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**1058**  
**PULMONARY ARTERIAL HYPERTENSION PREVALENCE IN CHILDREN FROM 2 TO 16 YEARS OLD WITH OBSTRUCTIVE SLEEP APNEA-HYPOPNEA SYNDROME LIVING AT HIGH ALTITUDE SEEN AT FUNDACION NEUMOLOGICA COLOMBIANA**  
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**Introduction:** A relation between Obstructive Sleep Apnea-Hypopnea Syndrome (OSAHS) and Pulmonary Arterial Hypertension (PAH) has been proven. However, there is lack of studies showing this relation at high altitude. The aim of this study was to establish the PAH prevalence in children from 2 to 16 years old with SAHS living at 2640 meters above sea level (masl)

**Methods:** We included children from 2 to 16 years old seen at Fundacion Neumologica Colombiana Sleep Laboratory (2630 masl), with a positive polysomnography (PSG) for SAHS and Transthoracic Echo-
cardiology. Variables such as demographic data, respiratory pattern, oxygen saturation (SpO2) and echocardiographic parameters were analyzed using medians, interquartile range (IQR), Chi-square and Kruskal-Wallis as needed

**Results:** Of 55 participants 63.6% were male, with a median age of 6 yrs. Weight variable: 14 children (25.5%) overweight, 6 (10.9%) obesity, 1 (1.8%) morbid obesity. OSAHS 12 (21.8%), 12 (21.8%), 31 (56.4%) mild, moderate and severe respectively. The indexes of apnea-hypopnea (AHI): 11 (6–24)/hour; obstructive apnea-hypopnea (OAH): 7 (4–15)/hour. Severe SAHS: minimum oxygen saturation during events 78%, oxygen desaturation index (ID) 33.8/hour (p < 0.01); median T90: 4 (7.2%) had right ventricular systolic pressure border line and has not been part of the neurodevelopmental evaluation.

**Conclusion:** Children with OSAHS living at high altitude show a significant and intermittent desaturation, however, we did not find association between OSAHS and PAH in this population

### 1059 OBESITY, SLEEP AND BREATHING IN CANADIAN CHILDREN AND ADOLESCENTS


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**Introduction:** Sleep disordered breathing (SDB) is an important comorbidity of obesity and is associated with poorer health outcomes. Elevated body mass index (BMI) is a major risk factor for SDB though insufficient alone to explain variability in SDB severity. The aim of this study was to identify predictors for SDB severity in children with obesity presenting for polysomnography (PSG).

**Methods:** The design of the study was a multi-centre retrospective chart review. Data was collected from 3 pediatric sleep laboratories for all children 8–16 years of age with a BMI ≥ 95th percentile undergoing PSG (2011–2012). SDB severity was measured by apnea-hypopnea index (AHI). Predictors of SDB severity were selected on univariate analysis where p < 0.10 was used for entry into the model with log transformed AHI as the outcome variable.

**Results:** A total of 225 children were identified, of whom 191 underwent a diagnostic PSG and were included in this analysis. The mean age of the group was 12.8 ± 2.6 years and 66% were male. The primary sleep symptoms included snoring (82%), daytime sleepiness (45%), and mouth breathing (42%). The majority of children had comorbidities (88%). Tonsils were enlarged in 25% of children. AH1 was < 1.5 events/h for 32%, 1.5–4.9 events/h for 30%, 5–9.9 events/h for 13% and > 10 events/h for 23% of children. Only 4 demographic or clinical features showed significant association with AHI on univariate analysis. Three showed independent associations on multivariate analysis; age (beta 0.19, p < 0.01) and BMI z-score (beta 0.017, p < 0.05) were positively associated with higher AHI while mouth breathing was associated with lower AHI (beta −0.29, p < 0.001).

**Conclusions:** Sleep symptoms, comorbidities and physical examination fail to show associations with the presence and severity of SDB in children with obesity. PSG is necessary to characterize SDB risk in children with obesity.

### 1060 SLEEP PROBLEMS IN CHILDREN WITH NEURODEVELOPMENTAL DISORDERS

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**Introduction:** Sleep related problems are well known in children with neurodevelopmental disorders. Some of the etiologies are due to dysregulation of melatonin synthesis and sensitization to environmental stimuli. They include circadian rhythm disorders, behavioral insomnia and multiple night time awakenings. Sleep fragmentation and poor quality of sleep maybe responsible for some of the behavior problems exhibited by these children.

**Methods:** This prospective study involved administering a 61-item questionnaire to 76 children who attended Neurodevelopmental (ND) clinic, 50 of whom had a diagnosis and 26 controls who were recruited from siblings or friends. Questions included demographic information, diagnosis, family history, medications and sleep related history.

**Results:** Fifty (31 males) were recruited from the ND clinic and 26 children formed the controls. Age of ND children was 9.6 ± 4.1 years (mean ± S.D.) and age for controls was 9.07 ± 4.5 years. The most common diagnosis were ADHD (10/50), and Autism (9/50). Of the available information, 22/50 children were Caucasian, 15/50 reported snoring and 19/50 restless sleep. Among the controls, 19/26 were Caucasian, 11 being male. Night time awakenings were much more commonly seen in children who co-slept with their care-givers (p = 0.001). Snoring and restless sleep are seen more in children with a neurodevelopmental diagnosis (Spearman coefficient = 0.32).

**Conclusion:** Sleep problems are much more common in children with a neurodevelopmental diagnosis. It is likely a combination of behavioral and organic factors. A detailed sleep history and sleep study should form part of the neurodevelopmental evaluation.

### 1061 SLEEP PROBLEMS IN CHILDREN WITH AUTISM SPECTRUM DISORDERS COMPARED TO CHILDREN WITH DEVELOPMENTAL DISABILITIES AND A POPULATION BASED SAMPLE IN THE STUDY TO EXPLORE EARLY DEVELOPMENT

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**Introduction:** Sleep problems are commonly reported in children with autism spectrum disorders (ASD) and Developmental Disability (DD), with prevalence rates ranging from 50 to 80%. The Children’s Sleep Habits Questionnaire (CSHQ) is a 33 item questionnaire with 8 subscales which was validated in children ages 4 to 10 years but has been used in younger populations.

**Methods:** Children 2 to 5 years of age in the Study to Explore Early Development (SEED) with ASD (n = 650), DD (n = 929), and from the general population (POP) (n = 873), whose parent completed a CSHQ were included. A univariable Analysis of Variance was used to compare total and subscale scores on the CSHQ between groups (ASD, DD, and POP). Chi-square tests were used to examine group differences in sleep problems using a total score (TS) cutoff of 41.

**Results:** The mean CSHQ TS was 48.05 in children with ASD, 45.63 in children with DD, and 42.7 for POP children. Differences between groups were significant (p < 0.0001). Children with ASD and DD had higher scores on all CSHQ subscales when compared to POP. Chil-
dren with ASD had higher scores than children with DD on all subscales except for Daytime Sleepiness. Children with ASD were more likely to be classified with sleep problems (70.62%) than POP (50.17%) [OR = 2.38, 95% CI = 1.93, 2.96, p < 0.0001] or DD (62.76%)(OR = 1.67, 95% CI = 1.15, 1.77, p = 0.0012).

**Conclusion:** Children with ASD had higher TS on the CSHQ than children with DD and children from the POP groups, and higher subscales scores in all areas except daytime sleepiness when compared to the DD group. The proportion of children with sleep problems, defined by TS 41, was higher in those with ASD compared to DD and POP groups, however, the cutoff score of 41 may not be appropriate for this age group.

**Support (If Any):** This study was supported by the Centers for Disease Control and Prevention and the Clinical and Translational Research Center.

### 1062 RESTLESS LEGS SYNDROME IN CHILDREN WITH A HISTORY OF PREMATURETY

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**Introduction:** Little is known about which children are at increased risk for restless legs syndrome (RLS) and periodic limb movement disorder (PLMD). Polysomnographic data from the Caffeine for Apnea of Prematurity-Sleep study showed that 14% of a cohort of ex-preterm children aged 5–12 years had an elevated periodic limb movement in sleep (PLMS) index (>5/hour), but the clinical importance of this finding is unknown. We hypothesized that ex-preterm children would have a high prevalence of RLS and PLMD.

**Methods:** Subjects underwent polysomnography and caregivers completed questionnaires. A diagnosis of RLS or PLMD was established by subjects meeting the ICSD3 criteria with positive symptoms derived from the Owens RLS questionnaire and the Pediatric Sleep Questionnaire (PSQ). Clinically available serum ferritin levels were assessed.

**Results:** 5 (19.2%) of the 26 subjects with a PLMS index > 5 who completed the RLS Questionnaire had RLS; 10 (7.0%) of the 143 subjects with a PLMS index < 5 had RLS (p = 0.04). 11 of the 26 subjects with an elevated PLMS index (42.3%) had PLMD. 9 subjects were referred for serum ferritin evaluation, and levels ranged from 11 to 48.9 mcg/L.

**Conclusion:** Children with a history of prematurity have an increased risk of RLS and PLMD. Iron deficiency likely contributes to RLS and PLMD symptoms in this population. Clinicians evaluating ex-preterm children with sleep disturbances should evaluate for RLS and PLMD. Prospective studies including serum ferritin evaluation are needed to confirm these findings.

**Support (If Any):** NIH RO1 HL098045, NIH KL2 TR000139

### 1063 KIDS AND IRON SUPPLEMENTATION IN SLEEP

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**Introduction:** Many children with potential Restless Legs Syndrome (RLS) present with vague “restlessness” in sleep. Iron supplementation has been shown to reduce symptoms of RLS, though limited data in pediatrics are available. The goal of this pilot study is to characterize the effects of iron supplementation (IS) on sleep quality, daytime function and behavior, and Quality of Life (QOL) in children reporting restless sleep with low ferritin levels.

**Methods:** Sixty participants (2–18 yrs) will be enrolled in this ongoing prospective observational study who are treated with IS for low ferritin levels (<50 ng/mL) in the context of restless sleep/possible RLS. Study outcomes at pre- and post-3 months IS include: Pediatric Sleep Questionnaire (PSQ), Epworth Sleepiness Scale (ESS), Pediatric Symptom Checklist (PSC), and Pediatric QOL Inventory (PedsQL). A subset of participants does pre- and post-iron treatment actigraphy. Iron compliance is monitored weekly, with ferritin monitored as part of clinical care.

**Results:** To date 31 subjects have been enrolled. The average age is 7.18 years old, 72% male, 93% Caucasian, 7% Hispanic. Pre-treatment ferritin levels were 19.91 ng/mL (SD ± 8.4 ng/mL). On average at baseline: parents report their children have 5 restless nights/wk (mean PSQ = 7.7), while the children report excessive daytime sleepiness (mean ESS = 10.4), and poorer quality of life than healthy children (mean PedsQL = 71.1). Preliminary results indicate fewer restless nights, improved QOL, and increased ferritin levels following iron supplementation.

**Conclusion:** As one of the first prospective studies investigating the effects of IS on children’s sleep quality and daytime function/behavior who present with restless sleep, the preliminary results from this pilot study highlight the need to address restless sleep in children with low ferritin, and suggest the need for more research in this area.

**Support (If Any):** Grant from Seattle Children’s Research Institute Nursing Research Program

### 1064 INADEQUATE SLEEP AS A MEDIATING VARIABLE BETWEEN EXPOSURE TO VIOLENCE AND DEPRESSION SEVERITY IN ADOLESCENTS

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**Introduction:** Exposure to violence is a serious concern that has been associated with depression. Little is known about mechanisms by which exposure to violence influences depressive symptoms. We sought to determine whether short sleep duration mediates the relationship between violence exposure and depressive symptoms. We predicted that adolescents who were exposed to violence would report obtaining less total sleep time; and insufficient sleep will, in turn, predict greater depression severity.

**Methods:** A 3-year longitudinal study of 1,042 (57% female) high school students was conducted where the majority of participants (75%) were in 9th grade (mean age = 15.1 ± 0.79), and the remaining in 10th grade at wave1. The retention rate of wave2 and wave3 were 31 subjects have been enrolled. The average age is 15.1 ± 0.79. Two waves were conducted, where the majority of participants (75%) were in 9th grade (mean age = 15.1 ± 0.79), and the remaining in 10th grade at wave1. The retention rate of wave2 and wave3 were 73%. Sixty participants (2–18 yrs) will be enrolled in this ongoing prospective observational study who are treated with IS for low ferritin levels (<50 ng/mL) in the context of restless sleep/possible RLS. Study outcomes at pre- and post-3 months IS include: Pediatric Sleep Questionnaire (PSQ), Epworth Sleepiness Scale (ESS), Pediatric Symptom Checklist (PSC), and Pediatric QOL Inventory (PedsQL). A subset of participants does pre- and post-iron treatment actigraphy. Iron compliance is monitored weekly, with ferritin monitored as part of clinical care.

**Results:** To date 31 subjects have been enrolled. The average age is 7.18 years old, 72% male, 93% Caucasian, 7% Hispanic. Pre-treatment ferritin levels were 19.91 ng/mL (SD ± 8.4 ng/mL). On average at baseline: parents report their children have 5 restless nights/wk (mean PSQ = 7.7), while the children report excessive daytime sleepiness (mean ESS = 10.4), and poorer quality of life than healthy children (mean PedsQL = 71.1). Preliminary results indicate fewer restless nights, improved QOL, and increased ferritin levels following iron supplementation.

**Conclusion:** As one of the first prospective studies investigating the effects of IS on children’s sleep quality and daytime function/behavior who present with restless sleep, the preliminary results from this pilot study highlight the need to address restless sleep in children with low ferritin, and suggest the need for more research in this area.

**Support (If Any):** Grant from Seattle Children’s Research Institute Nursing Research Program
friends’ dating violence was not (b = −0.01, p = 0.90). Sleep duration was negatively associated with depressive symptoms (b = −0.08, p = 0.002).

Conclusion: Short sleep duration mediated the relationship between exposure to interparental violence and depression severity, indicating that sleep duration may be a valid treatment target for youth exposed to violence.

1065
THE SENSE STUDY: A RANDOMIZED CONTROLLED TRIAL OF A COGNITIVE-BEHAVIORAL/ MINDFULNESS-BASED, MULTICOMPONENT GROUP SLEEP INTERVENTION AMONG ADOLESCENTS EXPERIENCING SLEEP AND ANXIETY DISTURBANCE
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Introduction: Existing literature links poor sleep and mental health problems in adolescents. The SENSE Study (Sleep and Education: learning New Skills Early) is a randomized controlled trial investigating whether a 7-week, multi-component group sleep intervention can improve sleep, anxiety and depression among at-risk adolescents.

Methods: Participants were 101 adolescents (Mean age = 14.4, SD = 0.92, Female = 65, Male = 36), recruited from screenings conducted at 23 secondary schools across Melbourne, who showed high levels of anxiety (Spence Children’s Anxiety Scale [SCAS] > 32 Males, > 38 Females) with comorbid sleeping difficulties (Pittsburgh Sleep Quality Index [PSQI] > 4). Eligible participants were randomly allocated to either a ‘Sleep-SENSE’ group intervention (Treatment, n = 49) or ‘Study-SENSE’ study skills group intervention (Active Control, n = 52), with randomization stratified by gender, age and presence/absence of an anxiety disorder at baseline. Sleep-SENSE is a multi-component, group program designed to improve sleep by addressing barriers to sleep across the sleep-wake cycle. It aims to improve sleep quality in the short term and, via sustained behavior change, the long-term, and is tailored to address the unique developmental challenges and opportunities of adolescence. It incorporates sleep hygiene, stimulus control, cognitive-behavior therapy and mindfulness-based therapy, and has a specific focus on identifying and overcoming barriers to change. It involves 7 weekly 90-minute sessions supported by a range of psycho-educational materials. Interventions were facilitated by psychologists or psychologists in training (Treatment) and teachers (Control) trained in the interventions. Participants underwent repeated assessments of sleep (PSQI), anxiety (SCAS) and depression (Centre for Epidemiologic Studies - Depression Scale [CESD]) before and after the intervention.

Results: A series of 2 (treatment condition; Sleep-SENSE, Study-SENSE) × 2 (assessment point; pre-intervention, post intervention) mixed-between-subjects ANOVAs were conducted. Results showed that participants in the Sleep-SENSE intervention improved significantly more than participants in the control intervention, from pre-post intervention, on most PSQI variables (Total Score [p = 0.00], Sleep Onset Latency [p = 0.03], Sleep Quality [p = 0.03], Daytime Dysfunction [p = 0.03]) and some SCAS sub-scales (Separation Anxiety [p = 0.01], Obsessive-Compulsive symptoms [p = 0.02]), with small-moderate effect sizes. There was a trend for participants in the Sleep-SENSE intervention to improve more than participants in the control intervention, from pre-post intervention, on SCAS Total Score (p = 0.06). There was no difference between the groups from pre-post intervention on CESD Total Score (p = 0.20).

Conclusion: This study provides evidence that a cognitive-behavioral/mindfulness-based, multi-component group sleep intervention can improve sleep and anxiety among at-risk adolescents. Its impact on depression needs further investigation.

Support (If Any): NHMRC (Australia) Grant (APP1027076).

1066
PARENTAL SLEEP PRACTICES IN INFANCY PREDICT LATER SLEEP PROBLEMS IN CHILDREN WITH GENERALIZED ANXIETY DISORDER
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Introduction: Parenting practices in infancy, particularly involvement in bedtime routines, predict later sleep problems and anxiety. Although sleep problems are prevalent in children with generalized anxiety disorder (GAD), little is known about the early sleep patterns of this group. This study examined parental sleep practices and bedtime routines during infancy and associations with later sleep problems among children with GAD and healthy controls.

Methods: Children ages 7–11 with primary GAD (n = 44) and non-anxious controls (n = 40) completed a diagnostic assessment, wore actigraphs for 7 consecutive nights, and completed the Sleep Self Report (SSR). Primary caregivers completed the Children’s Sleep Habits Questionnaire (CSHQ) and a measure of early sleep-related parenting practices from 0–6 months of age.

Results: Analyses were controlled for parental anxiety, preterm birth, and maternal education. Compared to non-anxious controls, as infants, children with GAD were more frequently rocked to sleep, F = 4.75, p = 0.03, and were more often already asleep when put to bed, F = 4.02, p = 0.05. For children with GAD, being rocked to sleep as an infant predicted longer parent-reported sleep onset latency (SOL), β = −2.41, p = 0.02 during childhood. Also, age at which GAD children slept through the night for the first time predicted longer parent-reported SOL, β = −2.04, p = 0.05, shorter parent and child-reported sleep duration (β = 2.31, p = 0.03; β = 2.13, p = 0.04).

Conclusion: Being rocked to sleep and first sleeping through the night at later ages predicted both parent and child report of subjective sleep problems during the childhood years in the GAD group. These findings highlight the role of early sleep practices in shaping later sleep and self-regulatory skills among children with GAD. Implications for early intervention are considered.

Support (If Any): Funding support for this study was provided by the National Institute of Mental Health (K23 MH081188).

1067
SLEEP MISPERCEPTION AND ITS CLINICAL CORRELATES IN CHILDREN WITH ANXIETY DISORDERS
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Introduction: Sleep state misperception (SSM) is characterized by an inaccurate perception of one’s sleep as alertness and is frequently experienced by individuals with insomnia. Inaccurate beliefs of inadequate sleep elicit arousal and worry, further perpetuating insufficient sleep (Harvey, 2002). Up to 90% of children with generalized anxiety disorder (GAD) report problems sleeping, but SSM has not been explored in this population.
Methods: Eighty-four children (44 females; Mage = 8.80, SD-age = 1.40) with either primary GAD (n = 44) or no diagnosis (n = 40) were studied across seven consecutive nights of actigraphy and self-reports of sleep onset latency (SOL), reported in minutes. Discrepancy between the measures was calculated using a difference score (self-report SOL - actigraphy SOL).

Results: Multilevel models using full maximum likelihood estimation were used. At level 1, we predicted the SOL indicator (actigraphy, self-report, or the discrepancy score) by an intercept. At level 2, we used group as a predictor of the intercept. Group only marginally predicted objective SOL (Intercept = 20.84, Beta = 5.18, SE = 2.74, p = 0.06) with GAD children evidencing slightly longer SOL (M = 26.08, SD = 13.43) than control children (M = 20.82, SD = 10.93). GAD children reported significantly longer SOL (M = 27.38, SD = 22.91) than control children (M = 14.89, SD = 10.15; Intercept = 14.95, Beta = 12.43, SE = 3.86, p = 0.002). Children with GAD were more likely to over-report SOL (Intercept = −5.87, Beta = 6.79, SE = 3.27, p = 0.04).

Conclusion: Results suggest that GAD children estimate significantly longer sleep initiation than they actually experience. On average, anxious youth only require about 6 minutes longer than controls to fall asleep. Future research is needed to explore the nature of SSM in this group including possible differences in EEG arousal based on spectral analyses.

Support (If Any): Funding support for this study was provided by the National Institute of Mental Health (K23 MH081188).

1068 COMPARISON OF NIGHT POLYSOMNOMGRAM FINDINGS IN CHILDREN WITH ATTENTION-DEFICIT/HYPERACTIVITY DISORDER WITH AND WITHOUT SLEEP COMPLAINTS

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Introduction: Our previous research using questionnaires revealed that 11.3% of Korean children with attention-deficit/hyperactive disorder (ADHD) symptoms have habitual snoring whereas only 5.88% of normal children have it. The aim of this study is to evaluate the objective sleep quality in children with ADHD depending on the presence of sleep complaints.

Methods: Children with ADHD who completed the sleep questionnaire were grouped as those with sleep complaints and those without sleep complaints. Each group of 19 age-, sex- and BMI matched children underwent a night PSG. Sleep structure, respiratory disturbance index (RDI), apnea-hypopnea index (AHI), periodic limb movement index (PLMI), oxygen saturation and end-tidal CO2 were analyzed.

Results: Total 38 children (mean age 7.5 ± 1.0 yrs, 32 male) performed a night PSG. There was no difference in sleep latency, REM sleep latency, sleep efficiency, arousal index and sleep architecture between groups except for the percentage of N2 sleep, which was higher in children with sleep complaints. PLMI was significantly higher in children with sleep complaints (0.25 ± 0.95/h vs. 2.5 ± 4.5/h, p = 0.020). AHI and RDI were similar between two groups (AHI, 0.9 ± 0.7/h vs. 1.2 ± 0.8/h; RDI, 3.0 ± 2.1/h vs. 3.2 ± 1.8/h). Oxygen saturation and ETCO2 did not reveal a difference.

Conclusion: Our study showed that children with ADHD have sleep-disordered breathing despite the lack of sleep complaints. Evaluation of their sleep should include not only sleep questionnaire but also night PSG.

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1069 USE OF AN EDUCATIONAL STORY TO PREPARE CHILDREN WITH DEVELOPMENTAL DISABILITIES FOR OVERNIGHT POLYSOMNOGRAPHY

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Introduction: Children with developmental disabilities (DD) are at risk for sleep problems. Overnight polysomnography (PSG) is a valuable diagnostic tool in sleep medicine. However, it requires patient cooperation with equipment placement and maintenance. Children with DD have cognitive and behavioral challenges which make this even more challenging. There is little research on how to prepare children for PSG. Our research tests effectiveness of an educational story, a simple, low-cost method of preparation, for parents and children in a randomized single-blind controlled trial. We hypothesized that our educational intervention would increase parent knowledge, child cooperation, and informational yield of PSG.

Methods: Parents of 10 subjects aged 4–17 years (mean = 8.2; SD = 3.2), 80% male, with DD, primarily attention-deficit/hyperactivity disorder and autism spectrum disorder, referred for clinical PSG participated. Families were randomized into a control group and an intervention group who received a printed copy of an educational story about a child coming to a sleep laboratory for PSG, illustrated with color photographs depicting the entire PSG process. Parents completed questionnaires on PSG knowledge and a Parental Beliefs Scale assessing parent confidence in supporting children through medical procedures, both on enrollment and the night of PSG. An adapted Wong-Baker FACES scale measured child distress during PSG setup.

Results: An interim analysis has been performed, since recruitment is ongoing. Preliminary assessment showed no significant difference between group pre-test knowledge. Both groups improved, although no significant difference in post-test knowledge was detected. Parental Beliefs Scale scores showed improvement for both groups. The intervention group improved from mean score of 75 to 79 (maximum score 100); the control group from 64.8 to 72.4. Adapted Wong-Baker FACES scale ratings were similar between groups.

Conclusion: An educational story could be a promising intervention to increase parent knowledge of and child cooperation with PSG. Our study is ongoing, and additional research is warranted.

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PARASOMNIAS, SLEEP QUALITY AND MATERNAL MENTAL HEALTH
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Introduction: Poorer maternal mental health was often shown in association with infant’s sleep disturbances. However, little is known about the link between maternal mental health and parasomnias in children. The present study aimed to investigate the potential association between the presence of parasomnias in children and maternal depression or anxiety and to assess the co-occurrence of parasomnias and sleep disruptions in children.

Methods: Participants (n = 349 mother-child dyads) were part of a longitudinal study (Maternal Adversity, Vulnerability, and Neurodevelopment; MAVAN). Maternal anxiety was evaluated with the State and Trait Inventory (STAI) and maternal depression with the Center for Epidemiologic Studies Depression Scale (CESD) at 24 months postpartum. The presence of parasomnias (nightmares, sleep terrors, sleep-walking, bruxism, and body rocking), sleep duration, longest period of uninterrupted sleep and bedtime were also assessed at 24 months by maternal reports. Parasomnias were dichotomized (never versus sometimes, often, or every night) and a total score was then computed for each child. Mother’s level of anxiety and depression was compared as a function of child’s number of parasomnias with one-way ANOVAs. Sleep variables were also compared as a function of child’s number of parasomnias.

Results: On 349 children, 128 had no parasomnia, 100 had one parasomnia, 55 had two parasomnias and 66 had three or more parasomnias. Mothers of children with 3 or more parasomnias had significantly higher levels of depression (13.3 vs. 9.4; p < 0.05) and anxiety (39.4 vs. 34.9; p < 0.05) than those without any parasomnia. In addition, children with 3 or more parasomnias went to bed later (20h27 vs. 20h04; p < 0.05) and slept in average 30 minutes less than children without parasomnia (10h12 vs.10h32; p < 0.05). Finally, children with 3 parasomnias had a shorter duration of uninterrupted sleep than those with one (8h00 vs. 9h08; p < 0.05) or two parasomnias (8h00 vs. 9h21; p < 0.05).

Conclusion: Present results show that mothers of children with parasomnias have higher levels of anxiety and depression compared with mothers of children without parasomnias. In addition, children with parasomnias present more sleep disruptions. The association between parasomnias, sleep quality and maternal mental health deserves more attention and the mechanism linking these phenomena remains to be clarified.

Support (If Any): Supported by the Canadian Institutes of Health Research

TOO LONG, TOO SHORT, OR TOO VARIABLE?
VARIABILITY OF DAILY ACTIGRAPHY SLEEP, PERCEIVED SLEEP QUALITY, AND NEGATIVE MOOD IN ADOLESCENTS
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Introduction: Average sleep duration and quality have been extensively researched in relation to adolescents’ mental health. A small number of studies in adults have linked higher day-to-day sleep variability to insomnia and depression. However, the relationship between variable sleep patterns and adolescents’ mental health remains unexamined.

Methods: 146 adolescents (47.3% male) aged 16.2 ± 1.0 years (M ± SD) from the general community wore an actigraph that assessed daily bedtime, risetime, time-in-bed (TIB), and sleep onset latency (SOL) throughout a two-week vacation with relatively unconstrained sleep opportunity. Self-report sleep quality (SSQ), negative mood (symptoms of anxiety and depression), and life stress for this period were assessed using questionnaires. For each sleep parameter, individuals’ mean values and daily variability were used to simultaneously predict negative mood with SSQ as mediator. The models were estimated in a purpose-built Bayesian framework, with age, sex, and life stress included as covariates.

Results: Longer and more variable TIB were both associated with poorer SSQ (p-values < 0.01), which in turn, was associated with more negative mood (p < 0.01). Similarly, more variable SOL was associated with worse SSQ (p < 0.01), which in turn, was associated with more negative mood (p < 0.05); the mean of SOL, however, was not significantly related to either SSQ or negative mood. Neither variability nor the mean of bedtime and risetime were significantly associated with SSQ or negative mood.

Conclusion: During a period of relatively unconstrained sleep opportunity, higher day-to-day variability of actigraphy TIB and SOL were associated with greater severity of anxiety and depressive symptoms, mediated by poorer perceived sleep quality. Significant effects of variability found in this study were over and above the effect of mean values, suggesting unique aspects of sleep variability that are relevant to symptoms of anxiety and depression in adolescents.

CIRCADIAN RHYTHM GENE VARIANTS INFLUENCE BODY MASS INDEX IN CHILDREN
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Introduction: Variants in circadian rhythm-related genes may influence obesity and metabolic phenotypes. However, little research in humans has examined associations among circadian rhythm/sleep-related genes and sleep, obesity and cardio-metabolic phenotypes.
Even less evidence is available in childhood and adolescence, when metabolic and obesity phenotypes are shaped. Our objective was to investigate potential associations of candidate circadian rhythm-related genes with parental report of sleep duration and with cardio-metabolic outcomes in a large pediatric population.

**Methods:** We selected 64 single nucleotide polymorphisms (SNPs) from 8 candidate genes (Clock, Period2, Period3, Cryptochrome2, Melatonin Receptor 1B, Adenosine Deaminase, Adenosine A2a Receptor, and BHLHE41) for association testing in 814 children participating in a pre-birth cohort study, Project Viva (79.4% European, 20.6% non-European ancestry). We also controlled for population structure using genetic ancestry. Sleep and cardio-metabolic measures included parental report of child’s sleep duration, body mass index (BMI), waist circumference, blood pressure, and heart rate. Outcomes were collected at 3 different time points: 6 months, early childhood (median 3.3 years), and mid-childhood (median 7.7 years). We used an additive genetic model in linear regression analyses adjusting for covariates age, sex, and race/ethnicity. Bonferroni-adjusted p-value (< 0.00078) was considered significant.

**Results:** We found significant independent associations of BMI at age 7 with 2 SNPs, Period 2 (PER2) rs11892306 and Adenosine deaminase (ADA) rs6031682. Minor allele carriers for PER2 rs1182306 had lower BMI (~1.52 kg/m²; 95% CI ~2.32, ~0.73) compared to non-carriers, whereas carriers of the ADA rs6031682 minor allele had a 0.88 kg/m² (95% CI 0.43, 1.33) higher BMI relative to non-carriers. No association was seen with other cardio-metabolic outcomes, including BMI in children at earlier ages. Sleep duration was not significantly associated with any SNP.

**Conclusion:** Using genetic analysis of circadian rhythm- and sleep-related variants we identified associations of PER2 and ADA with differences in BMI in children but results need replication.

**Support (If Any):** This study was supported by NIH/NCI grant U54CA155626. Data collection for Project Viva was supported by NIH/NICHD grant R37HD034568. A-MC was supported by NIH/NHLBI grant K01HL115458.

1073
BLOOD LEAD LEVELS IN EARLY CHILDHOOD ARE ASSOCIATED WITH SLEEP PROBLEMS IN LATER CHILDHOOD

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**Introduction:** Lead exposure has been linked to mental and behavioral developmental problems in children. Little is known about the impact of lead exposure on children’s sleep. This study examined the association between blood lead levels (BLL) and sleep problems as reported by both parents and children themselves in a sample of Chinese children.

**Method:** 1419 preschool children participated in a longitudinal cohort study of lead exposure and health outcomes in Jiangsu, China. BLL were measured when children were aged 3–5 years and sleep was assessed when children were aged 9–13 years. The Chinese version of the Child Sleep Habits Questionnaire (CSHQ) was used to assess parent-reported child’s sleep and an adolescent sleep questionnaire was used to assess self-reported sleep. A total of 665 children with complete data on BLL and sleep were included for the current study.

**Results:** Mean age of the sample at BLL assessment was 4.74 years (SD = 0.89). Mean age at sleep assessment was 11.05 years (SD = 0.88), 53% were males. Mean BLL was 6.26 µg/dL (SD = 2.54). There were significant correlations between BLL and 3 CSHQ subscales divided by BLL < 10 and BLL > 10: Sleep onset delay (r = 0.113, p < 0.01), Less sleep duration (r = 0.139, p < 0.001), and Night wakening (r = 0.089, p < 0.05). Insomnia was somewhat higher (45.7% vs 32.5%, p = 0.067), and excessive daytime sleepiness (26.1% vs 9.0%, p < 0.001), and use of sleep pills (6.5% vs 1.8%, p = 0.03) were reliably more prevalent in children BLL ≥ 10.0 µg/dl than in those children BLL < 10.0 µg/dl. After adjusting for demographics, BLL ≥ 10.0 µg/dl was significantly associated with increased risk for insomnia (OR = 2.01, 95% CI = 1.03–3.95) and excessive daytime sleepiness (EDS) (OR = 2.90, 95% CI = 1.27–6.61).

**Conclusion:** Our findings suggest that elevated BLL in early childhood are associated with increased risk for sleep problems in later childhood. Further research is warranted to examine the long-term impact of childhood lead exposure on objective sleep measures and the mechanisms underlying higher lead levels and associated sleep problems.

1074
DAY-TO-DAY ASSOCIATIONS BETWEEN SLEEP QUALITY AND DAILY EXPERIENCES IN YOUTH

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**Introduction:** Inadequate sleep is associated with increased risks of emotional and health problems among youth, but we know little about the relationships among sleep, emotions, and social experiences at the daily level. This study examined bidirectional associations between youths’ daily experiences and nightly sleep quality across one week.

**Methods:** The sample comprised 123 youths spanning 9 to 17 years of age (mean age of 13; 52% female). During telephone interviews on 8 consecutive evenings, youths rated their previous night’s sleep quality in addition to the current day’s emotions and both positive and stressful experiences involving their parents or others. Multilevel models tested daily experiences as predictors of same-night sleep quality, as well as the reverse associations (i.e., sleep predicting next-day experiences). Analyses adjusted for the previous day’s experiences and sleep quality, youth and parent demographics, and day-level covariates (e.g., school day, parent work day).

**Results:** Participants collectively provided 807 days of interviews. On average, youth reported positive social events on 73% of days and stressors on 27% of days. Mean sleep quality was 3.5, positive emotions were 3.3, and negative emotions were 1.3 on 1–4 rating scales. Numerous significant between-person associations emerged. Youth who had better sleep quality across the week tended to have more positive emotions, more positive experiences with parents, and were less likely to argue with parents or others. Accounting for between-person effects, within-person associations revealed that, after nights when sleep quality was better than usual, youth reported fewer stressors and more positive events than usual on the following day.

**Conclusion:** Individual differences in daily emotional and social experiences are linked to individual differences in youths’ sleep quality. Furthermore, decreases and increases in youths’ nighttime sleep quality from one night to the next are linked to decreases and increases in their next-day emotional and social experiences.

**Support (If Any):** This research was conducted as part of the Work, Family, and Health Network, which is funded by a cooperative agreement through the National Institutes of Health and Centers for Disease Control and Prevention: Eunice Kennedy Shriver National Institute of Child Health and Human Development (U01HD051217, U01HD051218, U01HD051256, U01HD051276), National Institute on Aging (U01AG027669), Office of Behavioral and Social Sciences Research,
B. Clinical Sleep Science

1075 SLEEP CHARACTERISTICS ASSOCIATED WITH NEUROCOGNITIVE DEVELOPMENT AT 3 YEARS OLD IN A FRENCH PROSPECTIVE BIRTH-COHORT STUDY (AUBE)
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Introduction: Sleep quantity and quality were associated in school-aged children to cognitive development measured by the executive functioning, school performance, intelligence quotient (IQ), language development, and memory learning. Few studies were conducted among preschoolers from healthy general population and usually focused on only one aspect. We aimed at identifying, among 3 years old children, factors associated with IQ estimated through WPPSI-III and its indicators i.e. full-scale (FSIQ), verbal (VIQ) and performance (PIQ) scores.

Methods: We included children from the French birth-cohort AuBE with a WPPSI-III test performed at 3 years old (N = 188) and available sleep data. Information on mothers and children were collected through self-questionnaires at birth, 6, 12, 18, and 24 months of age. We considered mother’s age at birth, working category, parity, pre-pregnancy BMI, smoking during pregnancy, gender, term at birth, birth weight, breastfeeding duration, childcare arrangement and child’s TV viewing duration. Child’s sleep duration (night and naps), snoring (≥ 3 times/week) and night-awakenings were also collected at each age. A day/total sleep duration ratio was calculated. Analyses were performed using linear regressions.

Results: Mean scores were 106 (range: 62–138), 92 (61–140) and 99 (61–138) for VIQ, PIQ and FSIQ, respectively. Being a ≥ 3 born-child from an unemployed overweight mother and watching TV ≥ 1 hours/day at 24 months were negatively associated with FSIQ while night-awakenings at 6 months were positively associated; Snoring at 18 months, watching TV ≥ 2 hours/day at 24 months, and having a manual worker mother was negatively associated with PIQ while day/total sleep ratio at 12 months and collective childcare arrangement at 24 months were positively associated. All factors but working category were significantly associated with FSIQ.

Conclusion: Factors associated with FSIQ reflected those associated with VIQ and PIQ subscales. Different sleep characteristics at 6, 12 and 18 months influenced IQs scores at 3 years old.

1076 ACTIGRAPHY-MEASURED SLEEP PATTERNS AMONG CHILDREN WITH AUTISM AND OTHER DISABILITIES
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Introduction: Children with disabilities are reported by their parents to experience sleep disturbances. This study characterized actigraphy-measured sleep patterns among children with disabilities and examined whether caregivers’ education was associated with children’s sleep disturbances.

Methods: This cross-sectional study was conducted among 125 children (aged 6–12 years; boys: 55.2%) with autism and other disabilities and their caregivers in Chile. Children wore ActiSleep monitors for seven consecutive days, while caregivers completed sleep logs for children with key measures including sleep latency, wake after sleep onset (WASO), sleep efficiency, and sleep duration. Linear regression models were fitted to estimate mean and standard error (SE) of sleep efficiency across caregivers’ education levels while adjusting for children’s age, sex, disability type, caregiver-child relationship, and caregivers’ age. Multivariable logistic regression analyses were conducted to estimate odds ratios (ORs) and 95% confidence intervals (CIs) for risks of longer sleep latency (≥ 30 minutes) and other dichotomized measures of sleep disturbances in relation to caregivers’ educational attainment.

Results: Median sleep latency was 27.3 minutes, WASO 88.1 minutes, and sleep duration 8.0 hours. Mean sleep efficiency was 80.0%. Adjusted mean of sleep efficiency varied by caregivers’ education, with the lowest sleep efficiency observed among children of caregivers with < high school (75.7% (SE = 1.4)), followed by children of caregivers with high school (80.4% (SE = 1.0)) and > high school (81.9% (SE = 1.0)). Caregivers’ education was significantly and positively associated with children’s sleep efficiency (P = 0.001). Compared to children whose caregivers had > high school, children of caregivers with < high school had higher odds of longer sleep latency (OR = 3.27; 95% CI: 1.12–9.61) and WASO ≥ 90 minutes (OR = 5.95; 95% CI: 1.91–18.53). Associations were generally consistent across disability groups.

Conclusions: Children with disabilities have long sleep latency, long WASO (a measure of sleep fragmentation), short sleep, and poor sleep. Caregivers’ lower educational levels are strongly associated with children’s sleep disturbances.

Support (If Any): This research was supported by awards from the National Institutes of Health (National Institute on Minority Health and Health Disparities: T37-MD001449; the National Center for Research Resources (NCRR), the National Center for Advancing Translational Sciences (NCATS): 8ULTR00170-05), and the Rose Traveling Award.
1077
SLEEP SYMPTOMS IN A POPULATION BASED SAMPLE OF 5-11 YEAR OLD CHILDREN WITH ASTHMA ENROLLED IN THE SUPERVISED ASTHMA MEDICINE IN SCHOOLS (SAMS) STUDY
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Introduction: There are few reports of the prevalence of symptoms associated with sleep problems in a non-clinical sample of children with asthma. SAMS is a school based study which provides an opportunity to examine these relationships in a community based sample of children.

Methods: Children were eligible if they had physician-diagnosed asthma, were enrolled in a participating Tucson Unified School District (Tucson, Arizona) elementary school, and spoke English or Spanish. Parents were interviewed by telephone upon enrollment to obtain demographic and sleep-related data. Snoring, daytime sleepiness, trouble falling asleep, witnessed apnea, and nighttime awakenings were considered present if the parent reported they occurred ‘frequently or almost always’.

Results: The 262 children had a mean age of 8.5 (1.7) years, were mostly male (65%), Hispanic (77%), and had a mean BMI of 19.6 (5.7). The prevalence of snoring (20.2%), nighttime awakenings (13.8%), and tonsillectomy (16.2%) are substantially greater in children with asthma than those reported in the general population of normal children of the same age. However, the prevalence of daytime sleepiness (9.4%), trouble falling asleep (16.2%), and witnessed apnea (2.6%) were similar to previous reports of these symptoms in non-asthmatic schoolchildren. Boys had trouble falling asleep more often than girls (20.3% vs 8.5%, p < 0.01). There were no differences in snoring, daytime sleepiness, or witnessed apnea within gender, ethnicity, BMI (> 95th percentile) or children with tonsillectomy. However, children with nighttime awakenings also had a greater prevalence of habitual snoring (57.9% vs 17.2%, p < 0.001) and trouble falling asleep (42.1% vs 14.0%, p < 0.001).

Conclusions: In this community based sample of 5–11 year-old children with asthma, the prevalence of habitual snoring, nighttime awakenings, and tonsillectomy are greater than reported in non-asthmatic schoolchildren. Asthmatic children with frequent nighttime awakenings are more likely to have trouble falling asleep and habitual snoring.

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1078
ADENOTONSILLECTOMY OUTCOMES OF CHILDREN WITH PRIMARY MEDICAL DIAGNOSES AS COMPARED TO HEALTHY CHILDREN: A RETROSPECTIVE REVIEW OF A CANADIAN TERTIARY PEDIATRIC SLEEP CENTER
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Introduction: Children with an underlying medical diagnosis have traditionally been excluded from studies reporting on the persistence of obstructive sleep apnea (OSA) post adenotonsillectomy (AT). Our aim was to determine the prevalence of persistent OSA in a cohort of children with an underlying primary medical diagnosis as compared to a cohort of healthy children.

Methods: We conducted a retrospective review of children that underwent PSGs pre and post AT in the sleep laboratory at SickKids, Toronto, Canada, between 2009 and 2013. Children with an underlying medical diagnosis were defined as those with ≥ 1 International Classification of Disease tenth revision diagnostic code (ICD-10). Data were collected on baseline demographics, medical diagnoses, and PSG results pre and post AT.

Results: A total of 280 children underwent pre and post AT PSGs or post AT PSG during the study period. The mean (SD) age was 5.9 (6.0) years. Fifty-nine (n = 165) percent were male. 245 (88%) children had ≥ 1 ICD-10 diagnosis. Pre AT, there were no differences in age, gender, obstructive apnea-hypopnea index, oxygen saturation nadir or maximum end-tidal carbon dioxide level between children with and without an ICD-10 diagnosis. Post AT, the oxygen saturation nadir mean (SD) was significantly lower for the children with an ICD-10 diagnosis, 82.9 (11.4) vs 88.7 (8.0), p = 0.03. Post AT, moderate-severe OSA persisted in 41.0% of children with an ICD-10 diagnosis as compared to 31.6% of children without a diagnosis (p = 0.026).

Conclusion: The prevalence of persistent OSA post AT is higher in children with an underlying ICD-10 diagnosis as compared to healthy children. Clinical factors which predict the persistence of OSA in these children including the presence of Complex Chronic Conditions as per Feudtner will be available by the time of the meeting.

1079
PREVALENCE AND CLINICAL CORRELATES OF NOCTURNAL SHORT ONSET REM (SOREM) PERIODS IN 12,113 PEDIATRIC PATIENTS
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Introduction: Sleep-onset REM (SOREM) during nocturnal PSG is suggested to be a unique diagnostic indicator of narcolepsy and is included in the newest nosology for narcolepsy (DSM-V and ICSD-3). We evaluated the prevalence of PSG SOREMs in a large sample of pediatric patients being evaluated for sleep disorders.

Methods: Data were extracted from SleepMed's repository of PSG data collected from 2004 to 2013. Multiple logistic regression analyses were employed to predict the odds (odds ratio; OR) of PSG SOREM across the following factors: sex, race, age, respiratory disturbance index (RDI), arousal index (AI), WASO, napping the day of test, habitual weekday/weekend napping, and symptoms of narcolepsy (sleep paralysis and hypnagogic hallucinations).

Results: The final sample consisted of 12,113 patients (58% Male; 46% Caucasian) with a mean age of 9.3 ± 4.7 yr (range = 1–17) and RDI of 6.3 ± 12.6. The prevalence of PSG SOREM was 1.0% (n = 125; SOREM = 5.8 ± 4.5 min) but varied with age. Overall, SOREM was most prevalent in infancy (age = 1; 4.3%) and declined to ≤ 0.5% through 13 years of age. A small increase was seen in children between 14 and 15 years of age (1.5%). The adjusted model was significant R² = 7.7%, χ²(11, n = 7,290) = 62.6, p < 0.001, but “napping the day of the test” (OR = 3.6; 50% vs. 27%; p < 0.001) contributed to most variance in SOREM (3.4%). Unique variance was accounted for by AI and WASO, but effect sizes were very small after controlling for napping.

Conclusion: The prevalence of NPSP SOREM in children was similar to our adult sample (0.9%); see accompanying abstract entitled “Predictors and Potential Confounders of SOREM in 239,047 Adult Sleep Clinic Patients”), but had different predictors. Napping children, regardless of age, were much more likely to have a PSG SOREM. Napping in older children may be a marker of unstable sleep/wake regulation and excessive sleepiness, a hallmark symptom of narcolepsy and certain other sleep disorders.

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1080
FACTORS ASSOCIATED WITH CHANGES IN RESPIRATORY TECHNOLOGY SETTINGS DURING PEDIATRIC POLYSOMNOGRAMS
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Introduction: There are long wait times for pediatric PSG in Canada. Our aim was to examine factors associated with changes in respiratory technology (Continuous Positive Airway Pressure (CPAP), Bi-level positive airway pressure ventilation (Bi-level) and invasive ventilation (IPPV)) settings during titration studies.

Methods: We conducted a retrospective review of children with ≥ 2 PSGs using CPAP, Bi-level and IPPV at the sleep laboratory at SickKids, Toronto, Canada, between 2009 to 2013. Major change in settings was defined as a change in pressure or rate. Repeated measures regression for major change was performed with age, gender, BMI, technology type, reason for ventilation (Central Nervous System (CNS), Musculoskeletal (MSK), respiratory), obstructive and central apnea-hypopnea indices, time from last PSG, and PSG within recommended limit. Initiation studies were excluded.

Results: A total of 224 patients, 108 (48%) male, underwent 521 PSGs during the study period. The technology subgroups were: Bi-level, 333 (64%), CPAP 87 (17%) and IPPV, 101 (19%). The mean (SD) age was 10.02 (5.09). The mean (SD) time between PSGs was 1.16 (0.98) years. 352 (67%) studies had a major change. Technology type and reason for ventilation were significant variables in the regression analysis. The odds of a major change was greatest for Bi-level as compared to both CPAP (OR 2.74, p = 0.0004) and IPPV (OR 1.72, p = 0.0495). The odds of a major change was greatest for a CNS diagnosis for ventilation as compared to both a MSK diagnosis (OR 2.23, p = 0.0049) and a respiratory diagnosis (OR 2.10, p = 0.0042).

Conclusion: Bi-level ventilation and a CNS diagnosis requiring ventilation were associated with the greatest chance of a major change in settings during technology titration. Further exploration of the specific CNS diagnoses associated with changes in the settings will be available at the time of the meeting.

1081
SLEEP DISORDERS IN BRAZILIAN CHILDREN: REGIONAL DIFFERENCES
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Introduction: Adenoid or tonsil hyperplasia is the most common cause of sleep disordered breathing (SDB) in children and together with the inflammatory condition can impair growth. The disrupted sleep and the oxygen desaturation are the most important characteristics of SDB and can lead to cognitive dysfunction. The pollution in big cities can provide an environment for allergies and inflammatory diseases, increasing the incidence of SDB. The objective is to verify the prevalence of SDB in children in a big city compared to a small town.

Methods: This study was carried out in elementary public schools, in Sao Luis City, Maranhao State, northeast of Brazil and in Sao Paulo City, Sao Paulo State, southeast of Brazil, a big industrial polluted city. Parents of 6 to 10 years old children filled in the Sleep Disturbance Scale for Children Questionnaire, adapted and validated for Brazilian Portuguese. We excluded children with genetic or neurological diseases.

Results: We analyzed 3023 questionnaires (51.5% girls) from Sao Paulo and 694 (51% girls) from Sao Luis. For all sleep disorders there was no difference between the two cities (21% in Sao Paulo; 18% in Sao Luis; p = 0.09). When we analyzed the subgroups of sleep disorders, we found more children with SDB (15.4%) and disorders of initiating and maintaining sleep (2.9%) in Sao Luis than in Sao Paulo (2.6%, 0.52%, respectively; p < 0.05); and more children with disorder of arousal (15%), disorder of sleep-wake transition (2.8%), and excessive sleepiness (2%) in Sao Paulo than in Sao Luis (1.2%; 0.7%; 0.14%, respectively; p < 0.05).

Conclusion: The data surprisingly showed a greater prevalence of SDB in Sao Luis compared to Sao Paulo. Economic and Social conditions, as poor health assistance and poor public health policies, can be more effective to impair sleep than industrial environmental aggression such as air pollution.

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1082
REVIEWING THE EFFECTS OF PRENATAL ALCOHOL EXPOSURE ON SLEEP AND CIRCADIAN FUNCTIONING IN CHILDREN: AN EMERGING PATHWAY TO NEUROCOGNITIVE IMPAIRMENT
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Introduction: Prenatal alcohol exposure (PAE) has been associated with a range of neurocognitive effects, including decreased executive function. Emerging research suggests that these children are also at increased risks for sleep problems, which may in turn exacerbate the neurocognitive symptoms. This systematic review explores the body of primary research literature surrounding the relationship between children’s sleep and circadian problems caused by PAE and daytime neurocognitive impairment.

Methods: We developed a detailed search string to capture relevant studies in both humans and animal models in PubMed. Studies in which the mother had consumed alcohol during pregnancy, and sleep or circadian functioning was measured in the offspring were included; reviews, studies in a language other than English, studies that were not peer-reviewed, and studies in which offspring studied were over 18 years old were excluded.

Results: Of the 524 studies yielded from applying our search string in PubMed, 40 studies met inclusion criteria for this systematic review. Sleep problems are common among children with PAE, with 21 studies documenting increased risks in animal models and 19 studies in humans. The specific sleep problems associated with PAE include shorter sleep duration (8 studies), longer onset latency (7 studies), bedtime resistance (4 studies), sleep anxiety (3 studies), and other physiologic abnormalities of sleep (10 studies). Finally, sleep problems in children with PAE are both more severe and prevalent with the presence of co-morbid neurocognitive problems such as ADHD, anxiety, and depression (2 studies).

Conclusion: The current state of the literature demonstrates a significantly increased risk of sleep problems among children with PAE, this burden may be translating in turn to a greater neurocognitive burden or decreased family quality of life. What remains unknown is the degree to which these sleep problems can be addressed with treatment, and whether children with PAE will show any amelioration of neurocognitive symptoms with improved sleep, as is seen among children with non-teratogenic behavior and development disorders.

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1083
FACTORs ASSOCIATED WITH NIGHT SLEEP TRAJECTORIES AMONG FRENCH PRESCHOOL CHILDREN FROM THE EDEN MOTHER-CHILD COHORT
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Introduction: Children sleep has been associated with subsequent health outcomes, but less is known about sleep trajectories and their associated factors among preschoolers.

Methods: We included 1258 children from the French mother-child EDEN cohort with sleep data between 2 and 5.5 years old. Group-based trajectory modeling was used to identify night sleep duration (NSD) trajectories and simultaneously identify time-stable factors explaining differences between trajectories and time-dependent factors associated with variations within trajectories. Studied time-stable factors concerned the family (income, educational level, familial status), the mother (age at birth, parity, pre-pregnancy BMI, depression, smoking status) and the child (term, gender, birth-weight, breastfeeding duration); Time-dependent factors were childcare arrangement, working mother, parental presence when falling asleep, BMI-z-score, nightmares, nap, physical activity and TV viewing durations.

Results: Five distinct NSD trajectories were identified: constant-short sleepers (CSS, < 10h/night, 5.5%), constant-medium-long sleepers (CMSLs, < 11h/night, 45.0%), constant-medium-high sleepers (CMHS, ≥11h/night, 36.5%), decreasing-long sleepers (DLS, ≥ 11h/night, 5.1%) and modifier sleepers (MS, i.e. LS-MLS, 7.9%). Factors associated with increased risk for SS trajectory were being a first-born child and having a smoking mother during and after pregnancy. Within SS group, NSD between 2 and 5.5 years was negatively associated with TV viewing duration. Factors associated with increased risk for LS trajectory were being a girl, born to a young or a mother who smoked during pregnancy. Within LS group, NSD between 2 and 5.5 years was negatively associated with TV viewing duration. Factors associated with increased risk for MS trajectory were being a smoking mother during pregnancy. In MS group, NSD was negatively associated with collective childcare arrangement.

Conclusion: Early life factors, especially maternal smoking during pregnancy, were associated with several sleep trajectories from 2 to 5.5 years. Factors associated with sleep duration changes within trajectory groups were mainly behavioral.

1084
CIRCADIAN PREFERENCE, SLEEP HYGIENE AND MEDIA USE IN ITALIAN CHILDREN
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Introduction: Circadian phase preference is an individual characteristic related to different daily rhythms of many physiological variables. Previous researches have demonstrated that poor sleep hygiene and screen-based media use is associated with poor sleep, but little is known about prepubertal children. Purpose of this study was to investigate relationship between circadian preferences, sleep hygiene, media use in children aged 4-11 y.

Methods: Data were collected on 2592 non-referred children (49% male), attending ten schools in Rome (response rate = 79.5%). Sample was divided into three groups (4-6, 6.1-9, 9.1-10.11 years). Parents completed Children's Sleep Hygiene Scale (CSHS), Children’s Sleep Habits Questionnaire (CSHQ), Children’s Chronotype Questionnaire (CCTQ). Questionnaires showed adequate internal consistency. Parents were asked about children’s screen time (time spent on screen-based activities, including mobile phone, television, video-game console, computer and electronic social media such as text messages and online social networking sites) over the past 30 days. Those who spent more than 120 min/daily were considered extensive users.

Results: ANOVA results showed poor sleep hygiene practices across evening types in all age groups (F 58.3; p < 0.001), particularly in the oldest group. Similarly, the Evening groups scored higher on CSHQ across all ages (F 111; p = 0.0001) and slept less than Morning and Intermediate types (F 438.6; p < 0.001). As expected, Evening children showed higher screen exposure than other circadian types (F 71.3; p < 0.001) constantly over time. Interestingly, 45%, 50%, 55% respectively in younger to older Evening children are media extensive users. SES and female sex as covariate showed a significant effect indicating that higher SES and sex act as protective factors.

Conclusion: This study indicated that evening circadian preference is importantly related to insufficient and low quality sleep, poor sleep hygiene and higher screen time exposure even in pre-schoolers. This trend increases as children get older, especially in males with low socio-cultural level.

1085
VARIATION IN OBJECTIVELY DETERMINED PHYSICAL ACTIVITY, SEDENTARY BEHAVIOR AND SLEEP BY SEASON IN 12-14 YEAR-OLD CHILDREN
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Introduction: An integrative consideration of multiple health behaviors may inform the development of novel approaches for reducing obesity risk in children. We sought to examine the extent to which physical activity, sedentary behavior and sleep vary by season.

Methods: We examined 302 12-14 year old children in Project Viva, a pre-birth cohort study in eastern Massachusetts, enrolled across all seasons. Activity levels were assessed from GT3X+ accelerometers worn on the wrist for at least 3 days and nights, and characterized as moderate-to-vigorous activity, sedentary time and sleep based on Evenson cut-points and the Cole-Kripke sleep algorithm. We used multivariable linear regression models adjusted for child age, sex, race/ethnicity and maternal education.

Results: Mean (SD) age was 12.9 years (0.4); 51% were male and 65% were white. Mean (SD) moderate-to-vigorous physical activity was 136 min (48); sedentary time was 229 min (76); total sleep time was 7.8 hours (0.7); wake after sleep onset was 55 min (23); mid-sleep time was 3.3 hours (1.2) and accelerometer wear time was 7.2 days (1.5). In multivariable models, children had higher moderate-to-vigorous physical activity during spring and summer compared to winter (spring: β = 17.1 min [95% CI: 1.5, 32.7]; summer: β = 19.5 min [95% CI: 4.9, 34.2]; autumn: β = 8.1 min [95% CI: -7.4, 23.5]; p = 0.05). The sedentary time and average total sleep time did not differ between seasons (p = 0.20 and p = 0.97, respectively), but wake after sleep onset was higher in summer compared to winter (β = 7.5 min [95% CI: 0.5, 14.4]; p = 0.01). The mid-sleep time was significantly delayed in summer compared to winter (β = 0.5 hours [95% CI: 0.2, 0.8]; p < 0.001).
Conclusion: Physical activity was higher in the summer than the winter, but sleep quality was worse. Longer wake after sleep onset and delayed sleep timing in the summer suggest influences associated with changes in routines, activities or sun exposure.

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1086
SLEEP IN THE MODERN FAMILY: PROTECTIVE FAMILY ROUTINES FOR CHILD AND ADOLESCENT SLEEP: RESULTS FROM THE 2014 SLEEP IN AMERICA POLL
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Introduction: The overall objective of the 2014 National Sleep Foundation Sleep in America Poll “Sleep in the Modern Family” was to obtain a current picture of sleep in families with at least one school-aged child.

Methods: Cross-sectional poll; Internet-based interview; Nationally-representative internet panel of US households with a child 6–17 years.

Results: Primary measures included parental perception of the importance of sleep, parental and child sleep quality, child sleep duration and habits, technology in bedroom, and family rules. Parents/guardians (n = 1103, mean age 42, 54% female) completed the survey. Although the majority of parents endorsed the importance of sleep, 90% of children obtain less sleep than recommended. Significant predictors of age-adjusted sufficient sleep duration (estimated conservatively as ≥ 9 h for ages 6–11, ≥ 8 h for ages 12–17) included parent education, regular enforcement of rules about caffeine, and whether children left technology on in their bedroom overnight. Significant predictors of excellent sleep quality included whether a bedtime was always enforced and whether children left technology on overnight.

Conclusions: Children generally have better age-appropriate sleep in the presence of household rules and regular sleep-wake routines. Sufficient sleep quantity and adequate sleep quality were protected by well-established rules of sleep hygiene (limited caffeine, regular bedtime). In contrast, sleep deficiency was more likely to be present when parents and children had electronic devices on in the bedroom after bedtime. Public health intervention goals for sleep health might focus on reducing the encroachment of technology and media into time for sleep and supporting well-known sleep hygiene principles.

1087
SLEEP DURATION AND INJURY-RELATED RISK BEHAVIORS AMONG US HIGH SCHOOL STUDENTS
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Introduction: In the US, more than two-thirds of high school students sleep < 8 h on school nights. Insufficient sleep is associated with an increased risk for injury from drowsy driving crashes and workplace errors.

Methods: To evaluate the association between sleep duration and injury-related risk behaviors, we analyzed data from 51,091 high school students (grades 9–12) who participated in the National Youth Risk Behavior Survey in 2007, 2009, 2011, and 2013. Students responded to questions about school night sleep duration and demographics, as well as how frequently they used a bicycle helmet, wore a seatbelt, rode with a driver who had been drinking, drove when drinking, and texted/emailed while driving. Adjusted prevalence ratios (PR) and 95% confidence intervals (CI) for the likelihood of each injury-related behavior were obtained from logistic regression analyses adjusted for sex, grade in school, and race/ethnicity with a referent sleep duration of 9 h.

Results: The distribution of sleep duration was ≤ 4 h (6.3%), 5 h (10.5%), 6 h (21.8%), 7 h (30.1%), 8 h (23.5%), 9 h (5.9%), and ≥ 10 h (1.9%). Never/rarely using a bicycle helmet was reported by 86%, but only 9% never/rarely wore a seatbelt. Riding with a driver who had been drinking (in past month) was reported by 26%, while driving when drinking (in past month) was reported by 10%. Texting/emailing while driving was reported by 41% of students. In fully adjusted models, the likelihood of each behavior (except texting/emailing while driving) was significantly higher for students sleeping ≤ 7 h (PR > 1.0); while infrequent seatbelt use, riding with drinking driver, and driving when drinking were also more likely for students sleeping ≥ 10 h compared to 9 h.

Conclusion: Since insufficient sleep and injury-related risk behaviors often co-occur, interventions efforts aimed at these behaviors might help prevent injuries resulting from drowsiness, as well as provide opportunities for increasing awareness of the importance of sleep.

1088
SERUM MICRONUTRIENT STATUS ASSOCIATED WITH SLEEP DURATION IN ADOLESCENTS
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Introduction: The role of serum micronutrient levels in habitual sleep duration during adolescence represents an underexplored pathway linking nutrition, sleep and health. The aim of this study was to examine serum levels of iron, zinc and copper in relation to sleep duration in adolescents.

Methods: This study represents a sub analysis of the China Jintan Child Cohort Study of 269 adolescents (12.03 ± 0.39 years old) enrolled from June to July 2013. Venous blood samples were collected and analyzed for iron, zinc, and copper concentrations, with the reference range of 75–175 μg/dl, 67–186 μg/dl, and 80–120 μg/dl respectively. Micronutrient concentrations below or above the reference ranges were categorized as low or high micronutrient level. Both adolescents and their parents were asked to fill in the question of habitual sleep duration on weekdays.

Results: The prevalence rates of insufficient (= 9 hours) in adolescents were 33.46% (n = 89), 40.23% (n = 107) and 26.32% (n = 70) respectively. After adjusting for age, gender, co-sleep status, family income and habitual sleep duration in parents, low iron level (OR = 0.80, P = 0.001) and high copper level (OR = 0.40, p = 0.00) in serum were negatively associated with sleep duration levels in adolescents, indicating a decreased likelihood of optimal sleep duration relative to normal range of iron and copper respectively. In contrast, adolescents with high iron level (OR = 1.72, p = 0.00) and low copper level (OR = 1.94, p = 0.007) were more likely to have optimal sleep duration. Although serum zinc status (p = 0.60) was not significantly correlated with sleep duration levels, the ratio of serum iron and zinc concentration showed a negative effect (OR = 0.69, p = 0.00) on the levels of sleep duration. Additionally, the ratios of serum iron and copper, as well as zinc and copper were not significantly associated with sleep duration levels in adolescents.

Conclusion: Our findings suggest that levels of serum micronutrient contribute to adolescent sleep duration. Future research is needed to examine the possible role of micronutrients in adolescent sleep in order

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to inform the future interventions for the interrelated health issues of nutrition and sleep during adolescence.

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CIRCADIAN PATTERNS IN TODDLERS BORN PRETERM: LONGITUDINAL ASSOCIATIONS WITH ATTENTIONAL AND BEHAVIORAL CONCERNS
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Introduction: Children born preterm are at elevated risk for developmental and behavioral concerns (Bhutta et al., 2002). Preterm infant survival rates are increasing, as is our need to understand the developmental cascade associated with preterm birth. Early sleep patterns may play a crucial role in child attentional and behavioral development. The current study assesses the roles of toddler circadian sleep/activity patterns on later school-age attentional and behavioral problems.

Methods: We used time series modeling to examine circadian sleep/activity patterns at two years of age in 70 children born preterm. Prematurity and family sociodemographic assets were recorded at hospital discharge. Child school-age concerns were assessed using parent and teacher reports on the Child Behavior Checklist and the Conners 3. Sleep/activity data (actigraphy) were assessed via cosinor models with two sinusoidal waves. The first wave modeled nighttime sleep and the second wave modeled a mid-day nap. We compared each child to this prototypical circadian pattern (PCP) and assessed their daytime activity patterns. Child sleep/activity parameters were regressed onto school-age concerns with gender, prematurity, and family sociodemographic assets as covariates.

Results: Sleep variations from the PCP at age two are associated with school-age concerns. Toddlers with patterns that closely aligned with the PCP had fewer parent-reported behavioral concerns at school age (p = 0.01) and fewer parent-reported attentional difficulties (p < 0.01). Toddler mean activity level adjusted for rhythm was negatively associated with teacher-reported attentional difficulties (p < 0.05) and parent-reported externalizing problems (p < 0.05). Within-child activity variability was also associated with elevated behavioral problems (p < 0.01).

Conclusion: The novel approach used in this study to index child circadian patterns provides a holistic analysis of sleep/activity, which may prove to be developmentally consequential. These findings may help practitioners identify preterm infants/toddlers at increased risk for later difficulties.

1090
GREATER DECLINE IN SLOW WAVE SLEEP IS ASSOCIATED WITH METABOLIC AND NEUROCOGNITIVE SEQUELAE IN ADOLESCENTS: A LONGITUDINAL STUDY
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Introduction: The loss of slow-wave sleep (SWS) across the lifespan has been well-documented. Recent work suggests that the decline in SWS during adolescence occurs more rapidly in males than females. Although SWS is thought to play a role in health and disease, no study to date has examined possible physical or neurocognitive consequences of this decline. The aim of this study was to longitudinally assess the effects of SWS loss from childhood to adolescence on cardiometabolic and neurocognitive outcomes in a large population-based sample.

Methods: The Penn State Child Cohort is a representative general population sample of 700 children (8.6 ± 1.7 y) of whom 421 (53.9% male) were followed up 8 years later during adolescence (17.0 ± 2.3 y). At both time points, participants underwent a single 9-hour polysomnography (PSG) recording, and ∆SWS was calculated as percentage of SWS at baseline minus that at follow-up. A dual-energy X-ray absorptiometry scan, fasting morning blood draw, and neurocognitive testing were also conducted at follow-up. Linear regression assessed the association of ∆SWS on various metabolic and neurocognitive outcomes at follow-up separately in males and females, adjusting for age, BMI percentile, race, and time elapsed between visits.

Results: In males, a greater decline in SWS was significantly associated with insulin resistance (HOMA; B = 0.17, p = 0.01). ∆SWS was also marginally associated with increased visceral fat area (B = 0.09, p = 0.09) and impaired vigilance (B = −0.15, p = 0.06). No associations between ∆SWS and any cardiometabolic or neurocognitive outcomes were observed in females (B = −0.06–0.06, p = 0.48–0.52).

Conclusion: A greater loss in SWS from childhood to adolescence is associated with insulin resistance, visceral adiposity, and impaired vigilance in adolescent males, but not females. Future studies should examine how the decline of SWS is associated with gender differences in physical health and neurocognitive outcomes into young adulthood and middle age.

Support (If Any): NIH R01 HL63772, R01 HL97165, UL1 RR033184, C06 RR16499

1091
SLEEP IN CHILDREN HAVING SURGERY
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Introduction: Five million children undergo surgery in the U.S. annually. Emerging literature in adults suggests that sleep plays a role in recovery after surgery. Limited research, however, has examined postsurgical sleep patterns in children. Through analysis of a large retrospective database and conduct of a smaller prospective study we aimed to examine (1) associations between surgery and sleep disturbances in a national sample of children, and (2) longitudinal trajectories of sleep in a local sample in the 12-months following surgery.

Methods: To address aim 1 we analyzed nationally representative data for children ages 10–17 (N = 6040) from the National Health Interview Survey-2012. Parents reported on child health during the preceding 12-months (insomnia, surgeries, psychosocial health). To address aim 2 we conducted a prospective study in 60 children 10–18 years (67% female, 83% White) undergoing major surgery. Children underwent 7 days of actigraphy monitoring of sleep patterns (sleep duration, efficiency), completed daily electronic diaries (sleep-quality, pain intensity), and completed validated questionnaires (sleep quality, anxiety, health-related quality-of-life/HRQOL) at 4 time-points from presurgery to 12-months postsurgery.

Results: In the national sample, surgery in the past 12-months was associated with increased odds of insomnia (OR = 2.03; 95% CI: 1.13–3.62; logistic regression adjusting for demographic and psychosocial factors). In our local sample, baseline sleep duration predicted pain intensity 2-weeks after major surgery (β = −0.26, p < 0.05; linear regression adjusting for anxiety). At 2-weeks postsurgery, children reported significant impairment in sleep (68% reported insomnia). At 4-months and 12-months, children’s sleep patterns improved to baseline on average, however a sizeable group continued to have sleep difficulties (46% reported insomnia at 12-months). Longitudinal models...
will be used to characterize trajectories of sleep over 12-months from our final dataset.

**Conclusion:** Preliminary findings from both studies suggest that postsurgical sleep disturbances occur commonly in children. Research is needed examining relationships between sleep and postsurgical outcomes including pain and HRQOL.

**Support (If Any):** This research was funded by Seattle Children’s Center for Clinical and Translational Research Clinical Research Scholars Program (P.I.: Rabbitts).

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# 1092

**SLEEP IN CAREGIVERS AND CHILDREN WITH A CHRONIC ILLNESS**

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**Introduction:** Children with cystic fibrosis (CF) and their caregivers often report poor sleep quality and disrupted sleep. Poor and disrupted sleep may lead to other negative health outcomes, such as poor QOL and elevated depressive symptoms, highlighting the importance of assessing sleep in caregivers and children with CF. However, few studies have examined sleep and feasibility of measures using the dyad of both caregiver and child.

**Methods:** Caregivers were over the age of 18, and children had to be between the ages of 8 and 13 years, with a documented diagnosis of cystic fibrosis. 10 dyads were recruited (mean age of caregiver = 38.4 ± 3.4 years; 80% high school grads; 8 female; mean age of child = 8.9 ± 2.5 years, 6 females, all Caucasian). Caregivers completed the PSQI, CES-D depression measure, PROMIS Sleep Disturbance (SF-6), and World Health Organization Quality-of-Life-BREF measure. Children filled out the Pediatric Daytime Sleepiness Scale (PDSS). Both caregiver and child wore an actigraph for a week and kept a sleep diary.

**Results:** Caregivers slept a mean of 6 hours and 33 minutes, but reported a mean of 7 hours on the PSQI, with a PSQI score of 6.56, PROMIS mean of 8.5. Children slept a mean of 7 hours and 45 minutes. Caregivers reported elevated levels of depressive symptoms (CESD mean 9.4 ± 7.2), and lowered physical QOL (mean 26.7 ± 4.8). Children reported a mean of 14.6 ± 4.7 on the PDSS.

**Conclusion:** Caregivers are reporting short sleep and poor quality of sleep, but may be overestimating the number of hours they actually get when compared to actigraphy. Children with CF are not getting adequate sleep as reported by actigraphy. Poor sleep may have further implications for children and caregivers on overall health, including depressive symptoms and QOL.

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# 1093

**FEASIBILITY OF HOME-BASED SLEEP RESTRICTION AND EXTENSION PROTOCOLS FOR ADOLESCENTS WITH AND WITHOUT CHRONIC PAIN**

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**Introduction:** Home-based sleep manipulation protocols have advantages of increased ease of implementation, generalizability to the home, and less burden. However, these protocols have not been well established for use in different populations. This study sought to test the validity and feasibility of a home-based sleep manipulation protocol for use in adolescent pain research to better understand the relationship between sleep and pain.

**Methods:** Sleep manipulation protocols were piloted in a randomized crossover study. Adolescents (12–17 years) completed a 4-week sleep protocol with daily electronic sleep diary and actigraphy monitoring. During Week 1, adolescents continued baseline sleep patterns. In Week 2, adolescents were randomized to sleep restriction or extension condition, followed by a washout period (2–4 weeks). During Week 3, adolescents continued baseline sleep patterns, and crossed over to the other sleep condition in Week 4. During sleep restriction, adolescents were instructed to go to bed one hour later than usual bedtime; during sleep extension, to go to bed one hour earlier.

**Results:** 21 healthy adolescents (males = 33.3%, M = 13.5 years, SD = 1.2) and 5 adolescents with chronic pain (males = 20%, M = 14.6 years, SD = 2.5) were recruited during the academic year. Baseline sleep duration did not differ between groups (M = 436 vs 431 minutes). For healthy adolescents, paired t-test revealed differences between baseline sleep duration and restricted sleep (M = −17 minutes, SD = −30, p = 0.02), and baseline sleep duration and extended sleep (M = 26 minutes, SD = 37, p = 0.005). For adolescents with chronic pain, paired t-test revealed significant differences between baseline sleep duration and restricted sleep (M = −55 minutes, SD = −16, p = 0.002), but not baseline sleep duration and extended sleep (M = 6 minutes, SD = 23, p = 0.6). There was good compliance with diary entries (90.9%) and protocol completion by all participants.

**Conclusion:** Preliminary findings indicate the validity and feasibility of a home-based sleep manipulation protocol in healthy adolescents. In contrast, adolescents with chronic pain demonstrated significant change during sleep restriction, but not extension. Given the limited sample size in this preliminary investigation, the next step is to test the sleep protocol in a larger sample of adolescents with chronic pain. Future studies will also examine the relationship between sleep restriction and pain responses.

**Support (If Any):** Sleep Research Society Foundation/JAZZ Pharmaceuticals Early Career Development Research Award

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# 1094

**POWER SPECTRAL ANALYSIS OF POLYSOMNOGRAPHY IN CHILDREN WITH ATTENTION-DEFICIT/HYPERACTIVITY DISORDER (ADHD)**

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**Introduction:** Sleep disorders have often been reported among children with attention-deficit/hyperactivity disorder (ADHD); yet, studies using objective measures of sleep have been unable to find reproducible consistent finding. The majority of studies have not found any differences in the macrostructure (e.g., sleep architecture) of children with ADHD compared to their typically developing peers. In order to examine whether there are differences in the microstructure of sleep, the electroencephalogram (EEG) frequencies were compared between children with ADHD and typically developing (TD) children.

**Methods:** Overnight polysomnography was recorded for 25 medication naïve children with ADHD and 25 age and sex matched TD children, ages 6–12 years, with no history of mental health comorbidities. Using data from channel C3-A2 or C4-A1, Fast Fourier Transformation was performed to obtain absolute power density in delta (0.5–4.0 Hz), theta (4.0–8.0 Hz), alpha (8.0–13 Hz), sigma (12–14 Hz) and beta (14–30 Hz) frequency domains as well as the total power of the EEG (0.5–30 Hz). Further, the relative power of each frequency bands (power of each band/Total power*100) and the ratio of theta/delta were calculated.
Results: No significant difference was found between children with ADHD and TD children when absolute power was assessed. In contrast, significant group differences were revealed when data was expressed as relative power. Compared to TD children, children with ADHD had significantly lower relative theta (p < 0.05) and sigma (p < 0.001), but significantly higher relative alpha (p < 0.001) and beta (p < 0.05). No significance difference was seen in delta.

Conclusion: This study demonstrated that relative values of alpha, theta and beta differed between children with ADHD and TD children and as such might be one of the important contributors of impaired sleep homeostasis. Further studies in children with ADHD need to investigate EEG abnormalities to better understand the clinical implications of this finding.

1095
IMPROVEMENT OF PARASOMNIAS AFTER TREATMENT OF RESTLESS LEG SYNDROME/PERIODIC LIMB MOVEMENT DISORDER IN CHILDREN
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Introduction: Previous studies have shown that parasomnias and restless leg syndrome/periodic limb movement disorder (RLS/PLMD) commonly co-exist in children, leading to speculation that RLS/PLMD may precipitate or worsen parasomnias. However, there is limited data about the effect of the treatment of RLS/PLMD on parasomnias in children. Hence, we performed this study to determine if the treatment of RLS/PLMD with oral iron therapy is associated with the resolution of parasomnias in children.

Methods: A retrospective database was created for children with RLS/PLMD and a review of the medical records was performed for children who were treated with iron therapy and followed for a year at Cincinnati Children's Hospital Medical Center. All subjects underwent ferritin level testing and were treated with iron therapy. All subjects underwent polysomnography before starting iron therapy for RLS/PLMD except for one subject who was already on iron but required a higher dose. Most subjects underwent polysomnography after iron therapy.

Results: Two hundred twenty six subjects were identified with the diagnosis of RLS/PLMD. Fifty one of these subjects had parasomnias and 31 of them were treated with iron therapy. Of the 31 subjects, RLS symptoms improved in 18 (58%) subjects and resolution of parasomnias was noted in 13 (42%) subjects after iron therapy. Repeat polysomnography after iron therapy was performed in 22 (71%) subjects. There was a significant decrease in PLM index (21.6 ± 13.9/hr [pre] vs 6.4 ± 7.0 [post]; P < 0.001), but there was no significant difference in arousal index (12.1 ± 5.5/hr [pre] vs 11.3 ± 5.7; P = NS).

Conclusion: Parasomnias are common in our cohort of children with RLS/PLMD. Iron therapy leads to significant improvement in PLM index as well as RLS symptoms, and resolution of significant proportion of parasomnias suggesting that RLS/PLMD may precipitate parasomnia. Persistent increased arousal index even after iron therapy raise the possibility of intrinsic hyper-arousal state in this population.

Support (If Any): This study was supported by the Cincinnati Children's Hospital Research Fund

1096
SLEEP HABITS, PATTERNS AND DISTURBANCES IN CHILDREN WITH HYPERSONIA
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Introduction: Extreme daytime sleepiness. While sleepiness and daytime functioning are well described, little has been reported on typical sleep patterns, and disturbances in this pediatric population once treated with medication for daytime symptoms. Further investigation to describe sleep patterns and complaints may provide additional areas of intervention.

Methods: Using a case control design, self-reported sleep habits using the School Sleep Habits Questionnaire were compared between thirty-three 8- to 16-year-olds diagnosed with and treated for narcolepsy or idiopathic hypersomnia and 33 healthy children matched by age, race, gender, and household income. Sleep outcomes included total sleep time during schooldays and weekends, schoolday-weekend sleep difference, daytime sleepiness, sleep/wake problems, phase delay of sleep, and sleep quality. Independent samples t-tests were performed and Holm-Bonferroni Sequential Correction was applied to adjust for the multiple comparisons. A few aspects related to sleep hygiene were assessed.

Results: Compared to the healthy children, children with hypersomnia had significantly more fluctuation in sleep time between schooldays and weekends (t = 2.60, p < 0.05), more phase delay of sleep (t = 3.34, p < 0.01) and poorer sleep quality (t = −5.24, p < 0.01). Children with hypersomnia, even when treated, were also sleepier during daytime (sleepiness index, t = 5.14, p < 0.01) and had more sleep/wake problems (t = 4.86, p < 0.01) than healthy children, particularly on items related to functioning upon awakening. On weekends, children with Hypersomnia go to bed 25 minutes earlier than controls and wake up 40 minutes later, thus on average obtaining 65 minutes more sleep per weekend night than the controls.

Conclusion: Children with hypersomnia, even when treated with medication, continue to have daytime sleepiness, poor sleep quality, and significant weekend oversleep patterns. While much focus has been placed on daytime sleepiness as an outcome of treatment, other aspects of sleep patterns and quality should be assessed.

Support (If Any): Kaul Pediatric Research Institute at Children’s of Alabama

1097
DEVELOPING OUTCOME MEASURES FOR ASSESSING NARCOLEPSY WITH CATAPLEXY IN CHILDREN AND ADOLESCENTS
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Introduction: Current measures of cataplexy and excessive sleepiness in patients with narcolepsy may not be adequate for assessment of these outcomes in a pediatric population.

Methods: Appropriateness of a daily cataplexy diary and the Epworth Sleepiness Scale for Children and Adolescents (ESS-CHAD) were evaluated by conducting face-to-face concept elicitation and cognitive interviews with children (7–9 years old; n = 13) and adolescents (10–17 years old; n = 16) who have narcolepsy with cataplexy; parents were interviewed separately. ESS-CHAD is a modification of the adult ESS Scale...
that adapts specific items to the pediatric population. Based on these interviews, the measures were modified as appropriate.

**Results:** Subtle differences were noted between narcolepsy concepts described by children and their parents, suggesting different but complementary perspectives; parents may not recognize cataplexy symptoms/triggers as well as children, but parents have greater recognition of the different circumstances of falling asleep. Interviews resulted in the following modifications to the cataplexy diary: providing definition and examples of cataplexy using child-friendly terminology; adding a quantitative question to determine daily frequency; standardizing the questionnaire for evening administration with self-completion by the child. Modifications were made to the ESS-CHAD for child-friendly wording and to assure that items more accurately reflect activities (eating, watching TV/video) and environments (school, bus/car transport) in which children are likely to participate. Two ESS-CHAD versions were proposed for assessment: a 1-month recall period for general use and one for research with a recall period of “since your last study visit,” which could be a shorter or longer period than 1-month duration (as short as 1 week).

**Conclusion:** The cataplexy diary and ESS-CHAD were modified to be used in children and adolescents. Further psychometric validation is recommended. The modified cataplexy diary and ESS-CHAD are being used as outcome measures in an ongoing phase 3, placebo-controlled clinical trial of sodium oxybate in children and adolescents with narcolepsy.

**Support (If Any):** This study was funded by Jazz Pharmaceuticals.

**1098**

**DESIGN OF THE FIRST STUDY EVALUATING THE EFFICACY, SAFETY, AND PHARMACOKINETICS OF SODIUM OXYBATE FOR THE TREATMENT OF PEDIATRIC PATIENTS WITH NARCOLEPSY WITH CATAPLEXY**

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**Introduction:** Sodium oxybate (SXB), approved for the treatment of cataplexy and excessive daytime sleepiness (EDS) in patients with narcolepsy, has not been formally evaluated in the pediatric population.

**Methods:** Primary objective of this double-blind, placebo-controlled, randomized-withdrawal study is to evaluate SXB efficacy and safety for treatment of narcolepsy-associated cataplexy in patients 7–17 years old. Secondary objectives are to evaluate efficacy for EDS treatment; characterize SXB pharmacokinetics; and evaluate safety of SXB titration to an effective, tolerable dose. An open-label extension will evaluate long-term efficacy and safety up to 1 year.

**Results:** A minimum of 100 patients will be enrolled: ≥ 30 SXB-naïve patients (titration to dose based on weight [10-week period]) and ≥ 30 on stable SXB doses. Patients on concurrent stable doses of drugs for EDS will be eligible. After a stable dosing period (2–3 weeks), patients will be randomized to SXB continuation or withdrawal (placebo) for 2 weeks. Primary efficacy endpoint is change in weekly number of cataplexy attacks evaluated using a daily diary. Secondary endpoints are Clinical Global Impression of Change (CGI-C) for cataplexy severity; EDS change using Epworth Sleepiness Scale for Children and Adolescents; CGI-C for narcolepsy overall; and change in quality-of-life using the 10-Item Short Form. Change in weekly school attendance and Patient Global Impression of Change will be exploratory endpoints. Blood samples for pharmacokinetic evaluation will be collected during the stable dose period. To address multiplicity, secondary endpoints will be evaluated only if the primary endpoint is met. Safety evaluation includes incidence of adverse events and vital sign changes.

**Conclusion:** Study results will help determine the benefits and identify any safety issues associated with SXB for the treatment of narcolepsy with cataplexy in pediatric patients, and characterize SXB pharmacokinetics to enable appropriate management strategies for titration and dosing. This trial is currently enrolling patients and is registered with clinicaltrials.gov (NCT02221869).

**Support (If Any):** This study is funded by Jazz Pharmaceuticals.

**1099**

**PRESENTATION AND TREATMENT OF CATATHRENA IN THREE PEDIATRIC PATIENTS**

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**Introduction:** Catathrenia, also known as sleep related groaning, is a relatively new and rare sleep disorder with characteristics consistent with loud moaning on expiration during sleep. The etiology of catathrenia is unknown and the decision of whether or not to treat is unclear. Limited research is available concerning appropriate treatment and none of the existing literature focuses primarily on pediatrics.

**Methods:** We report a series of three male pediatric cases with catathrenia that were treated with continuous positive airway pressure (CPAP). The first child was a seven year old boy who presented with daytime fatigue, nocturnal groaning, fatigue and behavioral problems. His polysomnogram showed expiratory groaning and pauses (catathrenia) with increased stage N1 (10% of total sleep time). The family of a fourteen year old boy complained of loud nocturnal moaning that disrupted their sleep. He also complained of generalized fatigue. Polysomnography showed catathrenia and hypoventilation as he spent 33.6% of total sleep time with etCO2 greater than 50 mmHg. Lastly the mother of a twelve year boy reported abnormal noises coming from her son at night which caused uneasiness and concern. He complained of fatigue and morning headaches. Polysomnography showed catathrenia and abnormal oxygenation with a mean saturation of 94.7% and spO2 was < 95% for 37% of total sleep time. Due to daytime symptoms and abnormal polysomnogram findings, all three patients were treated with CPAP. When re-evaluated at follow up, they showed clinical response to the treatment.

**Conclusion:** The etiology of catathrenia is unclear. Based on the three cases we presented, we speculate that catathrenia may be associated with sleep disruption, hypoventilation, and/or abnormal oxygenation during sleep which can cause daytime fatigue. If children with catathrenia present with abnormal PSG findings and/or residual day time symptoms, treatment with CPAP should be considered.

**1100**

**CHARACTERISTICS OF PATIENTS WHO MISSED POLYSOMNOGRAPHY APPOINTMENTS IN A TERTIARY CARE FACILITY**

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**Introduction:** Missed appointments, or “no shows” delay care for both the patient missing the appointment and others who could have been scheduled in their place. This is especially problematic in pediatric sleep medicine where the paucity of centers leads to long wait times.
We evaluated whether patients who no showed at our center shared characteristics.

**Methods:** We queried our electronic medical record for no shows within 9 months and collected the following variables: Ordering service, study order date, schedule date, and date missed, language, race, age, gender, diagnoses, distance from center, and date of any surgical interventions for sleep disordered breathing.

**Results:** 131 subjects were identified. Most frequent referring divisions were Primary Care (55.7%), Otolaryngology (22.9%), and Pulmonary (13%). Lack of problem list or symptoms on the study order was characteristic in 48.9%. Patients living 0–10 miles and 11–20 miles from the center represented 40% and 35% respectively. Time from scheduling to appointment was 8–10 weeks (35%), 6–8 weeks (23%), and 0–1 week (11%). 17% underwent surgery for SDB. Gender, race and insurance were representative of our population: 54% Boys, 42% Latino, 37% African-American, and 86% Medicaid.

**Conclusion:** No shows decreased productivity by 8%. These results suggest setting target wait times between 2–6 weeks, enhancing communication with families who live close to our center about why Polysomnography has been ordered, and working with physicians in Primary Care and Otolaryngology to order studies appropriately and improve adherence to recommendations.

**1101 HOW RECOMMENDATIONS ON BABY SLEEP HAVE CHANGED AND EXPANDED OVER THE LAST 100 YEARS**

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**Introduction:** Baby sleep is a major parental concern in the care of infants. Parents are often desperate for advice and recommendations. There have long been parenting guidebooks that offer help and advice with supposedly the best available advice at a given time. Often authored by health care professionals or more recently by mom’s these guide books a major source of information in addition to health care professionals, providing answers in the home. As new evidence based care is developed, changing behavior of baby care in the home is often the goal, however effective communication and the changing of past trends is difficult. Baby care in the home has changed, or not, over the past 100 years. Understand when and how these changes occurred could help inform future public health campaigns.

**Methods:** We collected a representative set of 40 parenting guides published over the last 100 years. In a process modeled after the creation of the Oxford English Dictionary, direct excerpts, along with the biographical data, were taken from the books on recommendation regarding sleep. The excerpts were then analyzed and specific recommendations were determined.

**Results:** Many different patterns were observed in how recommendation changed over time. Often recommendations were overly precise. For example, the variability in total sleep time between books was much larger than the range in sleep time recommended by individual books. Many books provided ranges of total sleep time of about two hours while the variability between books was about 6 hours. Some recommendations with seemingly little basis in evidence persist. Some recommendations are the result evidence and effective campaigns by the AAP and result in rapid adoption by most future books, such the Back to Sleep campaign. Other recommendations cycle as if due to some fashion or fade.

**Conclusion:** Recommendations in parenting guidebooks can have a large impact on the daily care of infants in the home and the expectation of care givers. Many recommendations have sound evidence to support them, other do not. This work demonstrates that is possible to make relatively quick changes that can persists, but likely more work is need to establish evidence based care in the daily care of infants.

**Support (If Any):** The authors declare that they are employees of JOHNSON & JOHNSON Consumer Companies, Inc. (Skillman, NJ). This study was funded in full by JOHNSON & JOHNSON Consumer Companies, Inc.

**1102 PHYSICAL ACTIVITY AND SLEEP PATTERNS IN INFANTS**

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**Introduction:** Sleep problems occur in 20–30% of infants and may cause childhood obesity, poor neurobehavioral function, and maternal depression. Previous studies show that adequate physical activity is associated with improved sleep quality and quantity in adults, but such associations have been inconsistent in pediatric populations, with no studies conducted in infants. The purpose of the study was to examine the association between physical activity and sleep patterns in infants.

**Methods:** 165 healthy full-term infants aged 6 months were recruited from a university affiliated hospital. Infants wore an actigraphy on the ankle to monitor physical activity and sleep patterns for 7 consecutive days. Parents and caregivers completed a sleep-activity diary.

**Results:** Actigraphy-derived nocturnal sleep latency, nocturnal sleep percent, nocturnal sleep duration, daytime nap duration, and 24-hour sleep duration were 13.2 ± 9.1 minutes, 87.5 ± 4.2%, 463.5 ± 52.6 minutes, 185.6 ± 54.4 minutes, and 649.8 ± 55.8 minutes, respectively. Time spent in sedentary-to-light physical activity, including watching TV or other electronic devices, being restrained, kept inactive, or sitting or lying in one position, was 559.8 ± 119.3 minutes per day. Time spent in moderate-to-vigorous physical activity, including floor-based play, rolling, or crawling, was 67.4 ± 77.9 minutes per day. Time spent in sedentary-to-light physical activity was negatively correlated with 24-hour sleep duration (r = −0.24, p < 0.01).

**Conclusion:** This is the first study to examine the association between physical activity and objectively measured sleep patterns in infants. Our results suggest a link between physical activity and infant sleep and that reducing sedentary-to-light physical activity may lengthen infant daily sleep duration.

**Support (If Any):** Partially supported by National Health Research Institutes in Taiwan (NHRI-EX103-10229PC).

**1103 BARRIERS TO SEEKING MEDICAL HELP FOR INFANT SLEEP PROBLEMS**

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**Introduction:** Infant sleep problems are a significant health issue, with a prevalence rate up to 46% reported in prior studies. Poor sleep negatively affects children’s physical and mental development and has been associated with overweight and obesity. Our previous study showed that mothers typically utilize informal sources of help, rather than seek medical advice, to identify infant sleep problems. The purpose of this study is to explore the barriers that mothers perceived in the process of seeking medical help for infant sleep problems.
Methods: Twelve mothers of one-year-olds living in northern Taiwan participated in this study. Data was collected through in-depth audio-taped interviews.

Results: The interviews yielded three main themes related to the barriers in seeking medical help for infant sleep problems including: 1) I do not know it; 2) I can handle it; and 3) I am not satisfied with it. Overall mothers know little about or misunderstand infant sleep behaviors. Lacking of proper information and knowledge about infant sleep prevents the mothers from receiving medical services. Mothers who had positive experiences through trial and error or those who can cope with infant sleep behaviors also hamper their decision to seek medical services. Mothers who have seen a pediatrician but received unsatisfied responses such as ambivalent attitude or insufficient examinations, reported being less motivated and unwilling to seek medical help again.

Conclusion: Mothers perceive a wide range of barriers that influence the likelihood that they will seek medical help for infant sleep problems. Providing adequate medical attention and reducing knowledge barriers likely facilitate parental access to health care services for managing infant sleep problems.

Support (If Any): Partially supported by National Health Research Institutes in Taiwan (NHRI-EX103-10229PC).

1104
5-HTTLPR MODERATES THE LONGITUDINAL EFFECTS OF SLEEP ON TEMPERAMENT: EVIDENCE OF DIFFERENTIAL SUSCEPTIBILITY
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Introduction: Sleep problems are frequent in young children, however, children vary in the degree to which they are affected by poor sleep quality. We investigated whether a polymorphism in the serotonin transporter gene, which is linked to emotional function, is a potential moderator of the influences of sleep duration on infant temperament using longitudinal data.

Methods: We examined the interactive effects of total sleep duration between 6 and 36 months of age and the 5-HTTLPR genotype on negative emotionality/behavioral dysregulation at 36 month in 235 children recruited into a longitudinal birth cohort study. Triallelic genotyping of 5-HTTLPR was performed by looking at SLC6A4 genotype, focusing on the serotonin transporter-linked polymorphic region (5-HTTLPR) including the SNP polymorphism (rs23351).

Results: After controlling for demographics and both previous and concurrent maternal depression, multiple linear regression analyses revealed a significant interaction effect of cumulative sleep duration for the first three years of life and 5-HTTLPR genotype on child negative emotionality/behavioral dysregulation such that the effects were exclusive to those with low expressing 5-HTTLPR genotypes.

Conclusion: The results suggest differential susceptibility to the cumulative effect of total sleep duration early in life, which reiterates that the short allele of the 5-HTTLPR represent a marker of increased environmental sensitivity regarding emotional development. Differential susceptibility theory posits that certain factors may increase an individual’s susceptibility to the environment, either positive or negative.

Support (If Any): CIHR

1105
CHARACTERISTICS OF CHILDREN WHO DO NOT NAP IN CHILDCARE
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Introduction: Over eighty percent of children aged 3 to 6 years in developed economies attend early childhood education and care services (including daycare and kindergartens) in the years prior to school. A scheduled naptime is a common feature of most of these environments. However, not all children are able to sleep during these times. Some of these children have been identified in the literature as ‘problem nappers’, not only because they do not get to sleep but also because they may present with behavioural difficulties during the scheduled nap-time. The characteristics of children who do not nap in childcare are not known.

Methods: To differentiate ‘problem nappers’ from those that either sleep or lie quietly during naptime, typical napping behaviour was obtained through educator report for 143 children aged 3 to 6 years. Parents completed standardized behavioural and temperament questionnaires for children. A test of cognitive ability, the Woodcock Johnson III Brief Intellectual Ability test, was administered to each child.

Results: Results indicated that children who have difficulty lying quietly during naptime sleep were significantly older than those who did nap (mean 2.9 months), performed significantly better on neurocognitive tests, and had significantly shorter night time sleep duration.

Conclusion: These data suggest a mismatch between children’s neuro-cognitive development, including their requirement for daytime sleep, and the practice of scheduling naptimes in early childhood education and care settings. Further research is needed to inform recommendations for sleep practices in childcare centers that best suit individual needs.

1106
PHYSICAL GROWTH AND SLEEP IN YOUNG CHILDREN
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Introduction: The aim of this study was to assess the relationship between growth and sleep in a large cross-cultural sample of Asian and Caucasian young children (birth to 6 years).

Methods: Parents of 10,085 children (birth to 6 years) from Australia/New Zealand, Canada, China, Hong Kong, India, Korea, Japan, Malaysia, Philippines, Singapore, Thailand, United States, and United Kingdom completed online a modified version of the Brief Infant Sleep Questionnaire and reported their child’s current height and weight. Weight to height ratio (WLR) was calculated.

Results: Children who snore 3 or more times per week had a significantly higher WLR than children who never snored (p = 0.001). After controlling for age and snoring, there were significant relationships between WLR and sleep patterns. Higher WLR was associated with earlier bedtimes, decreased number and duration of night wakings, later waketime, increased total nighttime sleep, decreased daytime sleep, and increased total sleep time (p < 0.001). These relationships were stronger in 0-35 month olds than in 3-6 year olds. Furthermore, these relationships were stronger in children in predominantly-Caucasian
countries compared to those in predominantly Asian countries. No differences were found in these relationships for girls versus boys.

**Conclusion:** As expected, increased weight to length was associated with increased snoring. Unexpectedly, it was also associated with “better” nighttime sleep, including earlier bedtimes and increased sleep consolidation. These relationships were stronger in young children and those from predominantly Caucasian countries. These findings were different from earlier studies, including one of 6-month-olds (Tikotzky & Sadeh, 2009), and thus require further study to understand these relationships.

**Support (If Any):** This study was supported by the Asia Pacific Pediatric Sleep Alliance and sponsored by Johnson & Johnson Consumer Products Company, Division of Johnson & Johnson Consumer Companies, Inc.

### 1107

**COMPARISONS OF SLEEP/WAKE PATTERNS AND PARENTAL PERCEPTIONS OF SLEEP IN CANADIAN AND AUSTRALIAN CHILDREN BORN PRETERM**

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**Introduction:** Research has shown later bedtimes and reduced total sleep time in Canadian compared to Australian toddlers. Adequate sleep duration may be particularly important for ex-preterm children who are at increased risk of sleep disruption due to obstructive sleep apnea or periodic limb movements. This study compared objectively assessed sleep/wake patterns and parental perceptions of sleep need in a cohort of ex-preterm Canadian and Australian children. We hypothesized that Australian children would have earlier bedtimes, later wake-times and longer sleep duration than the Canadian children; Australian parents would perceive their children as needing more sleep; and this would be associated with actual sleep practices.

**Methods:** 188 children (5–12 y, Canada N = 101, Australia N = 87) enrolled in the Caffeine for Apnea of Prematurity trial underwent 14-day actigraphy monitoring. Parents completed the National Sleep Foundation 2004 Sleep in America questionnaire. Actigraphy derived bedtime, wake-time, sleep onset latency, wake after sleep onset, total sleep time (TST), sleep efficiency and night-to-night bedtime variability were compared between countries for school nights (Sun-Thu) and weekends (Fri-Sat). Parental perceptions of child sleep need were compared and correlated with actigraphy data.

**Results:** According to actigraphy, Australian children went to bed earlier on school nights (~20 min, p < 0.05) and weekends (~33 min, p = 0.001) than Canadian children. Australian children also woke significantly earlier, resulting in no difference in TST. No other differences in actigraphy were found. Parent-reported TST was longer in Australian children (~33 min, p = 0.001) which was reflected in reports of perceived sleep need (Australia: 606 ± 58, Canada: 585 ± 66 min, p < 0.05). Perceptions of child sleep need was significantly correlated with actigraphy bedtimes (school: r = −0.38, p < 0.001; weekend: r = −0.34, p < 0.01) in the Australian, but not the Canadian cohort. TST was significantly correlated with perceptions of sleep need in both countries (Australia: r = 0.31, p < 0.01; Canada: r = 0.34, p = 0.001) on school nights, but only in the Australian cohort (r = 0.34, p < 0.01) on weekends.

**Conclusion:** This study shows that while the timing of sleep is shifted, sleep duration is equivalent between ex-preterm school-aged Canadian and Australian children, contrary to previously reported data in healthy toddlers. Differences in the associations with parental perceptions of sleep need suggest the environment has a greater influence on sleep behavior in Canada, providing important implications for sleep education.

**Support (If Any):** This study was supported by NIH grant R01 HL098045 and Canadian Institutes of Health Research grant MCT 13288. Philips Respironics, Inc. provided actigraphy devices.

### 1108

**DOES CHRONOTYPE RELATE TO ADIPOSITY IN URBAN MEXICAN MAYAN CHILDREN?**

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**Introduction:** Childhood obesity rates are increasing in developing countries, setting up a major health crisis as the children age. Changes in diet and physical activity levels are often identified as the major culprits. Few consider sleep’s role. The timing of sleep is linked to obesity and related diseases. The aim of this paper is to determine if chronotype relates to adiposity in urban schoolchildren.

**Methods:** Maya schoolchildren living in Merida, Mexico wore an Actiheart, combined heart rate and accelerometer, for seven days of free-living activity. These data were used to calculate mean wake and “fall asleep” times in the children with at least three days of usable nighttime data. The child’s stature, body mass, waist circumference, skinfolds (subscapular, supra-iliac, triceps) and bioelectrical impedance analysis were used to assess adiposity. Linear regressions used total sleep time to predict body mass index z-score, waist circumference z-score, and percentage body fat.

**Results:** On average, these 8.4 year-old Maya children woke up at 8.01 am and fell asleep at 22:48. Adiposity was high, with 20%, 15%, and 77% of the sample classified as overweight or obese by body mass index, waist circumference, and percentage body fat, respectively. Wake and sleep times were 37% correlated. Girls had significantly higher waist circumference z-scores and percentages body fat. In regressions, wake time predicted percentage body fat [B 1.38 (SD 0.705), p = 0.056, R2adj = 0.303] but age and gender contributed the most of the variance. Mean time fall asleep did not significantly predict any adiposity indicator.

**Conclusion:** Chronotype did not appear to relate to obesity risk in these urban Mexican Mayan children.

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### 1109

**THE ASSOCIATION BETWEEN SLEEP HYGIENE AND BODY MASS INDEX (BMI) IN TYPICALLY DEVELOPING SCHOOL-AGE CHILDREN**

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**Introduction:** Sleep deprivation has been shown to be a significant risk factor for obesity, and an inverse relationship has been observed between Body Mass Index (BMI) and sleep duration. A prevalent
cause for sleep loss in children is poor sleep hygiene. Despite the widespread and increasing prevalence of obesity in children and the high prevalence of poor sleep hygiene practices in children; however, little research has focused on the relationship between poor sleep hygiene and BMI. Here, we examined the association between sleep hygiene and BMI in typically developing school-age children.

Methods: As part of our preparation for designing a school-based intervention aimed at preventing childhood obesity, we measured the sleep hygiene and BMI of 34 elementary school students. Sleep hygiene was measured using subscales of the Children’s Report of Sleep Patterns, which is a parent-reported sleep questionnaire. BMI was calculated as weight (kg) divided by height squared (m2). BMI percentiles were obtained with reference to a standardized BMI percentile chart that reflected the child’s gender and age at the time of measurement.

Results: The studied children did not show any gender- or age-related difference in the results of the Children’s Report of Sleep Patterns. Correlation analyses indicated that the Sleep Hygiene Caffeine Index was significantly correlated with the BMI percentile (r = 0.49*, p < 0.003).

Conclusion: Poor sleep hygiene as it relates to consumption of caffeine (i.e., soda, iced tea, hot tea, or coffee) was associated with higher BMI percentiles in children aged 6 to 12 years. Given the negative impact of caffeine consumption on sleep and the observed association with BMI, caregivers should be made more aware that even small amounts of caffeine can negatively affect the health of school-age children.

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1110 PRELIMINARY RESULTS FROM A MULTICOMPONENT OBESITY PREVENTION SCHOOL BASED PROGRAM

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Introduction: The negative impact of insufficient sleep on weight regulation and the associations between sleep deprivation and other leading risk factors for obesity (e.g., lack of physical activity, poor nutrition, and too much screen time) have been well established in the scientific literature. However, no previous program has sought to apply this knowledge to benefit youth. Our group has used a community-based participatory research approach to develop the “Healthy Nights Healthy Days” (HNHD) program, which is designed to reduce the risk of childhood obesity by increasing total sleep and developing a healthy balance in terms of food intake, physical activity, sleep, and sedentary behavior. The goal of the present study was to evaluate a pilot implementation of this intervention.

Methods: To determine the effectiveness of the program, we compared a control group (students on school waiting lists) with an interventional group. A total of 194 students aged 7–12 years (M = 8.54 SD = 1.7) participated in HNHD activities. Of them, 46 students participated in the evaluation of the program. Before and after the intervention, food intake, physical activity, sleep, and sedentary behavior were measured using accelerometers and subjective measures. BMI was calculated based on the weight and height of each child before and 8 months after intervention.

Results: T-tests assessing differences in sleep measures before and after program implementation showed: 1) significant reductions in actigraphic measures of sleep variability, parental reports of bedtime resistance, sleep anxiety and time spent sitting; 2) a marginally significant decrease in sedentary activity counts, as measured by accelerometers; and 3) an increase in reported physical activity. The mean BMI of children was significantly lower in the intervention group, whereas this parameter showed a small but non-significant increase among children in the control group.

Conclusion: Positive changes in healthy behaviors and a decrease in BMI were observed following implementation of the HNHD program. Larger sample size is needed to determine which specific changes were associated with the observed reduction in BMI.

Support (If Any): American Sleep Medicine Foundation, Canadian Institute of Health Research 122165

1111 THE IMPACT OF VARIABLE MIDDLE SCHOOL START TIMES ON SLEEP DURATION


Children’s National Medical Center, Washington, DC

Introduction: In national surveillance studies, approximately 70% of adolescents report sleeping less than 9 h and 6% less than 6 h on week nights. One important contributor to deficient sleep is school start times (SST) before 8:30 am, as they conflict with adolescents’ biological drive for later bed- and wake times. This is one of a few studies that focuses on Middle School (MS) students.

Methods: Self-reported weekend sleep duration data was drawn from an annual statewide administration of a modified version of the CDC’s Youth Risk Behavior Survey. This study combined data from 3 years with a sample of 32,980 8th graders from 32 MS in a large and diverse school district in a major metropolitan area. This study capitalized on variable SST divided into three groups: earliest (7:20 am–7:30 am), early (7:40 am–7:55 am) and later (8:00 am–8:10 am). Participants were 50.2% female, and 58.2% non-white. Sleep data were grouped into 4 categories: ≤ 7 h, 7, 8 h, and ≥ 9 h. Multilevel multinomial logistic regression was used to evaluate the impact of start time on self-reported sleep time while accounting for the contributions of gender, race, and a proxy measure of socioeconomic status (SES).

Results: Students with the earliest and early start times were significantly more likely to report shorter sleep duration. For the earliest start time, almost equal percentages of students reported sleep duration ≤ 7 h (50.3%) and ≥ 8 h (49.7%); for early start times, 46% reported sleep ≤ 7 h and 54% ≥ 8 h; and for the latest start times, 41.3% slept for ≤ 7 h and 58.7% ≥ 8 h (ps < 0.05). Female and non-white students were more likely to report short sleep duration.

Conclusion: Early SST are a significant contributor to insufficient sleep in MS students. Variability in start times in this study are limited to 40 minutes, but are still earlier than those recommended by the American Academy of Pediatrics.

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1112 MULTILEVEL ANALYSIS OF SLEEP TIME AND RISK BEHAVIORS AMONG MIDDLE SCHOOL STUDENTS


Children’s National Medical Center, Washington, DC

Introduction: A number of studies have identified a relationship between short sleep duration and an increase in risky behaviors such as alcohol and drug use in adolescents. In this study, we examined the association between sleep and peer/individual risk factors (e.g., rebelliousness, sensation seeking) in a large ethnically and socioeconomically diverse community sample of early adolescents.
Methods: We used data collected by a modified version of the Youth Risk Behavior Survey (YRBS) from 10,718 and 11,240 8th grade students in a large suburban school district in 2010 and 2012, respectively. Self-reported school-night sleep duration (SD) was grouped as ≤ 4 h, 5 h, 6 h, 7 h, 8 h, 9 h, and ≥ 10 h. Scores on ten peer/individual risk behavior scales (i.e., Communities That Care Survey) included within the YRBS were dichotomized according to national cut-points established for 8th grade. Multilevel modeling was used to explore the relationship between SD and high versus low risk factor scores after adjusting for gender, race and a proxy measure of socioeconomic status.

Results: The percentage of students reporting an “optimal” SD of 9 h was 14.8%, and 15.6% in 2010 and 2012, respectively, while 45.6% and 46.1% reported ≤ 7 h. Odds ratios (ORs) for 9 of 10 risk factor scales were elevated when students slept ≤ 7 h, with a dose response effect for each hour less sleep compared to a SD of 9 h. For example, ORs for students sleeping 7 h ranged from 1.3 (early initiation of antisocial behavior) to 1.8 (early initiation of drug use). The risk factor scale ORs for ≤ 5 h SD ranged from 3.0 (sensation seeking) to 6.4 (gang involvement).

Conclusion: Middle school students are at high risk for insufficient sleep; a SD ≤ 7 h is associated with an increase in risk factors linked to high risk behaviors such as lifetime and recent substance use.

Support (If Any): During the study period, Wang G. was supported by the Scholarship for Studying Abroad from China Scholarship Council (201306140090), and the Distinguished Young Academics Fund from East China Normal University (xrzz2013009).

1114
ASSOCIATIONS BETWEEN SLEEP DISTURBANCE AND HEALTH SERVICES USE AMONG ADOLESCENTS: RESULTS FROM THE NATIONAL HEALTH INTERVIEW SURVEY
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Introduction: Sleep disturbance is common among adolescents and is associated with poor health outcomes that might increase health services utilization. However, patterns and predictors of health service use by adolescents with sleep disturbance have not been well described. The aim of this study was to examine relationships between sleep disturbance and health service use among adolescents.

Methods: We analyzed data from a nationally representative sample of adolescents ages 11–17 (n = 5,339) who participated in the 2012 National Health Interview Survey, the principal source of data on the health of the United States population. Adolescents with sleep disturbance were identified by parent report of their child regularly having insomnia, trouble sleeping or excessive daytime sleepiness during the past year. Parents also reported on health service use in the past year. We used multivariate logistic regression models, controlling for sociodemographics (e.g. age, sex, race/ethnicity, income), and health conditions (e.g., pain, anxiety, depression) to test associations between sleep disturbance and office-based healthcare visits, medication use, and emergency department visits.

Results: Parents reported that 11.1% of adolescents had frequent sleep disturbances during the preceding year. Compared to adolescents without sleep disturbances, those with sleep disturbances had higher rates of ED visits (27.9% vs 13.2%), office-based visits (92.1% vs 87.3%), and medication use (41.3% vs 14.3%). After controlling for covariates, adolescents with sleep disturbances had greater odds of ED visits (OR = 1.49; 95% CI: 1.06–2.10) and medication use (OR = 2.19; 95% CI: 1.63–2.94) than adolescents without sleep disturbance. After controlling for covariates, there were no differences however in office-based visits (OR = 1.16; 95% CI: 0.74–1.84) in youth with and without sleep disturbance.

Conclusion: In a nationally representative sample of adolescents in the USA sleep disturbance were associated with increased use of health services. Studies describing the economic burden associated with adolescent sleep disturbance are urgently needed.

Support (If Any): CBG was supported by National Institutes of Health Ruth L. Kirschstein National Research Service Award Institutional Research Training Grant T32GM086270 (PI: TMP).
Introduction: The purpose of this study was to identify demographic factors that predict presenting complaints and diagnoses at a pediatric sleep clinic.

Methods: This study utilized a retrospective review of electronic medical records for 325 consecutive youth presenting for an initial visit at a pediatric sleep clinic in an academic medical center. Demographic information, referral question, diagnosis, and recommendations were collected via medical chart review. Neighborhood data based on zip code was gathered utilizing the US Census Bureau’s American Fact Finder.

Results: Participants were 58% male, 53% White, with a mean age of 7.84 (SD = 5.34), living across 175 zip codes. Within participants’ communities, there was a median income of $64,974. The most frequent initial sleep complaints were symptoms of obstructive sleep apnea (OSA; 50.2%) and difficulty falling/staying asleep (42.5%). The most common diagnoses were rule-out OSA (64.3%) and behavioral insomnia of childhood (BIC; 16.5%). Stepwise logistic regression analyses were conducted that examined median community income, age, gender, and race as predictors of the top sleep complaints and diagnoses. Patients with initial complaints of difficulty falling/staying asleep were more likely to be White and female, whereas those with OSA symptoms were more likely to live in a lower median income community and be Non-White. In regard to diagnosis, being younger and White were related to BIC and being male and living in a lower median income community were related to OSA.

Conclusion: Findings from the current study suggest that, among a sample of youth presenting at a pediatric sleep clinic, OSA and BIC symptoms and diagnoses could be predicted by demographic variables, primarily neighborhood income and gender. Identifying demographic factors in patient-identified sleep problems and diagnoses can assist in understanding mechanisms underlying sleep disorders as well as in developing targeted assessments and interventions for diverse populations to ensure sleep problems are identified and diagnosed.

Introduction: The aim of the current study is to examine referrals to a pediatric sleep clinic and obtain information from both parents and referring physicians in order to help develop an action plan for the content and direction of dissemination about pediatric sleep medicine.

Methods: Demographic and questionnaire data were gathered from children and their parents who were attending the Youthdale Child and Adolescent Sleep Centre (YCASC) in Toronto Canada. Another survey was sent to physicians who had referred patients to the clinic within the last six months.

Results: Completed questionnaires were received from 67% of patients and their families and from 25% of physicians. Almost half of the referring physicians were pediatricians with their office in an urban location. The pediatric patients were predominantly male (76%, n = 38), mean age of 11 ± 5 years and of primarily Caucasian (82%) origin. The majority (84%) of physicians referred children for investigation of two or more sleep-related issues. Following diagnostic polysomnography, for most patients a mismatch was revealed between the primary reason for referral and the actual sleep diagnosis/diagnoses received. When asked what additional healthcare services physicians feel their patients would benefit from in conjunction with the sleep medicine services, the vast majority of physicians identified child psychiatric and psychological services.

Conclusion: The ethnic composition of the sleep clinic patients does not match the 50% visible minority composition of Toronto indicating that children of visible minorities are not being referred for sleep testing. Only one-third of children referred for insomnia received that diagnosis suggesting that insomnia-type symptoms are likely indicative of a variety of pediatric sleep-related problems. Based on the findings, a pediatric sleep referral form was developed to assist physicians in determining which of their pediatric patients would benefit from diagnostic sleep assessment.

Introduction: The association between pulmonary hypertension (PH) and obstructive sleep apnea (OSA) in children is poorly understood. This study aims to assess the clinical characteristics of pediatric patients with PH and OSA.

Methods: Retrospective data was collected from patients aged 21 years or younger with ICD-9 diagnoses of Primary PH, Secondary PH, congestive heart failure due to PH, and personal history of other diseases of the circulatory system from January 1, 2003 to March 22, 2013 from one tertiary center. Patients were deemed to have PH from echocardiographic and/or right heart catheterization reports confirming estimated elevated pulmonary artery pressures (PAP) > 25 mmHg. Clinical characteristics of patients with concurrent OSA and PH without other heart disease were examined.

Results: 1,613 patients were diagnosed with PH from January 1, 2003 to March 22, 2013. Of these, 731 were confirmed to have PH; 15 patients also carried a diagnosis of OSA. 9 patients had OSA demonstrated by polysomnography and mild to moderate PH by echocardiography estimated by right ventricular systolic pressure or by indirect methods (1 patient). 4 patients had Trisomy 21 and 3 had Prader-Willi Syndrome (PWS). 7 of 9 patients in this cohort were male and the median age of evaluation was 14.5 years (IQR 3.25 to 16.75). One child with PWS died of cor pulmonale.

Conclusion: The prevalence of PH in children with OSA was low with a preponderant male distribution. PH was most commonly observed in children with OSA in the presence of Trisomy 21 and Prader-Willi syndrome. Screening and monitoring for PH should be an integral part of management of pediatric OSA.

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1117
PHYSICAL ACTIVITY IS ASSOCIATED WITH FUNCTIONAL OUTCOMES OF SLEEPINESS AMONG OLDER ADULTS
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Introduction: Physical activity is associated with sleepiness, but whether it is associated with functional outcomes of sleepiness is unknown. Using data from the Wisconsin Sleep Cohort study we investigated whether, for a given level of subjective sleepiness, physical activity level was associated with reduced functional outcomes of sleepiness in older adults.

Methods: Four annual questionnaires that included questions about sleepiness, functional outcomes of sleepiness, physical activity, and work status were mailed to potential respondents. Subjects contributed 1–4 observations to the cross-sectional analysis. Linear regression estimated whether, for a given level of subjective sleepiness, physical activity level was associated with reduced functional outcomes of sleepiness in older adults.

Results: 2,136 individuals provided 6,880 observations (48% male, 46–86 years old). Participants reported physical activities that were estimated as a mean (SD) 25 (30) MET-hours per week. For a given self-reported level of sleepiness, more physical activity was associated with better functional outcome of sleepiness. Those with the highest level of physical activity (> 10 MET-hrs/week) scored 0.20 points higher on the FOS-Q than those with the lowest level of physical activity (p < 0.0001); subjects with 6–10 MET-hrs/week scored 0.11 points higher on the FOS-Q (p = 0.03); and subjects who reported 4–6 MET-hrs/week did not score significantly differently on the FOS-Q than those at the lowest level of physical activity (p-trend < 0.001).

Conclusion: For a given level of sleepiness, engaging in greater levels of physical activity may be associated with better functional outcomes of sleepiness among older adults.

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1118
SLEEP DISTURBANCES ARE ASSOCIATED WITH COGNITIVE DECLINE IN THE ELDERLY: RESULTS OF THE MULTI-ETHNIC NORTHERN MANHATTAN STUDY (NOMAS)
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Introduction: We examined the cross-sectional and longitudinal associations of frequent snoring, daytime sleepiness, and sleep duration with worse cognitive performance and decline.

Methods: NOMAS is an ongoing prospective cohort study with baseline data collected in 1993–2001 and neuropsychological assessments beginning in 2003. We analyzed a subsample of 711 NOMAS participants with sleep and cognitive data (mean age = 63 ± 8 years, 62% women, 18% white, 17% black, 67% Hispanic) and 687 with repeat cognitive testing. The main predictors were frequent snoring, daytime sleepiness (Epworth sleepiness scale) and sleep duration. Participants underwent a neuropsychological battery, and had repeated testing within a mean time span of 6 ± 2 years. We used factor analysis-derived domain-specific Z-scores for memory, language, executive function, and processing speed. We evaluated the associations between frequent snoring (yes versus no), daytime sleepiness (severe dozing and mild dozing with no dozing as the reference) and sleep duration (< 6 hours and ≥ 9 hours of sleep with 6–< 9 hours as the reference) with cognitive performance and decline for each domain.

Results: Adjusting for demographics and vascular risk score, frequent snoring had a cross-sectional association with worse executive function (β = −0.123; p = 0.04) and processing speed (β = −0.134; p = 0.02), but not with memory or language. Severe dozing (β = −0.265; p = 0.009), but not mild dozing, was associated with worse executive function. There was no cross-sectional association between sleep duration and the cognitive domains. When evaluating cognitive decline over time across domains, frequent snoring (β = −0.292; p = 0.0007), severe dozing (β = −0.287; p = 0.05), and long sleep duration (β = −0.289; p = 0.04), were associated with worse executive function, after adjusting for demographics and vascular risk score. No decline was observed in the domains of memory, language and processing speed.

Conclusion: We found significant cross-sectional and longitudinal associations between worse executive function and frequent snoring, daytime sleepiness and long sleep duration.

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1119
PREVALENCE OF INSOMNIA DISORDER DECREASES WITH AGE AMONG OLDER VETERANS
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Introduction: Previous studies have shown that sleep complaints increase with advanced age and worse health status. The present study
XI. Sleep and Aging

Methods: We sent a postal survey, designed to identify insomnia disorder based on ICSD-2 criteria, to all patients aged ≥ 60 years who live within a 25-mile radius of a VA clinic, and had received care within the prior 12-month period. We estimated the prevalence of insomnia disorder (5-year age groups). Health status was assessed with the single self-rated health question from the SF-36 (response options: excellent, very good, good, fair and poor). We then performed logistic regression to assess the odds of insomnia disorder across age groups adjusted for self-rated health status.

Results: 4637 veterans participated in the survey (response rate = 52.4%). Mean age was 74.1 [SD 9.4] years and 2451 (52.8%) had responses consistent with insomnia disorder. Among the age groups 60–64, 65–69, 70–74, 75–79, 80–84, and ≥ 85 years the prevalence of insomnia was 63.9%, 57.5%, 51.9%, 50.1%, 44.1%, and 45.6% respectively. After adjusting for self-rated health status the odds ratios comparing each age group (65–69, 70–74, 75–79, 80–84, and ≥ 85 years) to the reference group (60–64 years) were 0.82, 0.68, 0.57, 0.43 and 0.44 (all p-values < 0.05). More favorable health status was associated with decreased odds of having an insomnia disorder (OR = 0.48, p < 0.001).

Conclusion: The prevalence of insomnia in this group of older veterans was very high. However, the prevalence of insomnia decreased with age, which is inconsistent with reports from prior studies. This may be due to a healthy survivor effect, response bias, a cohort effect, or a confounder not included in the model.

Support (If Any): Veterans Administration Health Services Research and Development. Merit Review (IIR 08–295-1) “Implementing Sleep Interventions for Older Veterans.”

1120 SLEEP ONSET FRONTAL INTERMITTENT RHYTHMIC DELTA ACTIVITY AND COGNITION IN OLDER ADULTS
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Introduction: Sleep onset frontal intermittent rhythmic delta activity (SOFIRDA) occurs within normal EEG background activity and is considered to represent normal variation among elderly adults. However, initial data indicate a predominance of delta activity in dementia patients, raising the question of whether SOFIRDA is associated with impairments in cognition that precede the development of dementia. We examined the relationship of SOFIRDA to cognition in community-dwelling, older adults without dementia.

Methods: 153 community-dwelling older adults were administered overnight polysomnography, and the following cognitive measures (1) MMSE measure of global cognition; (2) delayed verbal memory; (3) information-processing speed and attention (Stroop); (4) verbal naming; and (5) visuospatial ability. SOFIRDA was defined as sequences of rhythmic, bilateral anterior delta activity (1–3 Hz), duration between 2 and 10 seconds without voltage criteria, arising from normal background in the transition from awake to sleep, and excluding delta activity in slow-wave sleep.

Results: Subjects were 83 women and 70 men, 52 to 90 years (Mean Age = 71.3 ± 0.6). SOFIRDA was present in 30 subjects (19.6%). Age, years of education, Gender and BMI were not different between SOFIRDA (+) and (−) groups. Multiple regression found Stroop performance to be significantly faster in the SOFIRDA (+) group (p = 0.007; covaried with age, gender, year of education and BMI). There was also a trend for better MMSE in the SOFIRDA (+) group (p < 0.058).

Conclusion: A significant percentage of participants had SOFIRDA, similar to that observed in prior studies of older adults suggesting it is relatively common in healthy older adults. However, SOFIRDA was not correlated with poorer cognition. Indeed, the SOFIRDA positive group demonstrated significantly better information processing speed, and global cognition. The lack of association of SOFIRDA with cognitive dysfunction suggests its presence in healthy elderly may indeed represent normal variation without pathological implications.

1121 HIPPOCAMPAL VOLUME IN OLDER ADULTS WITH MILD COGNITIVE IMPAIRMENT (MCI) IN RELATION TO SLEEP APNEA STATUS
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Introduction: Mild cognitive impairment (MCI) represents an early stage of the progression towards Alzheimer’s Disease, which is associated with sleep apnea and a variety of brain morphologic changes. The specific aim of this study was to compare the MRI scans of older adults with MCI (with and without sleep apnea), and explore relevant covariates. This data was obtained at the baseline assessment of the MEMORIES study, a pilot clinical trial on the effect of CPAP on cognitive and everyday function in older adults with MCI.

Methods: Primary inclusion criteria for this analysis were age 55–90, amnestic MCI using established diagnostic criteria and ability to undergo an MRI scan. Participants were divided into two groups: controls without sleep apnea (n = 12) and cases with sleep apnea (n = 44) defined as an apnea-hypopnea index (AHI) ≥ 10, and clinical response to CPAP as evidenced by AHI < 5 following optimal pressure during titration polysomnography. 56 participants [age 68.8 years, sd 8.20; 50% men; Mini-Mental State Examination (MMSE) 28.3, sd 1.40] were recruited from sleep, primary care, and geriatric clinics. Study participants were not on CPAP at the time of the baseline MRI scan.

Results: Untreated sleep apnea (apnea vs no-apnea control) was significantly associated with right hippocampal volume, with a larger volume noted in the apnea patients (2077.6 ± 329.6 vs 1850.3 ± 247.9; p = 0.031). The association between hippocampal volume persisted when controlling individually for age, sex, race, marital status and education in bivariate regressions (all p-values < 0.05, model R-square values from 0.15 to 0.29).

Conclusion: Right hippocampal volume was larger in the baseline MRI scans of older adult MCI patients with untreated sleep apnea as compared to controls. These findings are consistent with hippocampal hypertrophy noted in a cognitively intact younger cohort with sleep apnea, and may be due to neuroglial ischemic preconditioning (Rosenzweig et al., PLoS One, 2013).

Support (If Any): R01AG034682; CPAP units were donated by Philips Respironics

1122 SLEEP AND COGNITIVE PERFORMANCE FROM TEENS TO OLD AGE: MORE IS NOT BETTER
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Introduction: Research to date has not provided evidence of an optimal sleep duration, but assumes that there is wide variability in sleep need. Nonetheless, there is growing public health concern that chronic

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sleep deprivation in youth is pervasive and negatively impacts cognitive functioning (as reflected in school performance). In contrast, research in elderly people suggests that sleep in excess of 7 hours is associated with worse cognitive performance, although this relationship is generally attributed to confounding factors such as medical comorbidities. The current analyses benefit from a large sample of internet brainingame users to examine the relationship of sleep duration to cognitive performance across the lifespan. We hypothesize that there will be a decline in performance with extended sleep times, which will be most observable in older subjects.

Methods: We examined the relationship of subjectively reported sleep duration to users’ performance on three games (working memory, visual memory, and arithmetic, respectively) across ten-year age groups spanning from age 15 through age 90+, adjusting for gender and education. Each game represented a different sample of players (Speedmatch: N = 499,896; Memory Matrix: N = 448,063; Raindrops: N = 233,824) with similar demographics. Performance was defined by game score, a measure of speed and accuracy.

Results: Adjusted performance in all 3 games deteriorated with increasing age. Contrary to expectations, peak cognitive performance was at 7 hours habitual sleep duration in all age groups and younger subjects showed the greatest deterioration in performance with longer sleep duration.

Conclusion: These findings challenge the hypothesis that deteriorating cognitive performance with long sleep duration is driven by medical comorbidities. These data suggest that the model for the homeostatic recovery of cognitive function as a function of sleep duration has to incorporate a curvilinear decline with longer duration sleep, indicating that there may be a cost to increased sleep, even in young individuals.

1123
SPECTRAL ANALYSIS OF THE REM SLEEP EEG AS A DIAGNOSTIC TOOL FOR AMNESTIC MILD COGNITIVE IMPAIRMENT
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Introduction: The first brain neurotransmitter to be affected in Alzheimer’s disease is acetylcholine. Because acetylcholine is more crucial for the activation of rapid-eye-movement (REM) sleep electroencephalogram (EEG) than that of wakefulness, the superiority of quantitative REM sleep EEG as a discrimination tool for preclinical Alzheimer’s disease was assessed.

Methods: Thirty subjects with mild cognitive impairment [MCI; 19 men; 64.7 ± 7.2 years; 13 amnestic MCI (a-MCI) and 17 non-amnestic MCI (na-MCI)] and 30 control subjects (19 men; 64.9 ± 6.5 years) participated in the study. Spectral analyses of wakefulness and REM sleep EEGs were performed and the theta/alpha ratio was used to assess between-group differences in EEG slowing. Moreover, Pearson product-moment correlation coefficients were calculated between scores on memory variables and the theta/alpha ratio in wakefulness and in REM sleep for the 60 subjects.

Results: As a whole, the MCI group did not differ from the controls subjects. However, the a-MCI subgroup showed a slowing of the REM sleep EEG in frontal, frontal lateral and anterior temporal regions compared to both na-MCI and control groups and in posterior temporal and parietal regions compared to the na-MCI subgroup only. There was no between-subgroup difference for the wakefulness EEG. Furthermore, correlations were found between both the immediate and delayed recall for the Rey Auditory Verbal Learning Test and the REM sleep ratio in frontal, frontal lateral and anterior temporal regions. The poorer was the memory performance, the greater was the REM sleep EEG slowing in these regions. On the other hand, memory performance was not correlated with the wakefulness EEG ratio.

Conclusion: This study demonstrates the advantage of the REM sleep EEG in the discrimination between a-MCI and both na-MCI and control subjects. Follow-up studies should be conducted to assess the predictive value of the REM sleep measures.

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INSOMNIA SYMPTOMS IN A LARGE ELDERLY GREEK POPULATION ARE ASSOCIATED WITH COGNITIVE DECLINE
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Introduction: Sleep problems are very prevalent among older adults with cognitive deficits. The goal of our study was to assess the association of sleep complaints with cognitive decline in a large elderly population living in the island of Crete, Greece.

Methods: The sample consisted of 3220 community-dwelling older adults (60–100 yrs). The primary objective of this study was to assess the prevalence and risk factors associated with cognitive impairment. All participants completed a structured questionnaire assessing demographics, physical and mental health, life-style habits and cognitive function. Subjects were classified as having cognitive decline according to their Mini Mental Status Examination (MMSE) using a cut-off score of < 24. Sleep complaints were assessed in terms of difficulty initiating sleep (DIS), maintaining sleep (DMS) and early morning awakening (EMA). Multiple logistic regression stratified by gender was performed to examine the association between insomnia symptoms, physical/mental health and cognitive decline after controlling for age, marital status, education, smoking, alcohol and physical activity.

Results: We found that 496 (26.7%) women and 189 (14%) men were cognitively impaired (p < 0.0001). In women DIS and the composite score of mental illness were associated with increased odds of having a low MMSE score (OR 1.6; p = 0.002, OR 1.9; p = 0.001, respectively). In men DMS, and the composite score of mental illness were associated with increased odds of having low MMSE score (OR 1.9; p = 0.002, OR 1.9; p = 0.01, respectively). In women but not in men there was an association between two or more sleep complaints (OR 1.3, p = 0.043) and low MMSE score.

Conclusion: In a large elderly population, insomnia symptoms, particularly difficulty maintaining sleep, and mental health are associated with increased risk for cognitive decline. Future studies should assess whether treatment of sleep problems improves or delays the deterioration of cognitive function in older adults.

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DEPRESSIVE SYMPTOMS UNDERLIE THE ASSOCIATION BETWEEN SLEEP QUALITY AND COGNITIVE PERFORMANCE FOR MIDDLE-AGED BUT NOT OLDER ADULTS
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Introduction: Previous research suggests that sleep quality is associated with cognition in middle-aged and older adults. Furthermore, people with significant depressive symptoms with sleep disturbance report more impaired cognitive functioning, compared to people without sleep disturbance. However, less is known about whether depressed mood serves as a pathway from sleep to cognition. The purpose of the current study was to examine depressive symptoms as a mechanism underlying the association between sleep quality and cognitive performance. Additionally, age differences in this association were also examined.

Methods: An archival analysis was conducted using data from the Midlife in the United States-II study, Projects 3 and 4. Middle-aged (M = 50.23, SD = 8.09, range = 34–64, n = 835) and older adult (M = 71.84, SD = 5.40, range = 65–84, n = 239) samples were compared. Global sleep quality was measured using the PSQI. Depressive symptoms were assessed using the CES-D. Cognition was assessed with the Brief Test of Adult Cognition by Telephone. Specific cognitive outcomes included overall cognitive performance, episodic memory, and executive functioning.

Results: Multiple hierarchical regression mediation analyses were conducted to test whether depressive symptoms mediated the association between sleep quality and cognitive performance after controlling for gender. Additionally, age differences in this association were examined. For middle-aged adults, depressive symptoms partially mediated the association between sleep and overall cognitive functioning (β = −3.58, p < 0.001), episodic memory (β = −2.28, p = 0.03), and executive functioning (β = −3.75, p < 0.001). Depressive symptoms did not significantly mediate the sleep-cognition association for older adults.

Conclusion: For middle-aged adults, depressive symptoms may serve as a pathway from poorer sleep quality to poorer cognitive performance. Depressive symptoms did not serve as an underlying mechanism for older adults, which could suggest that older adults cope with depressive symptoms in a more adaptive way than their middle-aged counterparts. It is also possible that older adults have different expectations about their sleep.

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OLDER VETERANS WITH LOWER PHYSICAL FUNCTION BENEFIT FROM BEHAVIORAL SLEEP INTERVENTION
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Introduction: Studies show that behavioral interventions improve sleep in older adults. However, little is known about whether levels of physical function of older adults affect sleep after behavioral sleep intervention. We recently completed a randomized controlled trial of a brief Sleep Intervention Program (SIP) vs. Informational control (IC) for veterans at an adult day health care program (ADHC). This secondary analysis examined whether veterans with lower physical function could benefit from SIP.

Methods: Veterans (n = 42, mean age 77 years) were randomized to receive SIP or IC. Sleep data were measured using the Pittsburgh Sleep Quality Index (PSQI), Insomnia Severity Index ( ISI), and actigraphy at baseline, post-treatment, and 4-months follow-up. Physical function at baseline was measured using the Older Americans Resources and Services Multidimensional Functional Assessment Questionnaire, comprised of 14 items measuring activities of daily living (ADL) and instrumental ADL (IADL); total score ranges from 0 to 28; higher scores indicate greater independence. ANCOVA models were used to test interaction between treatment and physical function in sleep outcomes at follow-ups, with baseline sleep values as a covariate.

Results: For sleep efficiency, the SIP vs. IC by ADL/IADL interaction was significant (F[1,35] = 6.28, p < 0.05); sleep efficiency improvement in the SIP vs. IC was greater for veterans with lower levels of physical function, with significant differences when ADL/IADL ≤ 17. For ISI, the SIP vs. IC by ADL/IADL interaction was also significant (F[1,37] = 7.50, p < 0.01); ISI improvement in the SIP vs. IC was greater for veterans with lower levels of physical function; the effect was also significant when ADL/IADL ≤ 19. No significant interaction was found between treatment and physical function for other sleep measures.

Conclusion: Veterans with worse baseline physical function at ADHC may especially benefit from behavioral sleep interventions. Further studies of older adults with low physical function in other settings are needed to test its effectiveness.

Support (If Any): VARRD IRX00135–01 (Martin), Geriatric Research, Education, and Clinical Center.

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THE FEASIBILITY AND EFFICACY OF A SHARED YOGA INTERVENTION FOR SLEEP DISTURBANCE IN OLDER ADULTS WITH OSTEOARTHRITIS
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Introduction: Yoga is a complementary and alternative medical (CAM) approach with potential to reduce sleep disturbances and pain in older adults with osteoarthritis (OA). This study examined the feasibility and efficacy of a yoga program designed for persons with OA that incorporated a novel aim of exploring whether attending the classes with a practice partner (“Shared Yoga”) promoted adherence and improved efficacy.

Methods: Eligibility criteria: aged 50–85 years; OA of the hip, knee, or ankle; meeting Research Diagnostic Criteria for Insomnia; and having a willing practice partner (required of all for group equivalence). Participants were randomized to Shared Yoga (SY, n = 9) or Individual Yoga (IY, n = 7). Participants completed baseline and post-intervention assessments. The 12-week intervention involved a weekly 75-minute class, a 5-minute morning “warm up” routine, and a 30-minute daily home practice.

Results: The sample was 53% male and 59% white/Caucasian, with mean age 56.8 ± 6.6 years. General feasibility was supported by class attendance (SY = 8.8 ± 3.2 classes, IY = 9.0 ± 2.0) and home practice (SY = 5.8 ± 1.4 days per week, IY = 6.1 ± 1.1), with no significant group differences. For the efficacy outcomes, the Insomnia Severity Index and PROMIS Sleep Disturbance scale significantly improved in the whole sample, but no other significant improvements were seen on the Western Ontario McMaster Osteoarthritis Index, PROMIS Sleep-related Impairment or Fatigue, sleep diary, or actigraphy. Change scores on the outcomes did not significantly differ between the two groups.

Conclusion: The study supports the feasibility of this yoga intervention, both when performed with a partner and individually. Inclusion of a practice partner did not seem to improve adherence or efficacy, but
neither was it a barrier. Efficacy data suggest that this yoga program may improve perceived sleep, but further research is needed.

Support (If Any): P30 NR 011400 (Center for Research on the Management of Sleep Disturbance).

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SLEEP IS BOTH A DIRECT AND AGE-MODERATED PREDICTOR OF INDIVIDUAL PERCEPTIONS OF HEALTH
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Introduction: Sleep has frequently been studied in relation to objective health outcomes. However, work examining the unique contribution of sleep to subjective perceptions of health, and the role of age in these associations, is limited. This study examined the extent to which global sleep quality predicts subjective perceptions of health, including: self-rated physical health, perception of physical health compared to same-aged others, and ratings of physical health 10 years in the future. Of additional interest was whether these associations vary by age.

Methods: An archival analysis was conducted on cross-sectional data from Projects 1 and 4 of the Midlife in the United States follow-up study, MIDUS-II. Participants were 1255 community-dwelling adults aged 35 to 86 years (M = 55.99, SD = 11.60). Demographic information and health ratings were collected via self-administered questionnaires. Sleep outcomes were measured using the Pittsburgh Sleep Quality Index. All materials were completed by mail.

Results: Multi-tiered regression analyses were used to test study aims. Covariates included: gender, age, self-rated mental and emotional health, and number of health conditions and symptoms. Poor sleep quality significantly predicted lower self-rated physical health, β = 0.06, p = 0.03, and worse predictions of health 10 years in the future, β = −0.24, p < 0.001. Although poor sleep quality did not uniquely predict health compared to same-age others, β = 0.11, age emerged as a significant moderator in this association, such that older age buffers the negative impact of poor sleep quality on self-rated health compared to same-age others, β = −0.08, p = 0.003. Age did not significantly moderate the associations of self-rated health and future health ratings with sleep.

Conclusion: Overall, the present findings suggest that poor sleep may impact individuals’ overall perceptions of health in a negative way. However, this negative association may be attenuated at older ages. This research underscores the need to consider sleep experiences when assessing subjective beliefs about physical health.

Support (If Any): The MIDUS II research was supported by a grant from the National Institute on Aging (P01-AG020166) to conduct a longitudinal follow-up of the MIDUS I investigation. The MIDUS-II research was further supported by the following grants M01-RR023942 (Georgetown), M01-RR00865 (UCLA) from the General Clinical Research Centers Program and UL1TR000427 (UW) from the National Center for Advancing Translational Sciences (NCATS), National Institutes of Health.

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SLEEP AND NOCTURNAL FALLS: METEOROLOGICAL ANALYSIS OF INPATIENTS
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Introduction: Falls often cause fractures of variable part of a body in old patients. As a result, their quality of life deteriorates and medical costs are increasing. The aim of this study was to clarify the effects of meteorological factors on nocturnal falls of inpatients.

Methods: We performed retrospective analysis of fall-incident reports (April, 2010–March, 2014) in a medium sized hospital with 260 beds. We collected all fall-incident reports except for those of intensive care unit and out-patients. Patient characteristics, number of falls and fall-rates (total number of fall-incident reports/total of patient days x 1000 patient days), month and time, activities associated with falls were evaluated. After dividing the reports into two groups: diurnal falls (light-on 6:00–21:00) and nocturnal falls (light-off 21:00–6:00), we analyzed relationships between the nocturnal fall-rates and meteorological factors. For data analysis, t-test and regression analysis were used.

Results: We reviewed 464 fall-incident reports; in a total number of patients were 339,485 for 4 years. The mean age of these patients was 76 ± 11 years old, and 263 were male (57%). Fifty seven percent of the fall-patients (n = 265) associated with excretion activity. The mean number of falls per month was 10 ± 3 (fall-rates 1.4 ± 0.5), fall-rates was significantly increased in November compared with in May (p < 0.05). Fall-incidents significantly increased during 2:00–3:00 am, and 7:00–8:00 am compared with that of the 15:00–16:00 (p < 0.001). Additionally, we examined correlation between the length of night-time and fall-rates to investigate the factors of seasonal variation in nocturnal fall-rates. Regression analysis showed significant positive correlation between night-time length and fall-rates (R2 = 0.73, p < 0.001).

Conclusion: Since many incidents of nocturnal falls were related to excretion activity in dark period, we should pay more attention to meteorological factors, especially to the darkness in the early morning of the season with a long night-time in order to decrease the fall incidence.

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IS THE HIGH PREVALENCE OF SLEEP PROBLEMS IN ELDERLY MEXICAN-AMERICANS ASSOCIATED WITH NOT BEING BORN IN THE U.S.?
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Introduction: We previously reported that among elderly individuals enrolled in the Health and Retirement Study, Hispanics had significantly higher prevalence of sleep-complaints than non-Hispanics. We explored this association further by looking at sub-groups of Hispanics and whether or not they were born in the United States.

Methods: Data from the 2006 and 2010 waves of the Health and Retirement Study were used in this analysis. Participants with sleep-complaints (i.e., trouble falling asleep, waking during the night, waking up early, un-refreshing sleep) at baseline (2006) were excluded. Incidence of new sleep-complaints between 2006 and 2010 was determined (N = 3,850; 231 Mexican-Americans, 137 Puerto-Rican/Cuban-Americans, 3,025 non-Hispanics). The association between Mexican-Americans and sleep complaints versus non-Hispanics and other Hispanics
was determined using multivariable logistic regression. A four-level variable was created as follows: non-Hispanics, other Hispanics, U.S.-born Mexican-Americans, and non-U.S.-born Mexican-Americans to assess the effect of being born in the United States.

**Results:** Compared to non-Hispanics and other Hispanics respectively, Mexican-Americans had an increased likelihood of incident sleep-complaints (OR = 1.93, p < 0.0001 and OR = 1.55, p = 0.03, respectively). After adjusting for age, sex, race, education, and being recently retired, the association remained for Mexican-Americans versus non-Hispanic (OR = 1.90, p < 0.0001). The increased likelihood of sleep complaints was seen regardless of whether the participant was born in the U.S. (OR = 1.90, p = 0.004 and OR = 1.94, p = 0.001, respectively), after adjusting for age, sex, race, education, and recently retired.

**Conclusion:** Older Mexican-Americans are more likely to develop incident sleep-complaints that could not be explained by country of birth. These results suggest that patterns and correlates of sleep-problems differ among Hispanic ethnicity. Understanding these differences may help in developing culturally appropriate interventions to improve sleep problems.

**1131**

**SLEEP QUALITY AND COGNITIVE FUNCTION DETAILS IN ELDERLY HISPANICS: RESULTS FROM THE HISPANIC ESTABLISHED POPULATION FOR EPIDEMIOLOGICAL STUDY OF THE ELDERLY (HEPESE), WAVE 6, 2006–2007**

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**Introduction:** Sustained working memory and other cognitive functions have been shown to be affected by sleep dysfunction. Our study determined if sleep complaints, quality of sleep and average length of sleep is associated with specific cognitive function domains in elderly Hispanics.

**Methods:** Data of 1,542 individuals aged 75 years and above, participating in Wave 6 of the Hispanic Established Populations for the Epidemiologic Study of the Elderly (HEPESE) were analyzed. Scores in seven domains of the Mini Mental State Examination (MMSE) were constructed by contrasting a perfect score with any error. Association with self-reported quality of sleep, sleep dysfunction, and average length of sleep was assessed using logistic regression and adjusting for gender, age, education, marital status, BMI, physical activity, depression and ADL scores.

**Results:** After adjustment, sleeping 6 hours per night appears significantly protective in 4 specific cognitive domains: orientation to place (OR = 0.636, 95% CI 0.478–0.846), three word registration (OR = 0.399, 95% CI 0.257–0.729), language (OR = 0.707, 95% CI 0.539–0.928), attention & calculation (OR = 0.697, 95% CI 0.523, 0.931). While restless sleep was not associated with most domains, it was associated with significant impairment of attention & calculation (OR = 1.507, 95% CI 1.002–2.268; OR = 2.963, 95% CI 1.583–5.544; OR = 2.385, 95% CI 1.336–4.258 respectively for restless sleep “some,” “moderate” and “all the time”). Individuals who woke up tired after their usual amount of sleep 15 or more days a month were more likely to have impaired performance in the three word registration (OR = 2.631, 95% CI 1.323–5.232), recall (OR = 1.803, 95% CI 1.101–2.954) and language (OR = 1.723, 95% CI 1.004–3.840) domains.

**Conclusion:** Our findings suggest that sleep related dysfunctions and sleep length affect some cognitive domains more than others. Short sleep (< 6 hours) may have minimal, if any effect, on performance in MMSE domains in this very elderly study population.

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**DAILY BEHAVIORAL REGULARITY AND SLEEP: AN AGE-MODERATED ASSOCIATION**

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**Introduction:** Regularity in the timing of daily events has been linked to sleep outcomes, with separate studies indicating that this association changes with age. However, existing studies have been limited in that the age ranges studied were restricted (e.g., only younger adults, middle-aged adults, etc.). Further, such studies have had relatively small sample sizes. The present analyses extend existing literature by examining how daily regularity relates to sleep quality in a nationally representative sample and explores how this association varies across middle and older adulthood.

**Methods:** An archival analysis was conducted on cross-sectional data from the Midlife in the United States follow-up study, MIDUS-II. Participants were 785 community-dwelling adults aged 34 to 84 years (M = 55.99, SD = 11.60). Data regarding the duration of time spent on daily activities was collected by phone over 8 consecutive days. Sleep outcomes were measured using the Pittsburgh Sleep Quality Index, which was completed by mail.

**Results:** Multi-tiered regression analyses indicated that greater regularity in time spent on daily activities predicted better global sleep outcomes, across ages, but that this association was stronger at lower ages, β = −0.27, p = 0.01. A similar pattern emerged where better sleep outcomes predicted greater regularity, but to a greater extent at younger ages, β = −2.18, p = 0.04.

**Conclusion:** The present analyses indicate a bidirectional relationship, where regularity in time spent on daily activities predicted sleep outcomes and sleep outcomes, in turn, predicted daily regularity. The identification of this association in a population-based sample underscores the need to consider introducing regularity into individuals’ lifestyle practices to promote better sleep. The findings also prompt research on additional, positive outcomes associated with daily regularity in older adulthood.

**Support (If Any):** The MIDUS II research was supported by a grant from the National Institute on Aging (P01-AG020166) to conduct a longitudinal follow-up of the MIDUS I investigation. The MIDUS-II research was further supported by the following grants M01-RR023942 (Georgetown), M01-RR00865 (UCLA) from the General Clinical Research Centers Program and UL1TR000427 (UW) from the National Center for Advancing Translational Sciences (NCATS), National Institutes of Health.

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**THE ASSOCIATION OF SLEEP AND HEALTH IN WORKING MEN AND WOMEN**

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**Introduction:** While later mid-life is a time when individuals frequently achieve the height of their work career, it is also a time of increased prevalence of sleep disorders and chronic health conditions. The purpose of this study was to evaluate the association of age, gender, health disorders, hours worked and impaired sleep on self-rated health.

**Methods:** A secondary analysis of the National Sleep Foundation’s Sleep in America 2008 survey was conducted. The survey included demographic data, height and weight for calculation of BMI, sleep characteristics (sleep latency, sleep duration, waking unrefreshed), the Epworth Sleepiness Scale (ESS), total hours worked, number of chronic health conditions and self-rated health as “excellent” to “poor.”
An Insomnia Index was calculated from the sum of 3 questions (potential range 3–15): the frequency of difficulty in falling asleep, awakes a lot during the night, and woke too early/unable to return to sleep. Descriptive statistics and a linear regression were performed on a subset of participants ages 50–65 years. Statistical significance was set at p < 0.05.

Results: The sample (N = 392) was well distributed by gender (46% female), primarily Caucasian (89%), and married/partnered (69%). Participants were overweight or obese (75% with BMI ≥ 25) with 50% working ≥ 40 hours/week. Participants had inadequate sleep duration (mean = 6.6 hours ± 1.2); 18% had Insomnia Index scores ≥ 12; 35% had long sleep latency (> 15 min); 14% with an ESS ≥ 10. Women had higher insomnia scores (p < 0.001), but there was no difference in ESS or sleep duration. Men worked more hours per week (p < 0.001). Increased number of chronic health conditions and waking up unrefreshed were significant predictors of lower self-rated health (p < 0.001). Age, race, gender, Insomnia Index, ESS, sleep duration, and total hours worked/week were not statistically significant.

Conclusion: The results suggest that non-refreshing sleep and chronic health conditions are predictive of worse self-rated health in older workers.

1134 ACOUSTIC STIMULATION INCREASES SLOW WAVE ACTIVITY IN OLDER ADULTS

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Introduction: Age-related decrease in the amount of slow-wave sleep has been postulated to play a role in impaired cognitive and metabolic function. Acoustic stimulation during sleep has been shown to increase slow-wave activity (SWA) in young adults but has not been examined in older adults. The aim of this study was to examine the ability of acoustic stimulation to increase SWA in adults ≥ 50 years old.

Methods: Seven healthy adults (age 66.85 ± 10 years, 1 male) completed one night of acoustic stimulation and one night of sham stimulation. During sleep, an adaptive phase-locked loop (PLL) algorithm was used to lock on to slow waves measured in midline frontopolar electroencephalographic recordings in real time. Acoustic stimuli were delivered when the PLL system predicted the positive upstate of the slow wave. Stimuli consisted of pulses of pink noise lasting 50 ms with an inter-tone interval of approximately 1 s, depending on the individual’s slow oscillations. Tones occurred in blocks of 5 pulses (“ON blocks”) followed by a refractory period of equal length (“OFF blocks”). Power spectral analysis was used to identify power in the slow oscillation delta frequency band (slow delta: 0.8 Hz–2.1 Hz). Wilcoxon signed-rank test was used to evaluate differences in power within and between stimulation and sham nights.

Results: During the stimulation night, there was a 22.2% (± 12.0%) increase in slow delta during the ON blocks compared to OFF blocks (p = 0.016). Slow delta during ON blocks during the stimulation night was 15.5% (± 44.8%) higher when compared to ON blocks in the sham night (p = 0.018). There was a small (6%) but non-significant increase in total delta power for the stimulation night compared to the sham night.

Conclusion: Acoustic stimulation during sleep can enhance SWA and has the potential to improve sleep quality in middle-age and older adults.

Support (If Any): Dixon Translational Research Grant, NIH T32 NS047987, National Science Foundation GRFP DGE-1324585, NIA P01AG11412

1135 NAPPING IN OLDER AND YOUNGER ADULTS: FORBIDDEN TERRITORY?

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Introduction: Depending on individual and contextual circumstances, napping may be associated with positive or negative outcomes. Accordingly, the association between napping and sleep has proven complex. This study explored the association between napping and sleep in older and younger adults and examined both daily and average associations between these variables.

Methods: 50 younger (M = 19.88, SD = 2.76) and 50 older (M = 67.81, SD = 6.73) adults completed 14 consecutive-day sleep diaries. Sleep variables included sleep onset latency (SOL), number of nighttime awakenings (NWAK), time in bed (TIB), wake time after sleep onset (WASO), total sleep time (TST), sleep efficiency index (SEI), and sleep quality rating (SQR). Napping variables included mean and daily nap duration, nap frequency, and nap timing. Multilevel modeling analyses were used to predict sleep outcomes from daily and average napping variables.

Results: Health rating was a significant within-person predictor of SQR and TIB, β = 0.31, p = 0.01 and β = 30.00, p = 0.01, respectively, with a higher health rating associated with higher sleep quality and more time spent in bed. There was a significant within-person interaction between age and daily nap timing for NWAK, β = −0.52, p = 0.01, and SQR, β = 0.35, p = 0.02. For older adults, naps later in the day were associated with fewer awakenings during the night and higher sleep quality, while the opposite was found for younger adults. There was a significant interaction between daily nap duration and age for TIB, β = 0.70, p = 0.05. For older adults, longer daily nap duration was associated with slightly more time spent in bed, while the opposite was found for younger adults.

Conclusion: Daily napping was predictive of sleep outcomes while average, or overall napping was not, suggesting that associations may be masked when only mean napping values are considered. Several age differences were identified between napping and sleep outcomes. Implications and future research directions will be discussed.

1136 SLEEP EFFECTS ON COGNITION IN THE ELDERLY AND THE IMPORTANCE OF DAYTIME ACTIVITY

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Introduction: In cognitively normal elderly, short sleep duration is associated with deficits in cognitive performance while physical activity has shown to be protective and improve cognitive function. Actigraphy monitoring systems are used to objectively assess sleep but also capture measures of physical activity during the daytime. The purpose of this study is to determine whether daytime activity and sleep duration have independent effects on cognition in normal elderly.

Methods: 44 community dwelling cognitively normal (Clinical Dementia Rating = 0) elderly (Age 66.2 ± 7.3, Gender (36.4% Male, 63.6% Female), non-depressed (Geriatric Depression Scale < 7) participants wore an actigraph (Octagonal Basic Motionlogger, Ambulatory Monitoring Inc, NY) for 7 consecutive days. Data were analyzed in the zero crossing mode for total sleep duration (TST), and mean daytime activity using the provided automated algorithm. All subjects underwent a standard neuropsychological test battery with subscales assessing im-
mediated and delayed recall of orally presented paragraphs and verbal paired associates, digit span (backward and forward), and executive function (trail making test B [TMTB]).

Results: Daytime Activity and TST were not correlated with each other. Short sleep duration was associated with longer completion times in the TMTB (r = −0.3, p < 0.05) while Daytime Activity was associated with better performance in verbal paired associates (r = 0.4, p < 0.01) and digit span backward (r = 0.4, p < 0.01). Daytime Activity and TST showed additive effects on verbal paired associates (Daytime Activity F change = 5.95, p < 0.05 and TST F change = 3.18, p < 0.1).

Conclusion: Daytime Activity had a significant effect on cognition independent of sleep duration. While these preliminary findings should be interpreted with caution due to small sample size, our data suggest that in studies examining cognition in elderly subjects, actigraphic data should be analyzed for daytime activity in addition to sleep duration.

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1137

LIGHT TABLE TO TREAT SLEEP, DEPRESSION AND AGITATION IN PERSONS WITH DEMENTIA LIVING IN LONG-TERM CARE FACILITIES

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Introduction: Persons with Alzheimer’s disease and related dementia (ADRD) are often difficult for caregivers to manage because of sleep problems, nocturnal wandering, and associated daytime irritability. Light can be used to consolidate sleep and improve behavior in this population, but light levels required are generally high and lighting fixtures currently available in the market are not designed to deliver the desired light level and spectrum that maximally affect the circadian system. The present study tested whether a light table built using a television set could improve sleep and behavior in ADRD patients living in long-term care facilities.

Methods: A light emitting diode (LED) edge lit television, delivering 2,000 lux at the cornea of a 25,000 K (bluish white) light was placed on top of a table frame in a dining area in a senior facility. Six ADRD patients sat around the light table during the day for 4 consecutive weeks. Light-dark and activity-rest patterns were collected using a calibrated instrument prior to and after the lighting intervention. Measures of sleep quality, depression and agitation were collected using standard questionnaires.

Results: Light exposure significantly (p < 0.05) increased sleep percent from the actigraphy data and reduced global sleep scores from the Pittsburgh Sleep Quality Index. Light exposure also significantly reduced depression scores from the Cornell Scale for Depression in Dementia and agitation scores from the Cohen-Mansfield Agitation Inventory.

Conclusion: A light table built using edge-lit televisions is an effective and practical way to deliver light treatment to ADRD patients. A larger study is presently being conducted to extend these results. Given that practical and effective systems such as the ones used here can be designed and installed, light treatments could be beneficial to those with ADRD and their caregivers.


1138

REGIONAL DECLINES IN SLEEP SLOW WAVE ACTIVITY IN AMNestic MILD COGNITIVE IMPAIRMENT

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Introduction: Amnestic Mild Cognitive Impairment (aMCI) is a condition of memory loss that frequently progresses to Alzheimer’s disease (AD). There is growing evidence of a relationship between disturbed sleep and the pathogenesis of AD. Furthermore, reduced slow wave power correlates with impaired sleep-dependent memory consolidation in aMCI. Sleep slow waves are a regionally heterogeneous phenomenon, yet regional differences in sleeping brain activity have not been investigated in aMCI.

Methods: We studied 16 veterans with and without aMCI, matched for age, sex and Apnea-Hypopnea Index (n = 8 per group). aMCI diagnosis was determined by consensus of an expert panel according to current guidelines. Sleep was evaluated with standard polysomnography and with high density EEG (256 electrodes). After manual artifact removal (including EEG arousals), spectral analysis of NREM sleep was performed for all 256 channels (fast Fourier transform routine, Hanning window, 6 s epochs). Maps were then compared using both absolute and normalized power (z-scores computed for each subject across all electrodes) in standard frequency bands. Topographic differences between aMCI groups were determined by statistical non-parametric mapping.

Results: Sleep architecture, including quantity of slow wave sleep (% of total sleep time), did not vary between aMCI and control groups. However, subjects with aMCI showed reduced absolute and normalized power in the slow wave range (1–4.5 Hz) in a central region, compared to controls.

Conclusion: Preliminary analyses suggest a loss of slow wave activity in central brain regions in subjects with aMCI. Further analyses will confirm this finding in a larger sample and explore other aspects of sleep EEG that may distinguish aMCI from normal elderly subjects, including brain connectivity and homeostatic regulation of sleep. These changes in brain function were evident in the absence of group differences in gross sleep architecture, demonstrating the utility of measuring sleep with high temporal and spatial resolution.

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1139

REDUCED SLOW-WAVE SLEEP IS ASSOCIATED WITH INCREASED CEREBROSPINAL FLUID Aβ42 LEVELS PRIOR TO AMYLOID DEPOSITION IN HUMANS


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Introduction: The ‘Amyloid Cascade Hypothesis’ posits that the accumulation and deposition of amyloid beta (Aβ) in the brain are the initiating pathological events in Alzheimer’s disease (AD). In mice, Aβ
levels in the interstitial space rise during wakefulness and fall during sleep, while sleep deprivation increases Aβ concentrations and accelerates Aβ plaque deposition. In humans, CSF Aβ42 concentrations show a diurnal pattern and have been related to higher synaptic activity during wakefulness and decreased activity during slow wave sleep (SWS). In this study we examined the relationship of CSF Aβ42 levels and SWS in cognitively normal elderly.

**Methods:** We examined CSF in 22 elderly subjects without cognitive defects (age 66.5 ± 6.7; range 56–83). Nocturnal polysomnography was performed within 12.9 ± 10.1 months, range 0–31 of the lumbar puncture, and analyzed for %SWS and %power in SWS (SWA). 3 subjects had an AHI4% > 15. Preclinical AD was suspected in 3 subjects from a CSF P-tau/Aβ42 ratio and these were initially excluded.

**Results:** Total sleep time, percent time spent in N1, N2 or REM were not correlated with CSF Aβ42. In contrast, %SWS and absolute SWA were inversely correlated with CSF Aβ42 levels (r = −0.70, p < 0.01; r = −0.74, p < 0.01). Results remained significant after controlling for BMI, age, ApoE4, AHI4% or excluding those subjects with an AHI4% > 15. Results were also significant when including all 22 subjects (r = −0.5, p < 0.05).

**Conclusion:** In cognitively normal elderly with age and/or OSA related changes in sleep, %SWS and SWA are associated with increases in CSF Aβ42. These findings are consistent with the role of sleep in the development of AD.

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1140

**PRELIMINARY FINDINGS OF REST-ACTIVITY PATTERNS IN OLDER ADULT WITH MILD COGNITIVE IMPAIRMENT AS COMPARED TO COGNITIVELY NORMAL CONTROLS**

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**Introduction:** Sleep in Alzheimer’s disease (AD) is distinguished by increased nighttime activity. Little is known about the characteristics of rest-activity patterns of individuals with mild cognitive impairment, a precursor to AD. This investigation examines differences in sleep and rest-activity patterns in older adults with Mild Cognitive Impairment (MCI) as compared to non-impaired controls.

**Methods:** Twenty-seven older adults (mean age 72.93, SD = 6.74) were categorized as MCI (n = 10) or normal cognition (n = 17) by an independent ADRC Consensus Panel based upon health history, IADLs, neuropsychological testing, physical exam, and collateral (family) memory history. Actigraphy and sleep diary data were used to describe total sleep time-TST, sleep efficiency-SLEEP, sleep onset latency-SO, and wake after sleep onset-WASO. Traditional cosinor analysis was used to calculate mesor (mean activity level), amplitude (peak to nadir difference in activity), acrophase (time of daytime peak activity) and R^2 (fit of the overall curve) from actigraphic activity counts.

**Results:** Independent sample t-tests indicate groups were similar in health; no group differences were found in self-reported illness or illness interference (OARS), depression (CESD) or anxiety (Spielberger Anxiety State/Trait Index), sleep quality (PSQI), daytime sleepiness (Epworth), or insomnia (Insomnia Severity Index). Sleep diaries and actigraphy revealed no group differences in TST, SOL, SE, or WASO. Differences were found in overall fit of the rest-activity curve, R^2, with the MCI group demonstrating poorer fit than controls (p < 0.05). MCI group mesor and amplitude were lower and acrophase was slightly later but these differences with controls did not achieve significance. There were significant differences in variability (p < 0.05) for both mesor and amplitude between the MCI group and controls.

**Conclusion:** The preliminary results of this study of sleep in individuals with memory problems suggest that changes in rest-activity patterns may be present prior to AD onset and diagnosis.

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1141

**FEASIBILITY OF A CLINICAL TRIAL USING ACTIVE VERSUS SHAM CONTINUOUS AIRWAY PRESSURE (CPAP) IN OLDER ADULTS WITH MILD COGNITIVE IMPAIRMENT (MCI)**


**Introduction:** Sham (placebo) CPAP has become the research standard for double-blind, placebo-controlled clinical trials on the efficacy of CPAP. The specific aim of this study was to determine the feasibility of recruitment for MEMORIES, a 6-month double-blind clinical trial of active versus sham CPAP followed by a 6-month open-label trial on cognitive and everyday function in older adults with obstructive sleep apnea (OSA) and mild cognitive impairment (MCI).

**Methods:** Primary inclusion criteria were age 55–90, apnea-hypopnea index (AHI) ≥ 10, amnestic MCI using established diagnostic criteria, and clinical response to CPAP as evidenced by AHI < 5 following optimal pressure during titration polysomnography.

**Results:** After 1-year of active recruitment including presentations to 500 older adults at various senior centers, advertisements in monthly senior newsletters with a readership of 25,000, and collaborations with 8 physician practices, 337 older adults expressed interest, but no one was randomized. The major reason was that the older adults with MCI did not want to risk being randomized to the placebo group, since they could readily obtain active CPAP treatment from their doctors. We queried several geriatricians and sleep physicians regarding the low numbers of physician referrals to our study. The physicians expressed concern about using placebo CPAP in this population, but would be willing to allow our study team to actively recruit from their practices if the sham CPAP arm were removed.

**Conclusion:** Sham CPAP is not feasible as a control condition in a 6-month clinical trial on the effect of CPAP on cognitive and everyday function in older adults with OSA and MCI. Quasi-experimental designs and alternative control groups, such as a no-apnea group, should be considered.

**Support (If Any):** R01AG034682 and Philips Respironics
XI. Sleep and Aging

1142
EFFECT OF AGE ON IMPROVEMENT OF DAYTIME SLEEPINESS WITH CONTINUOUS POSITIVE AIRWAY PRESSURE THERAPY IN MODERATE TO SEVERE OBSTRUCTIVE SLEEP APNEA: A CLINIC BASED COHORT STUDY

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Introduction: There is increasing evidence regarding treatment of obstructive sleep apnea (OSA) with continuous positive airway pressure (CPAP) therapy. This research primarily reflects a patient group younger than 65. There is, however, limited evidence of treatment outcomes in CPAP use for OSA specifically in adults older than 65. Understanding treatment outcomes in patients older than 65 has implications on clinical care.

Methods: The data used in this study is from patients with newly diagnosed moderate to severe OSA (AHI ≥ 15). Patients were classified into younger and older group by age (< 65 and ≥ 65). Change in Epworth Sleepiness Scale (ESS) compared between the two groups was the primary outcome.

Results: Forty-five patients with moderate to severe OSA adherent to CPAP treatment were evaluated. In the 27 patients less than 65 (mean age of 49.5) there was a mean improvement in ESS of 4.0 points. In the 18 patients older than 65 (mean age of 69.2) there was a mean improvement in ESS of 2.4 points. These findings were present despite other variables; subjective sleep quality, baseline sleep efficiency and total sleep time, not being significantly different. The change in ESS was not statistically significant when categorizing individuals into groups as younger or older than 65 years of age; however, the change in ESS depending on age as a linear value was statistically significant (p value < 0.05).

Conclusion: Improvement in daytime sleepiness was less robust in older patients compared to younger patients when given CPAP therapy for moderate to severe OSA. These findings suggest a difference in CPAP treatment outcomes of older patients compared to younger patients. This has important implications for patient wellbeing. CPAP adherence and provokes questions regarding other treatment outcomes in CPAP treated OSA for older adults. Further studies looking at more primary outcomes will help better understand the distinctions in CPAP treatment of older patients compared to younger patients.

1143
ADHERENCE TO CONTINUOUS POSITIVE AIRWAY PRESSURE (CPAP) IN OLDER ADULTS WITH MILD COGNITIVE IMPAIRMENT (MCI)

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Introduction: Mild cognitive impairment (MCI), characterized by memory impairment but little or no decline in everyday function, is a transitional stage between normal aging and Alzheimer’s Disease (AD). Few pharmacological or behavioral interventions delay cognitive decline in older adults with MCI (oaMCI). Treatment of a prevalent comorbid condition in oaMCI, obstructive sleep apnea (OSA), has potential for delaying cognitive decline, but there is no information on whether oaMCI will adhere to CPAP or its effect on cognition over the long-term. The specific aim was to determine the 6-month and 1-year objectively-measured adherence to CPAP in MEMORIES, a pilot clinical trial on the effect of CPAP on cognitive and everyday function in oaMCI.

Methods: Primary inclusion criteria for participants with OSA were age 55–90, apnea-hypopnea index (AHI) ≥ 10, amnestic MCI using established diagnostic criteria, and clinical response to CPAP as evidenced by AHI < 5 following optimal pressure during titration polysomnography. Fifty-nine participants [age 69.9 years, sd 8.10; 54% men; Mini-Mental State Examination (MMSE) 28.1, sd 1.70] were recruited from sleep, primary care, and geriatric clinics.

Results: Nine (15%) chose not to try CPAP and they were significantly older (mean age 77.8, sd 8.20) than the group who chose to try CPAP (mean age 68.5 years, sd 7.30), but not different on sex, race, education, or MMSE. Mean hours of daily CPAP use at 6-months and 1-year for those who chose to try CPAP, was 4.97 hrs/night (sd 0.100), and 4.92 hrs/night (sd 0.106), and at both 6-months and 1-year, 64% averaged ≥ 4 hrs/night of CPAP use.

Conclusion: Older adults with MCI adhere to CPAP. Their adherence is comparable to that of reported values in other adult populations.

Support (If Any): R01AG034682 and Philips Respirincs
self-efficacy ($\beta = 0.01, p < 0.001$), over and above other measures (USE-PAP model’s adjusted $R^2 = 0.53$; $\Delta$ adjusted $R^2 = 0.04$).

**Conclusion:** Among older adults prescribed PAP, more disability is associated with worse PAP usability ratings. Favorable usability ratings of PAP equipment are associated with better PAP self-efficacy. These results support measuring PAP usability in older adults and improving equipment usability.

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**1145**

**SHORT SLEEP DURATION IS ASSOCIATED WITH THE DEVELOPMENT OF GESTATIONAL DIABETES MELLITUS**

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**Introduction:** Studies have demonstrated that sleep restriction adversely affects appetite regulating hormones, insulin sensitivity, inflammation and autonomic function. However, data regarding the clinical consequences of short sleep durations during pregnancy are limited. Our objective was to determine whether insufficient sleep is associated with increased risks of gestational hypertension (GHTN), pre eclampsia (PE), and/or gestational diabetes mellitus (GDM).

**Methods:** Women enrolled in a multi-center prospective cohort study of adverse pregnancy outcomes in nulliparous women with singleton gestation were recruited at the 2nd study visit (16 0/7–21 6/7 weeks) to wear an actigraph (Spectrum, Philips Respironics) to record objectively measured sleep activity for 7 consecutive days. Women with pregestational diabetes and chronic hypertension were excluded. Short sleep duration (SSD) was defined as average sleep of < 7 hours per night.

**Results:** Actigraphy and outcome data were obtained for 760 women. Median sleep duration was 7.4 (IQR 1) hours, and 28% of women had SSD, averaged over the 7 days. 5.1% of women developed GHTN, 5.1% developed PE, and 4.1% developed GDM. For those with SSD (n = 212) 6.6% had GDM, 11.3% had GHTN/PE and for those with No SSD (n = 548), 3.1% had GDM, 9.9% had GHTN/PE. SSD was associated with an increased rate of GDM even after adjusting for age and BMI (aOR 2.12, 95% CI 1.02–4.41), but was not associated with GHTN and/or PE.

**Conclusion:** SSD during pregnancy, a potentially modifiable factor, is associated with the development of GDM after controlling for maternal age and BMI. Further research can establish if screening for sleep disturbances and education to modify sleep patterns in women with SSD can lessen the risk of GDM.

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**1146**

**SLEEP DISTURBANCE AND NEUROPSYCHOLOGICAL PERFORMANCE FROM LATE PREGNANCY TO EARLY POSTPARTUM**


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**Introduction:** New mothers often complain of impaired neuropsychological functioning, though the mechanism behind such complaints is unclear. Sleep fragmentation, often experienced in the transition from pregnancy to postpartum, has a negative relationship with neuropsychological functioning, though this relationship has rarely been studied in this population. This study had three hypotheses: 1) perinatal women would experience increased sleep fragmentation from late pregnancy to early postpartum 2) perinatal women would perform worse on measures of neuropsychological functioning compared to a control group; 3) increased sleep fragmentation from pregnancy to postpartum would predict poorer neuropsychological performance.

**Methods:** Participants were 52 (20 pregnant, 32 non-pregnant) young adult women. Women wore an actigraph for four to seven nights and completed neuropsychological testing at baseline (last month of pregnancy in perinatal group) and again approximately six weeks later (fourth postpartum week in perinatal group). Actigraphy measured wake after sleep onset (WASO) and fragmentation index (FI). Three tests from the Automated Neuropsychological Assessment Metric (ANAM) were selected to measure processing speed, working memory, and executive functioning.

**Results:** 1) MANOVA results revealed a significant group*time interaction for sleep, indicating pregnant women experienced a significant increase in fragmentation from the first time point to the second compared to controls. 2) Perinatal women had significantly worse neuropsychological performance on all tasks during both time periods, but there was no group*time interaction. 3) Regression analyses showed increased fragmentation from the first time point to the second predicted worse performance on the executive functioning task but not the processing speed or working memory tasks.

**Conclusion:** Perinatal women experienced more sleep fragmentation and neuropsychological impairment from pregnancy to postpartum compared to a control group. An increase in sleep fragmentation from pregnancy to postpartum was predictive of executive functioning performance but did not impact processing speed or working memory. However, results might be limited due to small sample size.

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**1147**

**DEFICIENT SLEEP IN EARLY GESTATION IS ASSOCIATED WITH INCREASES IN INFLAMMATORY CYTOKINES**

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**Introduction:** Pregnant women experience a range of sleep disturbances from sleep maintenance issues to excessive daytime sleepiness. Emerging evidence suggests that there is also a lot of variability in sleep patterns and complaints, especially in early pregnancy. It is well accepted that sleep disturbance can dysregulate normal immune processes subsequently increasing risk for adverse health outcomes. While there is some evidence to support this in pregnancy, the data are limited. We examine whether substantial sleep disturbance (characterized by long sleep onset latencies, longer periods of wakefulness, low sleep efficiency and high sleep fragmentation (variability in these parameters)), during the first 20 weeks of pregnancy contributes to increased systemic inflammation.

**Methods:** Sleep data were collected from daily sleep diaries (D) and actigraphy (A) for three 2-week periods (10–12, 14–16, and 18–20 weeks) in 176 women without any self-reported sleep disorder or psychopathology. Morning plasma samples were collected at 12, 16 and 20 weeks gestation and assayed for IL-6, TNF-α, and IFN-γ. Univariate regression analysis was performed on all independent variables that showed moderate to strong correlation to the dependent cytokine value at a given time.

**Results:** Cross-sectional associations confirm previous studies which suggest that components of poor sleep are associated with higher levels of cytokines. We observed: 1) the average (avg) dSOL (β = 0.014, p = 0.02) and avgASOL (β = 0.018, p = 0.047), as well as the variability in aSOL (β = 0.016, p = 0.043) were associated with higher IL-6 at T1; 2) avgWASO at T2 was associated with IL-6 (β = 0.012, p = 0.04) and avgAWASO at T3 was associated with TNF-α (β = 0.014, p = 0.043); 3) the avgdSE and IL-6 at T1 (β = −0.035, p = 0.02).

**Conclusion:** This preliminary examination suggests (and corroborates) that specific aspects of disturbed sleep are associated with cytokine dysregulation in early pregnancy. This relationship is important given that cytokines are mediators of pathophysiology and that proper balance is necessary for fetal maintenance and success. Additional evalu-
ATION OF THESE ASSOCIATIONS ARE NECESSARY AS PERSISTENT SLEEP DISRUPTION MAY INCREASE RISK OF ADVERSE MATERNAL AND INFANT OUTCOMES.

Support (If Any): NRR00010813

1148
THE INTERACTION BETWEEN POSTPARTUM SLEEP AND BABY-RELATED DISCORD ON MATERNAL MOOD AND STRESS
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Introduction: The relationship of postpartum sleeping difficulties to maternal mood deterioration and stress is well documented. However, how maternal sleep interacts with the maternal-infant relationship to impact mood and stress is not well understood. The current study examined sleep-related moderators of mother-infant interactions, mood, and stress in first-time mothers in the Short-Term Postpartum (3–6 months; ST-PP).

Methods: Seven days of actigraphy and online sleep and social/mood diaries were collected from 60 healthy, non-depressed, first-time mothers (M Age = 29.37, 95% white). Total sleep time (TST), Sleep Onset Latency (SOL), and Wake After Sleep Onset (WASO) were estimated from actigraphy (10 minute SOL, Medium Wake Threshold). Morning sleep diaries asked participants to rate their previous night’s sleep quality (SQ; 1–7 scale, 1 = very poor, 7 = excellent). Evening social/mood diaries recorded the number of positive and negative interpersonal events (PIEs & NIEs) experienced throughout the day with Baby, Spouse, Family, and Friends, and daily levels of Positive and Negative Affect (PA & NA) and Perceived Stress (PS).

Results: Mixed linear modeling methods showed between-person effects of longer SOL predicting higher PS (B = 0.009), longer WASO predicting higher NA (B = 0.050) and higher SQ predicting higher PA (B = 0.049) and lower NA (B = −0.052) [all p’s < 0.05]. Moderating effects of SQ were found: on nights when participants had above average SQ, the effect of greater than average Baby-NIEs on NA was diminished (B = −0.038, SE = 0.019) and on nights when participants had lower than average SQ, the effect of greater than average Baby-NIEs decreased (B = 0.054, SE = 0.018) and PS (B = 0.315, SE = 0.153) was exacerbated (all p’s < 0.05). No between or within-person effects of TST were found.

Conclusion: These results suggest that high quality sleep is an important predictor of next-day mood and stress and may buffer against the negative effects of baby-related discord. Although poor sleep further exacerbated downstream negative mood and stress effects, it is important to note that the quality rather than the quantity of sleep was the main driver of the aforementioned relationships. These findings are consistent with normative ST-PP maternal sleep literature and belie the popular notion that sleep deprivation singularly drives postpartum malaise. These findings highlight the importance of examining maternal sleep quality in postpartum mood and stress management and early maternal-infant attachment processes.

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1149
MAGNITUDE AND CHRONICITY OF CHANGES IN SLEEP QUANTITY AND QUALITY ARE ASSOCIATED WITH POSTNATAL DEPRESSION
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Introduction: Depression is common in postpartum women, and the relationship between altered perinatal sleep and mood is increasingly being elucidated. However, the magnitude and chronicity of sleep changes that affect postnatal mood has received scant attention.

Methods: Women (n = 316 Māori, mean age 28.9 years; n = 635 non-Māori, mean age 32.2 years) completed comprehensive sleep, physical and mental health questionnaires during the third trimester of pregnancy (T2), and at 3–8 weeks (T3) and 11–13 weeks postnatal (T4). Pre-pregnancy sleep variables (T1) were reported retrospectively at T2. Symptoms of postnatal depression (PND) were assessed using the Edinburgh Postnatal Depression Scale (EPDS). Adjusting for demographics factors (maternal age, ethnicity and socioeconomic deprivation) and key risk factors (prenatal depression, stressful life events and relationship dissatisfaction), hierarchical regression was used to test the relationship between sleep variables and depression scores at T4.

Results: On average, sleep duration and quality were highest before pregnancy, lowest in late pregnancy and did not return to non-pregnant levels by 3 months postpartum. There were no differences in depression scores by demographic factors. The prevalence of PND was 7.8% of this sample (EPDS ≥ 13) and scores ranged from 0 to 25. Postnatal sleep duration was independently related to symptoms of PND (β = −0.398, p < 0.001). Postnatal sleep quality was also independently associated with symptoms of PND (β = −0.398, p < 0.001). Higher depression scores were associated with shorter and poorer quality sleep, and were seen among women whose sleep continued to decline after birth, or whose sleep changes across time were large.

Conclusion: Large changes from habitual sleep, or continued declining sleep quantity and quality into the postpartum period, were associated with higher depression scores. It is recognised that aspects of this relationship may be bidirectional. Enquiring about sleep is straightforward and clinically important when screening for and attending to PND.

Support (If Any): Health Research Council of New Zealand Project Grant (HRC 09/233)

1150
SLEEP DISTURBANCE: THE CHALLENGE FOR WOMEN’S MENTAL HEALTH
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Introduction: Sleep disorders (SDs) compromise health and wellbeing, increasing the likelihood of psychological disorders (PDs). Researchers speculate that sleep disturbances may be clinical indicators of PDs, contending that chronic, treatable SDs remain unrecognized when PDs are diagnosed without assessing sleep complaints. These issues are further complicated when sex differences in both SDs and PDs are not recognized. This project was designed to elucidate the complex covariance of sleep with physical and mental health specific to women.

Methods: We constructed a 111-item questionnaire to use in conjunction with nocturnal polysomnography (NP), multiple sleep latency tests (MSLT), the Epworth Sleepiness Scale (ESS), and medical chart reviews of people referred to our institution for evaluation of SDs. We
analysed these data comparing women (N = 482, mean age 49.46) and men (N = 561, mean age 49.55). We then analysed findings from women specific to two age groups (adult n = 370, age 19–65; geriatric n = 89, age 66–90) to provide a woman-specific characterization.

Results: We found patterns of similarities and differences when comparing women with men, such as women having a different pattern of sleep architecture than men, higher incidence of psychiatric disorders and complaints, and using more medications. Women were more likely to present with multiple health problems, and to report greater SD impact of interference with their social and work lives. Analysis of adult and geriatric women’s sleep issues across these age groups revealed differences specific to age group (e.g., adult women reported more sleep complaints, including the deleterious effects of menopause on sleep despite geriatric women having more clinically documented SDs, etc.).

Conclusion: Given the critical role of sleep in maintaining physical and mental health, we believe it is particularly imperative that clinicians recognize sex differences in the ubiquitous role of sleep on well-being to maximize quality of life for all.

1151
INEQUALITY IN THE HOME AS A MODERATOR OF SLEEP QUALITY
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Introduction: Gender differences in sleep quality have previously been identified. As women increasingly strive to achieve balance in different life domains (i.e., motherhood, established career, and personal time), the inequalities and obstacles they face in society may be adversely affecting their sleep. This study examines whether anxiety mediates the gender-sleep association and, further, whether this association differs at varying levels of inequality in the home.

Methods: The current study is an archival analysis of data from the Midlife in the United States-II study, Projects 1 and 4. The selected sample was comprised of 995 community-dwelling adults (43.2% male, 56.8% female) aged 34 to 84 years (M = 54.52, SD = 11.71). Global sleep quality was measured using the Pittsburgh Sleep Quality Index (PSQI). In-home inequality was measured using the MIDUS-II Perceived Inequality in the Home Scale. Anxiety symptoms were measured using the Mood and Symptom Questionnaire (MASQ).

Results: A moderated mediation analysis was performed. Anxiety symptomatology partially mediated the association of gender with global sleep quality (95% CI 0.05, 0.74). Women reported worse global sleep quality compared to men and greater anxiety symptoms appeared to underlie this association. Furthermore, the mediation of the gender and sleep association by anxiety symptoms was conditional on the experience of inequality in the home (t = 2.37, p = 0.02). Women who experienced more inequality in the home reported greater anxiety compared to women with less home inequality.

Conclusion: Inequalities in the home explained a portion of the gender difference in sleep quality. In particular, women exposed to more in-home inequality were more likely to experience anxiety symptoms, which in turn predicted poorer sleep quality. The present findings highlight the need to consider social experiences, and the home environment social structure, when studying sleep outcomes. Additional implications and future research directions will be discussed.

1152
EFFICACY OF TELEPHONE DELIVERED CBT-I VERSUS MENOPAUSE EDUCATION FOR TREATING INSOMNIA SYMPTOMS IN MIDLIFE WOMEN WITH VASOMOTOR SYMPTOMS
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Introduction: All women experience menopause and the majority of these also experience insomnia symptoms. These symptoms are associated with lost work productivity, mood disturbances and reduced quality of life. However, effective evidence-based treatments for insomnia symptoms in postmenopausal women are lacking.

Methods: 106 women were randomized into telephone-delivered cognitive-behavior therapy for insomnia (CBT-I) or menopause education (MEC). Treatments included six sessions over eight weeks. Telephone “coaches” were master’s-prepared women who received a 1-day training workshop and supervision throughout the study. The primary sleep outcome was the Insomnia Severity Index (ISI); the secondary outcome was the Pittsburgh Sleep Quality Index (PSQI). Exploratory outcomes included self-reported sleep and hot flashes from daily diaries, and ratings of depression, anxiety, pain, hot flash bother/severity/interference, and quality of life. Assessments were completed at baseline and post-treatment. Intent-to-treat analyses included all randomized participants who provided follow-up data, regardless of intervention adherence.

Results: Participants had an average age of 54.8 years (SD = 4.2), were predominantly white (91.5%), college educated (77.4%), married (78.3%), and averaged 7.5 hot flashes/day (SD = 4.3). Telephone sessions averaged 22.3 minutes. Ninety-five percent of women (N = 101) completed the intervention; to date, 79% of CBT-I women and 60% of MEC women have returned mailed post-treatment assessment materials. Women receiving CBT-I had significantly greater decreases in ISI and PSQI (p < 0.001) scores; from baseline to 8 weeks, ISI scores decreased 9.9 points in women receiving CBT-I and 4.6 points in women receiving MEC, a mean difference between groups of 5.3 points [7.3, 3.2 95% CI]. Women in CBT-I also showed significantly greater improvements in diary ratings of sleep efficiency (p < 0.001), depression (p = 0.006) and perceived stress (p = 0.04). There were no group differences in other exploratory outcomes.

Conclusion: Results indicate that a brief, telephone-delivered CBT-I intervention can improve sleep in midlife women with vasomotor symptoms compared to menopause education alone.

Support (If Any): The MsFLASH studies were supported by a cooperative agreement issued by the National Institute of Aging (NIA), in collaboration with the Eunice Kennedy Shriver National Institute of Child Health and Development (NICHD), the National Center for Complementary and Alternative Medicine (NCCAM) and the Office of Research and Women’s Health (ORWH), and NIA grants U01AG032659, U01AG032669, U01AG032682, U01AG032699, and U01AG032700.
TREATMENT OF OBSTRUCTIVE SLEEP APNEA IMPROVES MENOPAUSE RATING SCALES AND QUALITY OF LIFE

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Introduction: Menopause is characterized by physiologic and psychosocial changes in a woman’s life. The associated vasomotor symptoms, sexual dysfunction, mood changes and sleep disturbances can have a significant impact on quality of life. The prevalence of Obstructive Sleep Apnea (OSA) increases markedly at menopause for reasons that include weight gain and unclear hormonal mechanisms. The effect of treatment of OSA on the overall emotional and physical quality of life and Menopause rating scale (MRS) score is unknown. We hypothesized that treatment of OSA will improve quality of life and MRS scores in post-menopausal women.

Methods: We prospectively analyzed 23 post-menopausal women diagnosed with OSA presenting to the George Washington-Medical Faculty Associates Center for Sleep Disorders. They were treated with continuous positive airway pressure (CPAP). Pre-treatment SF-36, Hamilton rating scale for depression, insomnia severity index, Epworth sleepiness scale (ESS) and MRS scores were compared with three-month post-treatment scores using the Wilcoxon signed-rank test.

Results: Mean baseline apnea-hypopnea index was 40.1 events per hour [6.5–129.5]. All patients were treated with CPAP and reassessed 3 months after CPAP initiation (78; [29–148 days]). Reassessment revealed statistically significant improvement in insomnia (14.9 to 7.9; p < 0.001), ESS (9.2 to 7.0; p < 0.001) and MRS scores (14.3 to 8.3; p < 0.001), and improvements in the general mental health (73.7 to 82.6; p < 0.001), emotional health, vitality and menopause-related symptoms, as well as insomnia and sleepiness in post-menopausal patients with OSA. These findings suggest that postmenopausal women should be screened for the presence of OSA. Larger, prospective studies with longer follow-up time are needed to validate these findings and to identify how CPAP treatment leads to improvements of these symptoms.

COMPARISON OF PRE- AND POST-MENOPAUSAL WOMEN WITH OBSTRUCTIVE SLEEP APNEA

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Introduction: Obstructive Sleep Apnea (OSA), with recurrent arousals from sleep, oxygen desaturations, daytime sleepiness and fatigue, has an adverse impact on quality of life (QOL). Menopause with vasomotor symptoms, sexual dysfunction, mood changes and sleep disturbances also have a significant impact on QOL. We aimed to compare the QOL in pre and post-menopausal women with OSA.

Methods: We prospectively analyzed 24 pre- and 38 post-menopausal women diagnosed with OSA. Patients were enrolled prior to CPAP treatment. The 8 domains of SF-36 and Epworth Sleepiness scale (ESS) were compared between the two groups using student t-test.

Results: Mean baseline apnea-hypopnea index was significantly lower in pre-menopausal than post-menopausal women (21.3 ± 11.8 vs. 36.7 ± 30.7; vs. p = 0.01). The general health, general mental health and social functioning domains of SF-36 were statistically significantly lower in pre-menopausal women (33.2 ± 20.7 vs. 66.0 ± 22.8; p < 0.001, 60.5 ± 20.5 vs. 74.9 ± 18.3; p = 0.01, 72.4 ± 19.5 vs 84.9 ± 15.7; p = 0.01, respectively). On the other hand the vitality domain of SF-36 was statistically significantly higher in pre-menopausal women (69.7 ± 17.5 vs. 45.7 ± 26.5; p < 0.001). There were no difference in the ESS scores of two groups.

Conclusion: Pre-menopausal women had less severe OSA than post-menopausal women, with similar degrees of sleepiness according to ESS. Quality of life was affected in different domains between pre- and post-menopausal women. The lower general- and mental-health and social functioning scores in pre-menopausal women may suggest the stronger perception of sleep-related symptoms in younger females. The lower vitality score in post-menopausal women may suggest the other comorbidities and age. Treatment of OSA in both pre- and post-menopausal women may improve their quality of life but in different ways.

THE EFFECT OF MENOPAUSE ON OBJECTIVE SLEEP PARAMETERS: DATA FROM AN EPIDEMIOLOGIC STUDY IN SÃO PAULO, BRAZIL

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Introduction: Hormonal changes may influence objective sleep parameters. Our objective was to investigate the association of menopausal status and sleep patterns in a representative sample of women from São Paulo, Brazil.

Methods: A population-based survey with a probabilistic three-stage cluster sample of the city of São Paulo was used to represent the local population according to gender, age (20–80 years) and socioeconomic status. The female participants answered a sleep questionnaire, underwent polysomnographic recording and allowed their hormone levels to be measured. They also completed a gynecological questionnaire for classification of the reproductive aging stages: premenopausal or reproductive, perimenopausal or menstrual transition, and postmenopausal, defined as being after 12 months of amenorrhea. Women were allocated into early (the first 5 years after menopause) and late (after the first 5 years) stages.

Results: A total of 535 women were included in this study: 339 were premenopausal, 53 were early postmenopausal, 118 were late postmenopausal and 25 were using hormone therapy or isoflavone compounds. Our main findings were that women in postmenopause spent more time in N3 sleep, had a higher apnea-hypopnea index (AHI) and lower SaO2, compared with premenopausal women after an analysis adjusted for confounding factors. We found no significant differences between early and late postmenopausal women in the adjusted analysis.

Conclusion: Our results indicate menopause itself exerts a modest, but important influence on objective sleep patterns, independent of age, in particular on AHI and SaO2.

Support (If Any): AFIP, CNPq and FAPESP

PERCEIVED AND ACTIGRAPH DATA ON SLEEP IN OVERWEIGHT AND OBESE RURAL MIDDLE-AGED WOMEN

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Introduction: Short sleep duration has been related to higher body mass index in adults. Women have a higher prevalence of overweight or obesity than men; numerous adverse health effects have been established. Blood pressure and other health factors are influenced by
sleep quality and duration in overweight and obese adults. However, studies have not measured sleep duration in association with health-related factors in healthy, but overweight and obese, middle-aged women. The purpose of this study is to describe sleep and the associations of sleep with other health factors in overweight and obese middle-aged and older rural women.

Methods: This secondary analysis examined data from 221 women at baseline and 6 months from a randomized controlled trial (Women Weigh-In for Wellness). Data analyzed were from self-reported measures of sleep disturbance, pain interference (PROMIS 29 subscales), 7 days of hip actigraphy, and demographic/anthropometric/biomarker variables (i.e., age, body mass index, blood pressure). Statistical analyses included descriptive statistics, ANOVA, Pearson correlations, and regression modeling.

Results: Women self-reported lower, but not significantly different, sleep quality than the general population. Actigraph data for all sleep variables were within normal limits. Women who achieved 5% weight loss in 6 months had improved perceived sleep quality and pain interference, fewer numbers of awakenings (actigraph), decreased waist circumference, and lower systolic and diastolic blood pressures than those who did not achieve 5% weight loss. No association was found between short sleep duration and higher body mass index or weight.

Conclusion: Overweight and obese women who adopt healthy eating and physical activity behaviors may see improvements in self-perceived sleep quality, pain, and blood pressure; even if they achieve a small amount of weight loss. Implications are to promote weight loss and healthy lifestyle behaviors in middle-aged and older overweight or obese rural women.

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SLEEP HYGIENE AND ACTIGRAPHIC SLEEP CHARACTERISTICS IN PREGNANT WOMEN
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Introduction: Sleep disturbance is among the most prevalent symptoms during pregnancy. Sleep alterations during pregnancy are in part attributable to significant physical and hormonal changes as well as possibly to new roles and demands in the family and society, but to our knowledge the extent to which sleep hygiene practices contribute to poor sleep in pregnant women has not been described. The purposes of the study were to compare sleep hygiene and actigraphic sleep in pregnant women with and without self-reported poor sleep quality and to identify predictive factors associated with self-reported sleep quality in pregnant women.

Methods: A total of 197 third-trimester pregnant women completed the Sleep Hygiene Practice Scale (SHPS) and the Pittsburgh Sleep Quality Index (PSQI) as well as the Center for Epidemiologic Studies-Depression Scale (CES-D), and wore an actigraph for seven continuous days. Student t-test was used to compare the SHPS scores and mean as well as variability of actigraphy sleep variables between poor sleepers (i.e., PSQI global score > 5) and good sleepers (i.e., PSQI global score ≤ 5).

Results: Poor sleepers reported significantly poorer sleep hygiene (p < 0.05), with higher SHPS score and higher subscale scores (sleep schedule, arousal-related behavior, sleep environment). Poor sleepers had significantly greater day-to-day variability of sleep onset latency (p < 0.05), total nighttime sleep (p < 0.05), wake after sleep onset (p < 0.05), and fragmentation index (p < 0.01) than good sleepers. Stepwise linear regression analyses showed that working hours per week (p = 0.02), CES-D total scores (p < 0.01), and SHPS arousal-related behavior subscale scores (p < 0.01) emerged as significant predictors of PSQI global sleep quality scores.

Conclusion: Findings of this study support evaluating women’s sleep hygiene practices and mood status during routine prenatal care as one way to improve sleep health during pregnancy.

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1158
DOES MATERNAL OBSTRUCTIVE SLEEP APNEA INCREASE THE RISK OF POOR FETAL OUTCOMES?
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Introduction: Obstructive Sleep Apnea (OSA) is a condition associated with significant pathophysiologic sequelae, including intermittent hypoxemia and hypertension, and the presence of OSA during pregnancy has been associated with untoward consequences to both the mother and fetus. We studied the impact of maternal OSA during pregnancy in a group of infants admitted to the neonatal intensive care unit.

Objective: The objective of our study was to determine if excessive daytime sleepiness (EDS) and/or snoring were associated with unfavorable pregnancy outcomes.

Methods: The study group consisted of postpartum mothers who had delivered an infant that was admitted to the NICU. Mothers were randomly selected and they were asked to complete two standardized questionnaires (Epworth Sleepiness Scale and Snoring Symptoms Inventory) to identify symptoms of OSA, specifically, EDS and snoring. Maternal data regarding age, race, health status, pregnancy, labor and delivery were collected. Infant data regarding gestational age, birth weight, and Apgar scores were obtained.

Results: We enrolled 115 mothers in this study. Their mean age at study entry was 34 ± 5 years. Seventy percent of the participants were Caucasian, 18% Hispanic, 6% African-American, and 5% Asian. Smoking and alcohol use were reported in 2%. Most deliveries were via elective c-section (42%), followed by NSVD (32%), and emergency c-section in 24%. A high correlation between the ESS and the SSI was seen. The relationship of ESS and SSI totals to pregnancy outcomes was analyzed. Elevated scores on the SSI were associated with higher maternal Hb and Hct at delivery, and preeclampsia. Elevated SSI scores correlated with an increased incidence of gestational diabetes, and both preeclampsia and gestational diabetes correlated with the incidence of fetal intrauterine growth restriction (IUGR). We also found that high SSI totals were associated with lower 5 minute Apgar scores in the newborns at birth.

Conclusions: Maternal OSA was seen in a significant percentage of infants in a NICU. Although long term outcome studies are needed, maternal OSA is associated with conditions that suggest poor fetal and neonatal outcomes.
**1159**

**HOW MUCH DID I SLEEP? RELATIONSHIPS AMONG PERCEPTION OF SLEEP, AFFECT, AND SLEEP QUALITY IN FIRST-TIME MOTHERS IN THE SHORT-TERM POSTPARTUM**

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**Introduction:** Misperception of sleep (i.e., discrepancy between objective and subjective measures) has been associated with poor sleep quality (SQ) and related to indices of positive and negative affect (PA & NA). The purpose of this study was to examine the relationships among perceptions of sleep, SQ, PA, and NA in first-time mothers in the Short-Term Postpartum (ST-PP, 3–6 months). It was hypothesized that discrepancies between objective and subjective sleep would be related to lower perceived SQ, lower PA, and greater NA.

**Methods:** Longitudinal data were analyzed from a week-long study investigating sleep during the ST-PP. Data were gathered from 46 first-time mothers (93% Caucasian; M Age = 30.11 years). Participants reported daily PA, NA, and SQ, completed daily sleep diaries (i.e., subjective sleep), and wore actiwatches (i.e., objective sleep) for 7 days. Misperceptions of time in bed (TIB), total sleep time (TST), and sleep onset latency (SOL) were calculated by subtracting sleep diary self-reports from actigraphy calculated sleep estimates.

**Results:** Linear mixed model analyses showed that, on nights when participants had larger discrepancies between subjective and objective TIB, SQ was higher (β = 0.0086, p < 0.01). SQ was lower on days with larger differences between subjective and objective TST (β = −0.0085, p < 0.01). The discrepancy between subjective and objective SOL was smaller on days when participants reported higher PA (β = −0.0085, p < 0.01). Daily NA and PA were not significantly related to discrepancies between objective and subjective TIB or TST.

**Conclusion:** These data indicate that the more accurate participants were in reporting TST and the less accurate they were in reporting TIB, the higher they rated their SQ. Participants with higher PA were also more accurate in reporting SOL. Results highlight the importance of considering sleep misperceptions when evaluating reports of postpartum sleep quality as well as the possible role of affect in these perceptions.

**1160**

**MATERNAL SLEEP: WHAT ARE MOTHERS-TO-BE REPORTING AND DOES TRIMESTER PLAY A ROLE?**

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**Introduction:** Anecdotal evidence suggests that sleep symptoms change as pregnancy progresses such that fatigue is prevalent early on in pregnancy while insomnia symptoms are more prevalent during later pregnancy. Our aim was to examine self-reported sleep disorder symptoms across the pregnancy period. We hypothesized that women would report sleep disordered symptoms regardless of their trimester.

**Methods:** Participants were pregnant females attending a prenatal visit from October 2013 to October 2014 who completed a brief survey in-office asking about sleep disorder symptoms and sleep parameters. 148 (mean age = 26.8 ± 4.5 yrs) provided complete data on age, gestation week, and sleep. 39% were first time mothers-to-be. Women were compared on their sleep disorder breathing symptoms (STOP), daytime sleepiness (Epworth Sleepiness Scale [ESS]), insomnia symp-

toms (Women’s Health Initiative Insomnia Rating Scale [WHIIRS]), and mood symptoms (mood). Women’s sleep parameters the previous night, taken from the 24-Hr Sleep Pattern Inventory, were time in bed (TIB; duration from bedtime to waketime, night wakeings (NWAK; number of wakeings), and sleep quality (SQ; rating of 1 = very poor to 5 = slept like a baby). ANCOVAs examined differences between women in their 2nd and 3rd trimesters for sleep disordered symptoms and sleep parameters with age and 1st pregnancy status as covariates.

**Results:** Overall, 45% reported sleeping longer and 55% reported sleeping better prior to pregnancy. No significant difference was found between 2nd and 3rd trimesters for reported symptoms on the STOP (1.3 vs 1.1, p = 0.12, respectively), ESS (7.9 vs 8.3, p = 0.582), WHIIRS (11.7 vs 12.9, p = 0.252), and mood (3.9 vs 3.7, p = 0.656). Two trends were found: (a) 1st time mothers-to-be reported greater daytime sleepiness (p = 0.089) and older women reported more insomnia symptoms (p = 0.080). In addition, no significant difference was found between groups for TIB (8.5 vs 9, p = 0.113), NWAK (2.6 vs 3.1, p = 0.210), and SQ (2.9 vs 2.9, p = 0.767).

**Conclusion:** These data indicate that sleep is problematic throughout the pregnancy period. The high WHIIRS scores for both groups suggest that pregnancy may be a contributing factor to women being at greater risk of insomnia. While sleep disorders adversely affect health in the general population, very little is known about how these disorders impact maternal and infant postnatal outcomes. We hope to explore this more fully.

**1161**

**UNIQUE PRE-SLEEP MOVEMENT PATTERNS AT 6 WEEKS POSTPARTUM**

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**Introduction:** Maternal sleep disturbance gradually improves across postpartum weeks 2–12 but attentional deficits are persistent. Here, we evaluated whether movement during the 5 minutes preceding sleep onset might serve as a novel way to profile physiologic features of postpartum sleep pressure.

**Methods:** Forty-eight postpartum, primiparous women and 23 group-matched nulliparous controls wore continuous actigraphy. We identified the 5 minutes preceding nocturnal sleep onset during the 6th week postpartum or, for controls, each recording week night. Sleep onset was defined as the first two consecutive minutes (in 15-second epochs) of no recorded activity following reported bedtime. We evaluated the pre-sleep activity profiles of primiparas and controls using repeated-measures ANOVA and post-hoc Helmert contrasts to identify how long before sleep onset their movement decrease occurred. Polynomial analysis was used to identify linear changes in movement amplitude. A p < 0.003 was used to adjust for multiple comparisons.

**Results:** ANOVA for movement change was significant for both nulliparous (p < 0.001, partial eta squared = 0.21) and postpartum (p = 0.002, partial eta squared = 0.07) women. Controls’ movement decreased significantly and remained lower beginning 1.5 minutes before sleep onset (p = 0.001). Primiparas’ movement decreased significantly only 15 seconds before sleep onset (p = 0.001). Linear fit was significant during the 5 min-to-1.5 min interval preceding controls’ movement decrease (p < 0.001, partial eta squared = 0.52). The 5 min-to-15 sec interval preceding primiparas’ decrease was not significant after correction for multiple comparisons (p = 0.011, partial eta squared = 0.13).

**Conclusion:** Postpartum women’s sleep onset occurred within 15 seconds of their movement decrease, and their movement did not linearly decrease approaching sleep onset. In contrast, controls had a linear movement decrease that began 1.5 minutes before their sleep onset. Though these analyses do not determine whether postpartum
women have more rapid sleep onset, they do suggest that postpartum women experience unique, and perhaps more condensed, sleep transition. With further evaluation, this pre-sleep movement profiling may represent a novel way of analyzing and interpreting actigraphy data related to sleep disturbance.

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**1162**

THE EFFECT OF MATERNAL SLEEP DISORDERED BREATHING ON THE INFANT'S NEURODEVELOPMENT

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**Introduction:** Sleep disordered breathing (SDB) is common among pregnant women. No study has thus far investigated the effect of maternal SDB on the infant's neurodevelopment. Our objective was to examine the effect of maternal SDB on sleep and neurodevelopment at the age of one year.

**Methods:** Healthy pregnant women with uncomplicated, full-term pregnancies underwent ambulatory sleep evaluation (Watch-PAT; Itamar Medical) and categorized into SDB (i.e.: AHI > 5) and controls. At 12 months of age the Infant Development Inventory (IDI) and the Brief Infant Sleep Questionnaire (BISQ) were administered.

**Results:** Fifty-one full-term infants were studied (58% males). The mean birthweight percentile was 63.0 ± 23.6. The mean Apgar scores at 1 and 5 minutes were 8.7 ± 1.2 and 9.8 ± 0.5 respectively. Eleven women had SDB (i.e: AHI > 5). No significant differences were found in the gross and fine motor, language and self-help developmental scores between the two groups. The mean social developmental scores were lower in the study group when compared to the controls and almost reached statistical significance (97.8 ± 19.7 vs. 114.9 ± 28.3, p = 0.067). A social developmental score below 100 was detected in 7 (64%) in 1 and 5 minutes were 8.7 ± 1.2 and 9.8 ± 0.5 respectively. Eleven wom

**Conclusion:** Our preliminary results suggest that maternal SDB has no large adverse effect on neuromotor development but may affect social development at the age of one year. In addition, maternal SDB is associated with increased rate of infant's snoring.

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**1163**

DAYTIME NAPPING BEHAVIOR MINIMALLY IMPACTS NOCTURNAL SLEEP IN PREGNANT WOMEN

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**Introduction:** Expectant women experience progressively poorer nocturnal sleep as a result of normal physiological adaptations. Emerging evidence indicates that insufficient quantity and poor sleep quality are associated with increased risk of adverse pregnancy outcomes. One promising approach to counteract the negative effects of disturbed nocturnal sleep is to include daytime naps as part of a healthy sleep hygiene program. The objective of this study was to assess whether daytime naps negatively impact nocturnal sleep in early gestation.

**Methods:** Daily sleep information was collected in three two-week periods, at T1 (10–12), T2 (14–16), and T3 (18–20 weeks gestation) with a daily sleep diary and an actigraph from 161 pregnant women in early gestation (10–20 weeks). The average number of naps, as well as the average length of each nap, were calculated from sleep diaries. Women were categorized first as Non-nappers (0 Naps/2-weeks); Moderate Nappers (1–3 Naps/2-weeks); or Frequent Nappers (≥ 4 Naps/2-weeks); then based on the average nap length as short (< 90 minutes) or long (≥ 90 minutes). Nocturnal sleep parameters included SOL, WASO, SE and TST. SAS procedure MIXED was used for all analyses.

**Results:** Women who took naps had a decrease in diary-assessed nocturnal TST, but not actigraphy-assessed TST. This observation was group and time specific. There were no other group differences. Women who napped ≥ 90 minutes had poorer diary-assessed SE and lower diary-assessed TST compared to those who took shorter naps. Length of nap was not associated with any other sleep measures.

**Conclusion:** Daytime naps slightly impact nocturnal sleep duration, but do not impair sleep continuity or sleep quality among pregnant women. We propose that daytime naps provide a beneficial countermeasure to the sleep disruption commonly reported by pregnant women. This may be clinically beneficial given that sleep continuity and quality are important correlates of adverse pregnancy outcomes.

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**1164**

INSOMNIA TREATMENT PREFERENCES OF PREGNANT WOMEN

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**Introduction:** Sleep tends to worsen as pregnancy progresses, and research suggests by the third trimester between 20–30% of women experience clinically significant insomnia. Patient preferences are increasingly being recognized as an important factor in the delivery of evidence-based interventions. Although several treatments are available for insomnia during pregnancy, little is known about how these interventions are perceived by those who could benefit from them. Our investigation examined perceptions of three insomnia treatments among pregnant women: pharmacotherapy, cognitive behavioral therapy for insomnia (CBT-I), and acupuncture.

**Methods:** The sample (N = 54) was primarily white (63%) and employed (68%). As measured by the Insomnia Severity Index (ISI), 40.7% of the women had significant complaints of insomnia. Participants were asked to read treatment descriptions of each intervention, and to complete questionnaires assessing their perceptions of the treatment. The questionnaires included the Credibility Scale (CS), to assess how credible the participants perceived each treatment to be, and Personal Reactions to the Rationale Scale (PRR), to assess the perceived usefulness of the treatment to the participant.

**Results:** Ratings of treatment credibility differed significantly between all groups (F 2,106 = 22.71, p < 0.001) with CBT-I rated as more credible than acupuncture (t(53) = 2.66, p = 0.01) as well as pharmacotherapy (t(53) = 6.62, p < 0.001), and acupuncture as more credible than pharmacotherapy (t(53) = 3.99, p < 0.001). Similarly, participants' personal reactions also differed (F 2,106 = 38.91, p < 0.001), with CBT-I rated more favorably than acupuncture (t(53) = 3.72, p < 0.001) and pharmacotherapy (t(53) = 8.68, p < 0.001), and acupuncture rated more favorably than pharmacotherapy (t(53) = 5.10, p < 0.001). When forced
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CHARACTERISTICS OF INSOMNIA SEVERITY DURING THE PREGNATAL PERIOD IN A PREGNANCY SLEEP STUDY
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Introduction: Poor sleep is common during pregnancy but little is known about insomnia disorder (ID) during pregnancy. Even less is known about how insomnia that develops during pregnancy compares with preexisting insomnia among pregnant women.

Methods: Data were collected from pregnant women (gestational ages 18–32 weeks) undergoing screening for an ongoing treatment study of cognitive behavioral therapy for perinatal insomnia. Women who met DSM-5 criteria for ID with no coexisting affective or sleep disorders were recruited from local obstetric clinics and the surrounding community. All participants completed the Insomnia Severity Index (ISI) and the Edinburgh Postnatal Depression Scale (EPDS). Trained interviewers assessed ID onset relative to pregnancy.

Results: At present, 39 women (age 31.6 ± 4.2 years) with mean gestational age 26 weeks (SD = 5.2 weeks) have enrolled in this study. Thirty-one percent of participants reported at least one episode of insomnia prior to their current pregnancy (preexisting ID). Seventy-two percent were experiencing their first episode of insomnia, with onset during the current pregnancy (pregnancy-onset ID). Women who endorsed ID onset during their current pregnancy had significantly lower scores on the ISI [t(36) = 2.84, p = 0.007] and EPDS [t(35) = 2.21, p = 0.043], but did not differ statistically in regards to pregnancy week, age, or working status. An ANCOVA assessing differences in insomnia between groups while controlling for depression found no significant difference in the adjusted insomnia severity between the groups [F(1, 34) = 2.20, p = 0.15, partial eta squared = 0.06]; with depression being significant covariate in this model [F(1,34) = 9.40, p = 0.004, partial eta squared = 0.22].

Conclusion: Pregnant women with ID onset during the current pregnancy reported less severe insomnia than those with preexisting ID; however, this difference was no longer significant when controlling for depression symptoms. These results suggest insomnia that develops during pregnancy is a significant sleep disorder that merits clinical attention.

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POOR SLEEP QUALITY AND INFLAMMATION PREDICT PRETERM BIRTH: HEIGHTENED RISK AMONG AFRICAN AMERICANS
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Introduction: Poor sleep promotes inflammation. In turn, inflammation is a causal mechanism in term as well as preterm parturition. In the US, a persistent racial disparity in preterm birth exists, with African Americans showing ~1.5X greater risk. This study examined associations among sleep quality, serum proinflammatory cytokines, and length of gestation in a racially diverse sample of 138 pregnant women.

Methods: Women completed the Pittsburg Sleep Quality Index (PSQI) and other psychosocial and behavioral measures during mid-pregnancy. Serum levels of interleukin (IL)-6, IL-8, IL-1β, and tumor necrosis factor (TNF)-α were determined by high sensitivity assays. Birth outcomes were determined via medical record review.

Results: Among African American women (n = 79), shorter gestation was predicted by poorer overall sleep (rs = −0.35, p = 0.002) as well the following PSQI subscales: subjective sleep quality (rs = −0.34, p = 0.002), sleep latency (rs = −0.27, p = 0.02), and sleep efficiency (rs = −0.27, p = 0.02). African American women with poor sleep quality (PSQI > 5) had 3.12 times the odds of preterm birth compared to those with good sleep quality. In contrast, among European American women (n = 53), gestational length was not significantly predicted by sleep quality (ps > 0.12). Bootstrapping analyses showed that IL-8 significantly mediating the relationship between sleep quality and length of gestation among African Americans. (indirect effect estimate −0.029; 95% CI −0.06, −0.002).

Conclusion: These data provide novel evidence that, as compared to European American women, African Americans exhibit greater inflammation in response to sleep disturbance and these effects correspond with length of gestation. Racial differences in susceptibility to sleep-induced immune dysregulation may contribute to marked racial disparities in preterm birth.

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PREGNANCY AND THE RISK OF UNDIAGNOSED SLEEP APNEA USING THE STOP-BANG QUESTIONNAIRE IN MOTHERS OF NICU BABIES, A PILOT STUDY
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Introduction: Specific Aims: To identify patients whose children have been born and sent to the NICU at UC Davis Medical Center who are at risk for obstructive sleep apnea (OSA) by utilizing the STOP-BANG questionnaire. (STOP-BANG stands for Snoring, Tiredness, Observed apnea, high blood Pressure, BMI, Age, Neck circumference, Gender). We also evaluate the mothers in the newborn nursery with the STOP-BANG questionnaire as our control group. This is a prospective study. Hypothesis: A large population of mothers who delivered neonates that were admitted to the NICU will have a higher risk of sleep apnea based on the STOP-BANG questionnaire.

Methods: A prospective study evaluating mothers in the NICU and newborn nursery with the STOP-BANG questionnaire to evaluate for the risk of OSA.

Results: The base study prior to this was at UCSF Fresno that showed 70% of the patients that were admitted to the hospital pregnant and hypertensive surveyed had either snoring and/or witnessed apneas. The Epworth Sleepiness Scale was between 1–22. More specifically, 10%
Introduction: The Veterans Health Administration (VA) is one of the largest integrated healthcare systems in the United States, with over 150 medical centers that serve nearly 9 million veterans. Given that the VA is comprised of nearly 90% men, studies of women veterans are often neglected. We had the opportunity to examine the diagnostic and treatment adherence rates for women veterans referred for suspicion of sleep apnea.

Methods: Retrospective chart review from 2012 to 2013. A total 32 women veterans were identified as being suspected of having OSA at the VA San Diego Healthcare System (VASDHS) during this one-year time period.

Results: Of the 32 women veterans who were referred to the VASDHS Pulmonary Sleep Program, 28 performed home sleep testing. Of the 28, 24 (85.7%) were diagnosed with OSA (4 negative for OSA; 1 diagnosed with insomnia). Mean age was 51.3 ± 9.1 and mean body mass index 31.6 ± 5.7 kg/m². Mean baseline AHI was 15.7 ± 9.0 and Epworth was 13.2 ± 5.2. OSA patients were prescribed APAP treatment. The average APAP adherence was 5.1 ± 2.4 hrs/day and the average APAP residual AHI was 2.5 ± 2.0 events/hr. Over the course of therapy, there was no change in weight (1.0 lb change; p = 0.796) or blood pressure (SBP change = 3.85 mmHg; p = 0.219; DBP change = −0.85 mmHg; p = 722). However, there was a significant decrease in Epworth (mean change = −3.7; p = 0.05).

Conclusion: In those tested for OSA, 85% of women veterans were diagnosed with OSA. APAP adherence and efficacy were high in this group of women veterans. While APAP did not appear to be associated with weight loss or blood pressure reduction, it was associated with a decrease in sleepiness scores.

Support (If Any): Veterans Affairs

WAIST CIRCUMFERENCE AND POSTMENOPAUSAL STAGES AS THE MAIN ASSOCIATED FACTORS FOR SLEEP APNEA IN WOMEN: A CROSS-SECTIONAL POPULATION-BASED STUDY

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Introduction: Obstructive sleep apnea syndrome (OSAS) is a common sleep disorder characterized by repetitive, partial, or complete collapse of the upper airway. Although OSAS has been thought of as a disease that mainly affects men, a recent study observed that OSAS affects 26.1% of women in the general population. The current study aimed to investigate the stages of reproductive aging and others anthropometric variables as associated factors of OSAS in women from a representative sample from Sao Paulo, Brazil.

Methods: 407 women underwent clinical evaluation, polysomnography and biochemical analysis. The stages of reproductive aging were defined as premenopause (PRM), early postmenopause (EPM) and late postmenopause (LPM).

Results: OSAS was more frequent in the postmenopausal groups, with 68.4% of women affected by severe OSAS being in the LPM group. After adjustment for potential confounding factors, the associated factors of OSAS, regardless of its severity, were waist circumference, modified Mallampati score IV, and both postmenopausal stages. In relation to moderate-severe OSAS and severe OSAS, we have found waist circumference, and both postmenopausal stages to be the main factors. We carried out a ROC curve analysis which demonstrated that the cut-off value for waist circumference was 87.5 cm, with a maximum of 75.7% accuracy for classification of women as OSAS or non-OSAS.

Conclusion: OSAS is a prevalent condition in postmenopausal women, especially in the LPM stage. This study highlights the association between waist circumference, the EPM and LPM and the severity of OSAS. Our findings suggest that the postmenopausal stages may potentially exacerbate the presence of sleep disturbance and that reducing waist circumference may be an important strategy for the management of OSAS in women.

Support (If Any): Associação Fundo de Incentivo à Pesquisa, Coordenação de Aperfeiçoamento de Pessoal de Nível Superior, Conselho Nacional de Desenvolvimento Científico e Tecnológico and São Paulo Research Foundation (grant #13/14945-7)

SLEEP QUALITY OF MOTHER-CAREGIVERS OF DUCHENNE MUSCULAR DYSTROPHY PATIENTS LINKED TO LENGTH OF TIME OF USE OF NONINVASIVE VENTILATION

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Introduction: Sleep disturbances is a common problem for caregivers. Beyond 20 years of age, Duchenne muscular dystrophy (DMD) patients use noninvasive ventilation to maintain quality of life and improve survival. The aim of this study was to evaluate the sleep quality of caregiver-mothers of sons with DMD, and the factors that affect their sleep quality.

Methods: We evaluated 32 caregiver-mothers of sons with DMD and 32 mothers of sons without any neuromuscular or chronic disease (CTRL group). The evaluation of quality of sleep was made using the Pittsburgh questionnaire.

Results: Caregiver-mothers had significantly increased scores in the Pittsburgh questionnaire, suggesting a poor sleep quality. More specifically, longer sleep latency, reduced sleep efficiency and worse sleep quality were found. The sleep quality of the caregiver-mother was associated to the length of time of noninvasive ventilation use by their son.

Conclusion: Our results suggest that caregiver-mothers of sons with DMD have poor quality of sleep, mediated in part by the time of use of noninvasive ventilation of their son.

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SLEEP DISTURBANCE, DIABETES AND CARDIOVASCULAR DISEASE IN POSTMENOPAUSAL VETERAN AND NON-VETERAN WOMEN

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Introduction: While impaired sleep may be a risk factor for increased health problems, the association between sleep disturbance and clinical health outcomes has received relatively little attention in post-menopausal women veterans. The current study examined the impact of Veteran status, sleep disturbance, and cardio-metabolic outcomes among a large sample of women Veterans participating in the Women’s Health Initiative (WHI).

Methods: The prevalence of sleep disturbance (i.e., extreme sleep duration [SLD], medication/alcohol use for sleep, insomnia [WHI Insomnia Rating Scale ≥ 9], risk for sleep-disordered breathing [SDB; adapted Berlin Questionnaire, i.e., snoring history, sleepiness, and history of hypertension or obesity], and risk for co-morbid insomnia+SDB) was assessed at study baseline for 145,061 postmenopausal women (3,707 Veterans, 141,354 non-Veterans) using logistic or multinomial logistic regression. Cox proportional hazards models were employed to evaluate whether baseline sleep disturbance was differentially associated with cardio-metabolic morbidity (cardiovascular disease [CVD] and type 2 diabetes) among Veteran and non-Veteran participants. All models adjusted for demographics, current smoking, physical activity, BMI, vasomotor symptoms, baseline napping and study arm assignment.

Results: In fully-adjusted models, Veteran women had increased risk for insomnia+SDB relative to non-Veteran women at study baseline, RR = 1.13 (95% CI 1.03–1.25). Rates for insomnia and SDB were similar across Veteran and non-Veteran groups. In the full sample, various measures of sleep disturbance predicted cardiovascular disease (CVD): very short SLD (≤ 5 hrs; HR = 1.15; 95% CI 1.09–1.22), medication/alcohol use for sleep (HR = 1.18; 95% CI 1.14–1.22), insomnia (HR = 1.08; 95% CI 1.04–1.11), SDB risk (HR = 1.28; 95% CI 1.24–1.33) and insomnia+SDB risk (HR = 1.26; 95% CI 1.20–1.33). Similarly, individual measures of sleep disturbance predicted type-2 diabetes: very short SLD (HR = 1.12; 95% CI 1.06–1.19), long SLD (≥ 9 hrs; HR = 1.12; 95% CI 1.04–1.22), SDB risk (HR = 1.37; 95% CI 1.32–1.42) and insomnia+SDB risk (HR = 1.30; 95% CI 1.24–1.37).

Conclusion: Sleep disturbance is a significant predictor of cardio-metabolic morbidity among post-menopausal women. Veteran status did not moderate this association.

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THE EFFECT OF OBSTRUCTIVE SLEEP APNEA ON THE FEMALE SEXUAL FUNCTION INDEX SCORE

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Introduction: The relationship between obstructive sleep apnea (OSA), erectile dysfunction and loss of libido in men is well established and CPAP treatment is known to improve these symptoms. In contrast, the prevalence and effect of OSA on female sexual function is less well understood. The correlation between the apneahypopnea index (AHI) and sexual dysfunction (SDF) is also not clear, nor whether female SDF improves following OSA treatment.

Methods: Prospective observational single-centre study. Women 21 years or older with a regular sexual partner, with OSA, were enrolled prior to starting CPAP treatment. Baseline sexual function was determined by a self administered gender-specific, validated sexual function questionnaire; Female Sexual Function Index (FSFI). The FSFI consists of 6 domains, and a total FSFI score of ≤ 26 is indicative of sexual dysfunction. Patients were classified as having either mild (AHI 5–15), moderate (AHI 15–30) or severe sleep apnea (AHI > 30), and their sexual function scores were compared with ANOVA one-way variance for independent samples. Baseline FSFI scores were compared with three-month post-treatment scores using the Wilcoxon signed-rank test.

Results: Twenty-four women were enrolled between July 2013 and November 2014. Mean age was 44 ± 10 years, BMI 33 ± 8 kg/m² and AHI 21 ± 12 events per hour. Baseline total FSFI score was 16 [7–22], with 79% of women classified as having SDF. There was no difference in total baseline FSFI scores (mild OSA- 18.9; moderate OSA- 15.6; severe OSA-12.1; P = 0.57) according to AHI. Six women completed a follow-up survey (mean follow-up time 99 [70–121 days]). No significant change in FSFI scores was noted following treatment with CPAP (signed Rank S = 1.5, p = 0.81).

Conclusion: Women with OSA have a high risk of suffering from SDF, and should be screened. In this small cohort, treatment with CPAP did not improve SDF.

DETERMINANTS OF SLEEP QUALITY AMONG PREGNANT WOMEN FROM THE PEOPLE’S REPUBLIC OF CHINA

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Introduction: Sleep problems are a common health issue in women with pregnancy. Various factors such as depression, perceived stress, body weight, gestational age, contribute to the impaired sleep quality. Few studies are currently available regarding the determinants of sleep
quality among pregnant women in China. The aim of the present study was to (a) calculate the prevalence of sleep disorder during pregnancy, (b) examine the difference in sleep quality among three trimesters, and (c) identify determinants of sleep quality of pregnant women.

Methods: This study was designed as a cross-sectional survey. 500 pregnant women were recruited at the outpatient department of obstetrics and gynecology of two teaching hospitals in central China. The face-to-face interview used to collect data, included information of sample characteristics, sleep quality (Pittsburgh Sleep Quality Index, PSQI), prenatal depression (the Edinburgh Postnatal Depression Scale, EPDS), perceived stress (Perceived Stress Scale, PSS) and perceived social support (Multidimensional scale of perceived social support, MSPSS).

Results: A total of 454 pregnant women participated in the study between December 2013 and July 2014. 87% pregnant women experience sleep disorder (PSQI score > 5). Poorer global sleep quality, subjective sleep quality, lower sleep efficiency and sleep disturbances were most prevalent during third trimester. The significant contributors of sleep quality for pregnant women were prenatal depression, age and gestational age.

Conclusion: Sleep disorder is very common in pregnant women from China. Depressive symptoms, increased age and gestational age are determinants of sleep quality. Health care professionals should identify determinants to conduct preventive intervention.

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MATERNAL SLEEP DIFFERS BY TYPE OF INFANT FEEDING AND SLEEPING ARRANGEMENT
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Introduction: Bed-sharing is a common cultural practice for new mothers and infants. Done safely, bed-sharing allows ease in infant feeding, enhances the likelihood for mothers to return to sleep quickly, and thus increases sleep consolidation. We previously reported more total sleep time for breastfeeding mothers, but the influence of sleeping arrangement has not been evaluated. The purpose of this analysis was to compare maternal nocturnal sleep duration and daytime sleepiness by type of infant feeding and sleeping arrangement.

Methods: Data were collected in primiparous mothers at 1 month postpartum. A wrist actigraph was worn for 72 hours to estimate sleep time. Mothers logged infant sleep location, and infant feeding type and times. Mothers (n = 42) in the control arm of a larger randomized clinical sleep intervention trial and who had complete data were included in this analysis.

Results: Mothers were ethnically diverse, 18–47 years old, with infants 27 ± 5.3 days old. Most (64%, n = 27) were exclusively breastfeeding during the three nights of monitoring and about half (48%, n = 20) were bed-sharing. Bed-sharing rates were slightly higher among infants given formula at night (60%, n = 9 of 15) compared to infants breastfed at night (41%, n = 11), but the difference was not statistically significant (p = 0.23). A two-way analysis of variance of maternal sleep times indicated a main effect for breastfeeding (p = 0.04) and an interaction between breastfeeding and bed-sharing (p = 0.03), but no main effect for bed-sharing (p = 0.67). Feeding type made no difference in the sleep of mothers who did not bed-share (355 ± 57 vs 357 ± 61 minutes), but among bed-sharing mothers, breastfeeding was associated with significantly longer maternal sleep times (408 ± 77) than formula-feeding (321 ± 38 minutes).

Conclusion: Exclusive breastfeeding at 1 month was associated with longer maternal sleep time among bed-sharing dyads, but not among mothers who slept separately from their infants.

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DROSPIRENONE AND ETHINYL ESTRADIOL COMBINED ORAL CONTRACEPTIVE INCREASES CORTISOL AND AFFECTS SLEEP QUALITY IN ADULT FEMALE PATIENTS WITH ACNE
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Introduction: Several studies have reported an increase in adult female acne prevalence. This subtype of acne presents peculiar characteristics, such as the types and location of lesions, and refractoriness to some treatments, compared to adolescent acne. It is very common to treat adult female acne with combined oral contraceptives and topical acid, as azelaic acid. However, combined oral contraceptives has demonstrated to be capable to increase cortisol and adrenocorticotropic hormone concentrations which are hormones tightly related with sleep. About azelaic acid there are no studies conducted to evaluate its influence on sleep quality or cortisol concentrations. Herein we evaluated the sleep quality and stress hormones on adult female acne patients before and after treatment with 2 different approaches.

Methods: Sleep quality and stress hormones were assessed in a randomized comparative single blind trial of combined oral contraceptive ethinyl estradiol plus drosiprenone versus azelaic acid topical gel, at baseline and after 6 months of treatment. Before and after treatment the patients completed the Pittsburgh Sleep Quality Index, and had blood collected to measure cortisol and adrenocorticotropic hormone levels.

Results: The group treated with the combined oral contraceptive presented higher concentrations of cortisol and worse sleep quality after 6 months of treatment compared with baseline and with the group treated with azelaic acid. No significant differences were observed in the group treated with azelaic acid.

Conclusion: These data suggest that, although combined oral contraceptive ethinylestradiol plus drosiprenone are a very effective treatment for adult female acne, they can also increase cortisol concentrations and even impair sleep, which is an important factor related with welfare and quality of life.

Support (If Any): Associação Fundo de Incentivo à Pesquisa (AFIP), Fundação de Amparo à Pesquisa do Estado de São Paulo (FAPESP, #2014/00923-4 to RGRA; #2014/15259-2 to CH) and Conselho Nacional de Desenvolvimento Científico e Tecnológico (CNPq). Bayer® (Germany) provided the combined oral contraceptive (20 µg of ethinyl estradiol and 3 mg of drosiprenone) and 15% acid azelaic gel.
A COMPARISON OF ACTIGRAPHY SLEEP ONSET AND SLEEP OFFSET SETTINGS ACROSS WAKE THRESHOLD SETTINGS
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Introduction: Refinement of actigraphy analysis may improve measurement accuracy of wake parameters, i.e., sleep onset latency (SOL), wake after sleep onset (WASO), and terminal wakefulness (TWAK). Previous data suggests the low wake threshold setting affects WASO, but not SOL or TWAK. Sleep onset and offset software settings can be adjusted to better detect sleep/wake transitions, which directly affect SOL and TWAK measurement. We hypothesized that as wake threshold increased, SOL, WASO, and TWAK would decrease, and that as onset and offset epochs increased, SOL and TWAK would increase. Because these settings interact, we hypothesized wake values would overlap across wake thresholds.

Methods: Participants (N = 153) were 18–29 years old (20.24 ± 2.53) and 58.8% female. Actigraphy data was analyzed in 30-second epochs with low, medium, and high wake thresholds (20, 40, and 60 activity counts, respectively) and with sleep onset and offset settings of 10, 20, 30, 40, 50, and 60 consecutive epochs using Actiware 6.0. Means were calculated across one week for each participant. We compared SOL, WASO, and TWAK for 18 settings using repeated measures analysis of variance (rANOVA).

Results: Modifying settings for wake threshold and sleep onset/offset altered measurements of each wake parameter. Interactions between settings were also statistically significant. Increased wake threshold consistently decreased SOL, WASO, and TWAK [e.g., SOL F(2,304) = 180.64, p < 0.001]. As epochs increased, SOL and TWAK increased [e.g., SOL F(5,760) = 170.39, p < 0.001]. Wake values overlapped across wake thresholds.

Conclusion: This suggests that actigraphy settings (i.e., wake threshold and sleep onset and offset criteria) significantly affect SOL, WASO, and TWAK values. Settings can be adjusted to increase actigraphy specificity. Further research will compare actigraphy to sleep diary and polysomnography data so that standard settings can be recommended.

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ASSSESSMENT OF NOCTURNAL BLOOD PRESSURE DIPPING BY ELECTROCARDIOGRAM AND PULSE WAVE ANALYSIS
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Introduction: Sleep fragmentation or short sleep duration is a risk factor for hypertension associated with cardiovascular disease. In patients with normal clinic blood pressure (BP), 24-hour ambulatory blood pressure monitoring (ABPM) is helpful to detect abnormal circadian BP patterns such as morning BP surge and non-dipper change. In particular, morning BP surge is associated with an increased risk of target-organ damage in hypertension and higher cardiovascular morbidity and mortality. However, 24-hour ABPM often causes sleep disturbance due to cuff inflations. We investigated the usefulness of a new cuffless BP estimation method.

Methods: Of the 18 adults (mean age, 23.2 ± 4.2 years) examined, none had a history or symptoms of cardiac, vascular, pulmonary, metabolic, and neurological disease, or a history of medication use before or during the study. We measured 24-hour BP during sleep based on electrocardiogram and pulse wave analysis, and 24-hour ABPM using a FB-270 monitor (Fukuda denshi, Tokyo, Japan). BP was continuously measured for over 30 minutes. A nocturnal BP fall was calculated by (daytime BP – nighttime BP) / daytime BP × 100. Subjects with a < 10% nocturnal systolic BP fall was defined as non-dippers. We evaluated sleep-wake rhythm measures, such as sleep efficiency and sleep fragmentation using actigraphy. Daytime sleepiness was quantified using the Epworth sleepiness scale.

Results: Bland and Altman plots of systolic and diastolic BP by cuffless monitoring and an autonomic sphygmomanometer revealed good concordance. Non-dipper BP patterns were observed in four subjects (22.2%). Mean 24-hour, daytime, and nighttime systolic and diastolic BP measured by the cuffless method were correlated with those of 24-hour ABPM. Sleep fragmentation and daytime sleepiness were associated with nocturnal BP elevation.

Conclusion: Cuffless BP monitoring appears to demonstrate relatively good performance, and together with actigraphy, could provide important information on nocturnal BP elevation leading to cardiovascular events.

ACCURACY OF A SMARTPHONE APPLICATION IN ESTIMATING SLEEP
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Introduction: Several commercial devices purport to measure sleep via wristband or smartphone application (app). These devices use an accelerometer to measure motion, similar to the methods of actigraphy, thereby estimating sleep. These may offer a simple, inexpensive means to measure sleep in the home. We compared one such app simultaneously with overnight polysomnography (PSG) to assess the accuracy of the technique.

Methods: Eighteen patients ranging in age from 2–17 years were recruited from the sleep laboratory at the Children’s Hospital of Philadelphia. All had been referred for a clinical suspicion of sleep disorders, usually obstructive sleep apnea. An iPhone 4S running Sleep Cycle App (Maciek Drejak Labs, Sweden) was placed on the bed, near the patient’s head, before “lights out.” The PSGs were scored by an experienced technologist and reviewed by a Board-certified sleep physician. Data from the app were downloaded, reviewed, and calculated by the investigators who had no knowledge of the PSG results. The study was approved by the IRB. All parents gave informed consent. Statistical analysis included bivariate and stepwise regression.

Results: There was a significant relationship between the app and PSG measurements of Total Sleep Time (TST) (r² = 0.50, p < 0.01) but none for sleep latency, sleep efficiency, or awakening index. The app overestimated TST and sleep efficiency while underestimating sleep latency and awakening index. This is likely due to difficulties differentiating quiet wakefulness from sleep. Twelve of the subjects had an Apnea-Hypopnea Index (AHI) ≥ 5; 5 had an AHI ≥ 5. The AHI did not affect the accuracy of the app’s estimates of TST or sleep efficiency.

Conclusions: Smartphone apps and other commercial devices claiming to estimate sleep must be validated before use in clinical or research settings. Difficulties differentiating quiet wakefulness from sleep may lead to overestimating sleep efficiency and TST, while underestimating sleep latency and awakenings.
B. Clinical Sleep Science

1179
FRACTAL ANALYSIS: A NEW TOOL FOR CHARACTERIZING THE SLEEP EEG IN CHRONIC INSOMNIA
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Introduction: Previous studies have used traditional, visually-scored sleep parameters and power spectral analysis to identify insomnia-specific characteristics in the sleep EEG, usually with low discriminating power. Non-stationary biologic signals such as the EEG are also characterized by long-range (fractal) correlations that require additional analysis techniques. Fractal dimension represents the relative self-similarity or ‘complexity’ of a given signal. We compared fractal dimension, EEG power from spectral analysis, and traditional PSG measures in individuals with chronic insomnia (CI) and good sleepers (GS), with the long-term goal of identifying a better explanatory model for insomnia.

Methods: Participants included 20 individuals with CI (mean age 67, 55% female) and 20 GS (mean age 65, 100% female). One non-adaptation night of PSG, conducted at participants’ habitual sleep-wake times, was analyzed. PSG data were visually-scored and analyzed with EEG power spectral analysis using standard methods. We used Detrended Fluctuation Analysis (DFA) to estimate the fractal dimension of EEG sleep data for each NREM and REM period. Mixed models and t-tests were used to test group differences.

Results: Fractal dimension showed significant Group (p = 0.03) and Group*Period (p = 0.05) effects for NREM, and a significant Group effect for REM (p = 0.01). Post-hoc analyses showed higher fractal dimension, i.e., greater signal complexity, among CI than GS in NREM1, NREM2, and REM1 (p < 0.05 for each). Spectral analysis showed significant group differences only for beta in NREM1 (p = 0.01), and for theta and alpha in NREM4 (p = 0.05, p = 0.04). PSG measures showed group differences in WASO (p < 0.04), but not in sleep latency, sleep time, or sleep efficiency.

Conclusion: Fractal analysis of the sleep EEG shows promise as a new method for detecting electrophysiologic differences between CI and GS. Group differences in fractal dimension were evident when few visually-scored or EEG power differences were identified. Our findings need to be replicated in larger samples and with more rigorous control over the selection of EEG samples.

Support (If Any): AG020677, MH024652

1180
RECEIVER OPERATING CHARACTERISTICS OF IMPULSE OSCILLOMETERS PARAMETERS IN PREDICTING OBSTRUCTIVE SLEEP APNEA IN OBESE SNORERS
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Introduction: To examine the receiver operating characteristics (ROC) of impulse oscillometry (IOS) parameters in the prediction of obstructive sleep apnoea syndrome (OSAS) in obese snoring patients.

Methods: 230 obese patients with normal spirometric values were included in the cross-sectional study. Full laboratory polysomnography was performed and IOS measurements was applied in the sitting and supine positions to obtain the parameters of respiratory impedance (Zrs), resistance (Rrs) and reactance (Xrs), and the parameter of respiratory resistance at zero-frequency (Rr0) was also extrapolated by linear regression analysis of Rrs versus low-oscillatory-frequencies and then its inverse, respiratory conductance (Grs0) was calculated.

Results: The parameter of Rr0, Zrs, Rrs at 5 oscillatory-frequency (Hz) and Grs0, reciprocal of Zrs5 (Gz), Xrs at 5 Hz in both positions was found a significantly positive and negative correlated with the severity of OSAS as defined by apnea-hypopnoea index (AHI). This association was globally stronger in the supine position, the correlation coefficient between Rr0, Zrs5, Rrs5, Grs0, Gz, Xrs5 and AHI were 0.424, 0.393, 0.377 and −0.424, −0.393, −0.514, respectively (all p < 0.001). The ROC curves for those parameters showed that the Xrs5 (reactance) in supine position was the best of which to predicting OSAS, with a sensitivity 73% and specificity 84% by the optimally cut-off points of −0.21 (kPa.s.L−1). The other parameters also showed an acceptable discriminating power, consequently logistic-regression model was used based on respiratory function abnormalities to further confirmed our findings, which also indicated the reactance combined with sex and lung volume yielding a good specificity of 83.3% with a sensitivity of 76.8% than other parameters yielding for the diagnosis of OSAS.

Conclusion: Respiratory resistance and reactance measured by IOS are abnormalities in obese OSAS patients, especially when they lie down as those parameters are moderately-closely correlated with the severity of OSAS, and had moderate sensitivity and specificity. IOS might be useful as a screening tool for detecting OSAS in a clinic based population.

XIII. Instrumentation and Methodology

1181
USE OF CHEST WALL EMG TO DETECT RESPIRATORY EFFORT DURING POLYSOMNOGRAPHY
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Introduction: Detection of respiratory effort during polysomnography (PSG) is usually based on signals from respiratory inductance plethysmography (RIP) belts around the chest and abdomen. In some patients, deflections in the RIP signals during obstructive apneas are small and may result in misclassification of an apnea as central. Monitoring inspiratory EMG activity from chest wall muscles may provide a useful alternative method to detect respiratory effort.

Methods: Chest wall EMG (CW-EMG) was recorded using a bipolar AC amplifier with two electrodes placed 2 cm apart in the 8th intercostal space at the right mid-axillary line. Respiratory effort was simultaneously monitored with uncalibrated RIP thorax and abdominal bands. Apneas (N = 76) were randomly chosen from 15 patients with both central and obstructive events in whom RIP signals and CW-EMG signals were recorded. A physician experienced in scoring respiratory events (blind to event selection) classified each apnea as obstructive, mixed or central based on tracings showing EITHER the RIP signals or CW-EMG signal (blind to the other signal). The order of events was adjusted so that the appearance of a given event using the two methods could not be compared. The method agreement was analyzed using the kappa statistic.

Results: The classification of apneas using RIP versus CW-EMG showed good agreement: obstructive apnea (26 vs 27), mixed apnea (18 vs 20) and central apnea (32 vs 29). The kappa was 0.82 consistent with very good agreement. Analysis of events with disagreement revealed that the CW-EMG signal showed inspiratory bursts not associated with an identifiable deflection in the RIP signals.

Conclusion: Classification of apnea based on CW-EMG showed very good agreement with classification based on respiratory effort by RIP.
Monitoring CW-EMG may be more sensitive for detection of respiratory effort than RIP effort bands in some individuals.

1182 USING BUSINESS INTELLIGENCE TOOLS AND DATA VISUALIZATIONS TO FACILITATE MULTICENTER SLEEP RESEARCH
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Introduction: Significant informatics advancements have prompted a transition from paper-and-pencil to electronic data collection for healthcare/clinical research. The Comparative Outcomes Management with Electronic Data Technology (COMET) Study was designed to create a platform that facilitates electronic data management for multicenter clinical trials, enabling the generation of meaningful, well-defined outcomes structured for use with business intelligence (BI) tools.

Methods: The COMET Sleep Research Platform was utilized to manage multicenter sleep research data (Stanford, University of Pennsylvania, University of Wisconsin-Madison, Harvard) for a randomized trial comparing obstructive sleep apnea treatments: positive airway pressure (PAP) vs. oral appliance (OA) therapy in 196 randomized participants (98 PAP/98 OA). Between December 2011–June 2014, three BI tools were tested: Microsoft SQL Server, SharePoint, and Excel Add-ins.

Results: SQL Server was selected as the data pipeline subsystem based on its performance, reliability, capacity for growth, and mature BI features. During data collection, databases stored webform/device data, enabling interactive data visualization. The current size of the databases ~20 GB and the main log table has 82,235 transactions (far below system capacity). Performance monitoring revealed high availability and reliability with no downtime. SharePoint was selected as the collaboration/presentation subsystem to promote team communications and to enable secure document management and access to live reports. A total of 16 dashboards were created with permissioned access to a set of 1,422 study management documents, 39 report documents, and 469 project management documents (content accessed > 100,000 times). Use of Excel (Add-ins for 2010) is the tool-of-choice for an insightful, user-driven BI experience incorporating Power Pivot/Power View demonstrations/explorations for presentations, study monitoring, and quality control procedures. A total of 9 visualizations were accessible from the study portal.

Conclusion: The use of BI tools in multicenter sleep research can help initiate discussions, enhance collaboration, support data discovery, promote hypothesis development, and facilitate a learning healthcare system.

Support (If Any): COMET is funded by grant 1-RO1-HS-019738 from the Agency for Healthcare Research and Quality (AHRQ).

1183 UNTRAINED USER ERROR RATES SETTING UP HOME SLEEP TESTING DEVICES
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Introduction: Home sleep testing (HST) frequently determines the presence and severity of sleep disordered breathing. Patients undergoing HST must set-up and operate HST devices and receive varying levels of training to do so. Operator errors can result in lost data and negatively impact cost savings of HST. The aim of this study was to evaluate the ability of untrained, naïve participants to correctly set-up four HST devices.

Methods: Adults without prior exposure to sleep diagnostic procedures were recruited. Each participant set up two of the four HST devices. All participants set-up one HST device (Alice NightOne, Philips Respironics) which was randomly paired with one of three other HST devices. An observer explained the purpose of the evaluation. The participant was instructed to set-up the HST device following instructions packaged with each device. No further instructions were provided. Set-up time was recorded for each device. After the participant completed efforts to set up the device, the observer determined if they were successful. Participants then completed visual analog scales (VAS) rating characteristics of each device and the set-up process.

Results: Eighty-five participants (42 male) were recruited (Mean age 45.8 ± 12.4). The time to set-up Alice NightOne averaged 4.0 ± 2.7 minutes, significantly less than all of the others (8.9 ± 4.2, p < 0.001). Alice NightOne had significantly fewer set-up errors (p < 0.001). The failure rates in powering on the devices was: Apnea Link Plus (50%), Apnea Link Air (42.9%), Medibyte Jr (90%), T3 (33.3%), Alice NightOne (0%). Based on VAS scores, Alice NightOne was rated as easier to setup (p < 0.001), easier to use (p < 0.001), and had more helpful instructions (p = 0.02) than the other devices.

Conclusion: Naïve patients face challenges setting-up a HST device. Carefully designed product features, such as the Alice NightOne’s automatic powering on, can reduce the likelihood of set-up errors and increase chances of a successful recording.

Support (If Any): This study was funded by Philips Respironics

1184 COMPARISON OF SCORING OF RESPIRATORY EVENTS FOR HOME SLEEP STUDIES: MANUAL SCORING BY INTERNATIONAL SLEEP TECHNOLOGISTS VERSUS AUTOMATED SYSTEMS
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Introduction: Home sleep tests (HSTs) are now commonly used worldwide to confirm the presence of obstructive sleep apnea. Automated scoring offers a way to standardize the scoring of HSTs. We sought to determine the agreement between manual scoring of HSTs by international sleep technologists and automated scoring systems.
B. Clinical Sleep Science

Methods: 15 HSTs that included recordings of nasal pressure, chest and abdominal movements, oxyhemoglobin saturation, and pulse rate were saved in European Data Format. The studies were scored by nine experienced technologists from the sleep centers of the Sleep Apnea Genetics International Consortium (SAGIC) using the locally available software. Each epoch was manually scored for respiratory events using a ≥4% oxyhemoglobin desaturation to define a hypopnea. Each study was scored separately by human scorers using either the nasal pressure (NP) or flow derived from the NP signal (Flow). The same procedure was followed using two automated scoring systems: Remlogic (RLG) and Noxturnal (NOX). The primary outcome for analysis was the intraclass correlation coefficient (ICC) of the apnea-hypopnea index derived from the average of the manual human scoring (AHI\textsubscript{MANUAL}) and the automated systems (AHI\textsubscript{RLG} and AHI\textsubscript{NOX}).

Results: The ICCs of the respiratory event scoring using the NP were: AHI = 0.99 [95% CI: 0.97–0.996]; apnea index = 0.78 [0.56–0.91]; and hypopnea index = 0.52 [0.20–0.78]. The ICCs using Flow were: AHI = 0.98 [0.96–0.99]; apnea index = 0.79 [0.57–0.91]; and hypopnea index = 0.72 [0.47–0.88]. The ICC of the oxygen desaturation index (ODI) was 0.997 [0.993–0.999]. Using the NP signal, the mean differences in AHI (Bland and Altman method) were: −0.9 ± 3.1/hr (AHI\textsubscript{RLG} vs AHI\textsubscript{MANUAL}); −1.3 ± 2.6/hr (AHI\textsubscript{NOX} vs AHI\textsubscript{MANUAL}); and −0.3 ± 1.9/hr (AHI\textsubscript{RLG} vs AHI\textsubscript{NOX}). Using the Flow signal, the mean differences in AHI were: −1.9 ± 3.3/hr (AHI\textsubscript{RLG} vs AHI\textsubscript{MANUAL}); 1.6 ± 3.0/hr (AHI\textsubscript{NOX} vs AHI\textsubscript{MANUAL}); and 3.5 ± 3.4/hr (AHI\textsubscript{RLG} vs AHI\textsubscript{NOX}).

Conclusion: There is strong agreement in the scoring of the AHI for HSTs between the automated scoring systems and experienced technologists from international sleep centers. The scoring agreement for the apnea index and the hypopnea index is not as high as the AHI.

1185 INFLUENCE OF PHYSICAL CONDITION ON THE FINDINGS OF DRUG-INDUCED SLEEP ENDOSCOPY
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Introduction: Obstructive sleep apnea (OSA) is a multi-level, dynamic and complex disease caused by repetitive upper airway collapses during sleep. Drug-induced sleep endoscopy (DISE) was first introduced by Croft and Pringle in 1991 as a tool to evaluate upper airway obstruction sites in patients with snoring and apnea events. However, although several previous studies showed that the DISE is a useful diagnostic modality for evaluating obstruction sites of the upper airway in OSA, questions are still being raised. One of the important questions is the effect of physical condition in drug-induced breathing pattern or drug-induced muscle relaxation.

Methods: On the basis of apnea-hypopnea index in full-night attended polysomnography, 35 OSA patients participated in the study. All patients underwent to DISE twice. First exam were performed after treadmill stress test (We defined as stressful physical condition). Second exam were performed before surgery or PAP titration (We defined as normal physical condition).

Results: A total of 35 subjects (26 men and 9 women) were included in this study. Mean age was 48.4 ± 9 years, mean AHI 28.2 ± 21.4/hr, and mean BMI 25.6 ± 2.9 kg/m². The degree of airway narrowing was aggravated in 20 of 35 patients (57.1%) at the velum level, in 10 of 35 patients (28.6%) at the lateral wall of oropharynx level, in 2 of 35 patients (5.7%) at the tongue base level, in 1 of 35 patients (2.8%) at the epiglottis level, respectively.

Conclusion: The degree of upper airway narrowing can be aggravated according to the physical condition, but it mainly confined at the velum and lateral wall of oropharynx. However, there was no difference on presence of obstructive site and configuration of upper airway obstruction according to the physical condition of patients.

1186 SLEEP DISORDERS SCREENING QUESTIONNAIRES IN PRIMARY CARE OF ADULTS: A SYSTEMATIC REVIEW OF THE LITERATURE
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Introduction: Minimizing the devastating personal and societal impacts of sleep disorders requires early detection and treatment thus falls under the umbrella of primary care. When primary care providers assess for sleep disorders, they typically under-detect. Using a reliable and valid sleep disorder screening questionnaire could remedy this situation. However, availability of questionnaires that can screen for multiple disorders without sacrificing productivity in busy adult primary care practices is unknown.

Methods: A systematic review of the literature for ten-minute-or-shorter self-report questionnaires that screen for six sleep disorders was performed. Included questionnaires were assessed for correspondence with diagnostic criteria, validity of scoring strategies, and generalizability to the adult primary care population.

Results: None of the seven identified questionnaires have both ten-minute completion time and coverage of six sleep disorders. One brief questionnaire covered five disorders, and another covered six disorders but would require more than twenty minutes to complete. Criteria for an ideal questionnaire targeting primary care comprise n = 15 items that encompass thoroughness, efficiency, content validity, criterion validity, and generalizability to adult primary care population are presented. Though two of the questionnaires meet half of the ideal criteria, neither can be completed in ten minutes or less.

Conclusion: Unavailability of a single accurate reliable self-report questionnaire that can screen for six common sleep disorders likely contributes to the under-detection of sleep disorders in primary care settings. A questionnaire meeting-to-be-established specifications for sleep disorder screening in primary care of adults should be developed and rolled-out with education to primary care providers.

1187 PERSONALIZED PROGNOSTICS OF CARDIORESPIRATORY DISORDERS: A CASE STUDY FOR OBSTRUCTIVE SLEEP DISORDER
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Introduction: This paper reports investigations into complex cardiorespiratory dynamic couplings, aimed at developing a personalized prognosis of obstructive sleep apnea (OSA) episodes in real time during sleep based on signals from a wearable heart rate sensor. Recent advances in wearable sensors, flexible electronics, and “big data” predictive analytics are fueling growth in point-of-care (POC) therapies for OSA and other sleep disorders. The effectiveness of POC therapies can be substantially enhanced by providing personalized, real-time prognosis of OSA episodes based on information gleaned from the wearable sensor signals. Previous attempts at OSA episode prognosis are mostly limited by their inability to harness information from measured sensor signals and insufficient methods for capturing the non-
linear nonstationary dynamics of the coupled physiological processes underlying the measured sensor signals.

Methods: A multivariate state space was reconstructed from two features, namely, power spectral density and longest vertical length extracted from the heart rate variability signals. A novel prognosis method based on a nonparametric statistical Dirichlet Process Mixture Gaussian Process (DPMG) model was used to estimate the transition pathways from a normal state to an anomalous (apnea) state in the reconstructed state space and hence the distribution of the remaining time until onset of the next OSA episode.

Results: The approach was tested using 20 recordings from 14 different subjects in a benchmark ECG apnea database (Physionet.org), as well as from a subject wearing wireless wearable multisensory suite during sleep. Validation tests suggest that the model can predict the estimated time until the onset of a disorder (OSA episode) to within 15% of the actual observed times 1–45 minutes ahead of inception.

Conclusion: Tracking the evolution pathways from normal state to an anomalous (apnea) state in the state space reconstructed from heart rate variability signal features can be used to forecast the distribution of the time until the onset of an OSA episode. The wearable device for personalized OSA prognosis resulting from the present approach can thus serve as an effective decision support tool to facilitate precise, timely, and personalized treatment and therapies.

1188
LOW CORRELATION BETWEEN BASELINE EPWORTH SLEEPINESS SCORE AND AHI
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Introduction: The Epworth Sleepiness Scale (ESS) is a validated, self-administered, screening tool used to assess the level of daytime sleepiness in a patient’s life. A score of > 10 suggests the possibility of excessive daytime sleepiness (EDS) and the need for further investigation for obstructive sleep apnea (OSA). However, patients with undiagnosed OSA may present with symptoms not-related to EDS, such as snoring and night-time apneas.

Methods: A group of 86 patients were enrolled; 14 had mild OSA, 39 moderate OSA, and 33 severe OSA. The Epworth Sleepiness Scale (ESS) score was compared between the 3 groups using ANOVA one-way variance for independent continuous samples.

Results: There was no significant difference between the ESS scores in the three groups (9.6 [6.8–12.8] for mild; 9.5 [6.0–12.5] for moderate and 9.5 [5.0–13.0] for severe OSA). The coefficient of determination (r²) between the actual AHI and the predicted AHI (PredAHI) was 0.81 (r = 0.90), which was significant at a p = 0.000. The areas under the ROC curve ranged from 0.90 to 0.95.

Conclusion: In this cohort of patients at a single-centre, a baseline screening ESS score had poor correlation to the degree of obstructive sleep apnea in patients diagnosed with OSA. As the mean ESS was 9.5, a lower cut of value may be required when using the ESS as a screening tool to ensure that patients with OSA without symptoms of EDS are referred for further investigation.

1189
ACTIVE REMOTE MONITORING OF CPAP TREATMENT IN OBSTRUCTIVE SLEEP APNEA MAY IMPROVE ADHERENCE IN MILITARY VETERANS
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Introduction: Adherence to continuous positive airway pressure (CPAP) for treatment of Obstructive Sleep Apnea (OSA) is extremely poor, especially among military veterans. Timely support and troubleshooting influence early experiences with CPAP, and early experiences predict long-term adherence. We hypothesize that wireless modems on CPAP devices may allow providers to monitor CPAP use to improve adherence.

Methods: We randomized veterans that newly started CPAP for OSA to receive either “wireless care” or “usual care.” “Usual care” consists of face-to-face visits with the physician at designated intervals to evaluate adherence, leak and efficacy. “Wireless care” involves more frequent monitoring via wireless modems. If adherence, leak or therapy parameters are abnormal, patients receive phone calls to identify problems and are triaged to the appropriate clinician or equipment provider.

Results: In this on-going study, we reviewed data for 30 patients at week 1 and week 6.

Conclusion: Our data shows that active continuous remote monitoring of CPAP therapy may improve adherence to CPAP and treatment of OSA. Although our results did not reach statistical significance thus far, upon completion of our full study, this trend may reach statistical significance. Further studies are needed to determine whether this short-term improvement in adherence over six weeks translates to improved long-term adherence.

Support (If Any): ResMed and Phillips Respironics

1190
THE DIAGNOSTIC ACCURACY OF A MODEL TO PREDICT APNEA-HYPOPNEA INDEX USING NIGHTTIME PULSE OXIMETRY
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Introduction: The intent of this study was to develop a predictive model to convert oximetry data to an apnea and hypopnea index (AHI). This model was then compared to actual AHI to determine its precision.

Methods: A group of 1467 subjects given polysomnograms with concurrent pulse oximetry between April 14, 2010 and February 7, 2012, were divided into model development (n = 733) and verification groups (n = 734) in order to develop a predictive model of AHI using oximetry data.

Results: The coefficient of determination (r²) between the actual AHI and the predicted AHI (PredAHI) was 0.81 (r = 0.90), which was significant at a p = 0.000. The areas under the ROC curve ranged from 0.90 to 0.95.
1191
SLEEP DISORDERED BREATHING AND QUALITY OF LIFE, COMPARISON OF THE SF-36, FOSQ, AND SAQLI QUESTIONNAIRES
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Introduction: The impact of sleep on quality of life (QoL) has been well documented; however, there is a great need for reliable QoL measures for persons with sleep disordered breathing (SDB). We compared the QoL scores between the 36-Item Short Form of the Medical Outcomes Survey (SF-36), Functional Outcomes Sleep Questionnaire (FOSQ), and Calgary Sleep Apnea Quality of Life Index (SAQLI) in participants with SDB.

Methods: A total of 1,187 participants from the Sleep Heart Health Study second examination, who completed the SF-36, FOSQ, and SAQLI and in-home polysomnograms, were included. The respiratory disturbance index (RDI) at 4% desaturation was categorized as no SDB (<5), mild SDB (5–14.9), moderate SDB (15–30). QoL scores for each SDB category and QoL questionnaire were determined.

Results: Participants were approximately 53% female with a mean age, body mass index, and total sleep time of 61.6 years, 28.6 kg/m², and 6.4 hours. Nineteen percent had an Epworth Sleepiness Scale score ≥ 11. Participants were categorized as no SDB (34.3%), mild SDB (38.1%), moderate SDB (17.8%), and severe SDB (9.8%). The SF-36 Physical (PCS) and Mental Component Scores (MCS) were correlated with the FOSQ and SAQLI (r = 0.37 PCS vs FOSQ; r = 0.31 MCS vs FOSQ; r = 0.42 PCS vs SAQLI ; r = 0.25 MCS vs SAQLI ; and r = 0.67 FOSQ vs SAQLI, p < 0.001 for all). Kruskal-Wallis tests showed significant differences between the SDB categories for the SF-36 PCS scores (mean = 47.1, SD = 10.8; p = 0.002); however, no significant differences between SDB categories were found for the SF-36 MCS (mean = 54.0, SD = 8.1), the FOSQ (mean = 11.5, SD = 8.2), or the SAQLI scores (mean = 6.0, SD = 8.2).

Conclusion: Differences in QoL scores for SDB categories may be a function of individuals’ perceived physical limitations. More discriminant methods are needed to evaluate factors impacting QoL in persons with SDB.

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1192
RELIABLE IDENTIFICATION OF CHEYNE-STOKES RESPIRATION WITH CENTRAL SLEEP APNEA BY POLYSOMNOGRAPHY WITH ADDING ANALYSIS OF CARDIORESPIRATORY SIGNAL DETECTED BY A PIEZOELECTRIC SENSOR
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Introduction: Cheyne-Stokes respiration with central sleep apnea (CSR-CSA) is currently confirmed manually by sleep experts who analyze the absence of both airflow and respiratory efforts in chest/abdomen belt-sensor signal obtained by overnight polysomnography (PSG) recording. The respiratory efforts are identified by paradoxical chest/abdomen motions in the belt-sensor signal, which however, is sometimes inarticulate and lead to an overestimated number of CSR-CSA. To identify the respiratory efforts more accurately, we sought a solution that uses a piezoelectric-transducer (PZT) sensor which is made of a flexible, thin plastic plate and a PZT and put under a bed sheet under a patient.

Methods: After simultaneous overnight PSG and PZT-sensor recording, 102 CSR-CSA events identified from 10 patients by sleep experts according to AASM standard were re-evaluated by observatory analysis of the PZT-sensor signal and its power spectral density (PSD) value of < 0.6 Hz extracted from fast Fourier transform (FFT) analysis result.

Results: Of the 102 CSR-CSA events, 25 were re-identified as Obstructive sleep apnea (OSA) by the analysis of the PZT-sensor signal. In the observatory analysis, signal waveforms representing respiratory efforts were clearly appeared in the PZT-sensor signal in most cases in contrast to belt-sensor signals that were inarticulate in the 25 events. In the other 77 events, respiratory efforts were not observed in the PZT-sensor signal. PSD value of < 0.6 Hz in re-evaluated CSR-CSA and OSA events were (0.4 ± 0.3 vs 57 ± 123 V²/Hz; p = 0.0000, Mann-Whitney U test), respectively.

Conclusion: Observatory analysis and FFT analysis of PZT-sensor signal in addition to the conventional PSG analysis may reduce CSR-CSA overestimation and inappropriate treatment choice for patients who suffer from sleep disorder breathing.

Support (If Any): This study was supported in part by JSPS KAKENHI Grant Number 24590268, and AINY Co., Ltd., Akita, Japan.

1193
AN AMBULATORY DEVICE FOR MEASURING ADHERENCE TO BRIGHT LIGHT THERAPY: A COMPARISON OF WRIST-WORN AND UPPER-CHEST PLACED LIGHT SENSORS
Gordon R, Loewy D, Dawson A, Kline L
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Introduction: Bright light has been shown to shift the human sleep-wake circadian rhythm, in well-controlled conditions. This study compares the usability of two ambulatory sensors, one worn on the wrist (WLS) and one affixed to the upper chest (UCLS), to measure adherence to bright light in a clinical population.

Methods: Ten adults (8 women), with delayed sleep-phase syndrome, were recruited from our sleep clinic. They were outfitted with two ambulatory light sensors, WLS and UCLS, capable of measuring ambient light. Patients were provided a light box for home therapy, and instructed to view the box from a maximum distance of 3' and gaze angle of 45°, equivalent to 1100 lux as measured by UCLS. The target for bright
light exposure was the one-hour period beginning thirty minutes after a predetermined habitual awakening time. Fourteen consecutive days of light treatment data were recorded. Illumination intensity (lux) recorded during the one-hour target window plus-or-minus one hour was examined for both sensors. Three contiguous 30-minute intervals with the highest measured adherence lux-minutes (ALM) were identified as the adherence treatment window. Adherence was defined as light exposure above 1100 lux for at least 45 minutes. Data from the two sensors were examined separately to calculate the number of “adherent” and “non-adherent” days for each patient.

Results: UCSL showed five of 10 patients met our adherence threshold. Adherent patients averaged 52.1 ALM per day, 71.4% days above the 45-minute threshold, compared to 24.4 ALM, and 25.7% days above threshold, for the non-adherent group. WLS showed 0 adherent patients: averaged 12.3 ALM per day and 6.4% days above threshold with the five UCSL adherent patients averaging 17.3 ALM.

Conclusion: A light sensor affixed to the front of the chest is more precise than a wrist worn light sensor for measuring adherence to light box therapy in a clinical setting.

Support (If Any): Partial funding provided by the Scripps Health Foundation and Scripps Clinic Medical Group Light boxes furnished by Sunbox® (SunRay II) Light sensors provided by Onset® (HOBO Pendant UA-002-64 Data Logger) and ActigraphCorp® (Actisleep+)

1194
THE UTILITY OF A NOVEL AMBULATORY DEVICE FOR MEASURING ADHERENCE TO BRIGHT LIGHT THERAPY
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Introduction: Bright light has been demonstrated, in well-controlled conditions, to effectively shift the human sleep-wake circadian rhythm. This study seeks to determine if an ambulatory light sensor, affixed to the upper front chest on a patient, can serve as an effective means of measuring adherence to bright light in a clinical population.

Methods: Ten adult patients (8 females), diagnosed with delayed sleep phase syndrome, were recruited from a sleep clinic patient population. Participants were outfitted with an ambulatory light sensor, worn on a necklace, capable of recording the timing and intensity of ambient light. Participants were issued a light box for use at home, a wrist-worn actigraph with light measurement, and sleep log and instructed to view the light box from a maximum distance of 3’ and gaze angle of 45 degrees, equivalent to 1100 Lux as measured by the sensor. Fourteen consecutive days of light treatment data were obtained. The target for bright light was the one hour period beginning thirty minutes after habitual awakening time. Illumination intensity (lux) recorded during the one-hour target window plus or minus one hour was examined. Three contiguous 30 minute intervals with the highest measured lux-minutes were identified as the adherent treatment window. Adherence was defined as light exposure above 1100 lux for at least 45 minutes (adherence lux-minutes). The number of “adherent” and “non-adherent” days was calculated for each patient.

Results: Five of 10 patients were determined to be adherent. The average lux-minutes per day were 52.1 for the adherent group and 24.4 for the non-adherent group. The adherent group met 45 min. criteria on 10.0 days whereas the non-adherent group met criteria on only 3.6 days.

Conclusion: A light sensor affixed to the front chest may be an effective means of assessing adherence to bright light therapy in a clinical practice.

Support (If Any): Partial funding provided by grants from Scripps Health Foundation and Scripps Clinic Medical Group Light boxes (Sunray II®) furnished by Sunbox® Light sensors provided by Onset® (HOBO Pendant UA-002-64 Data Logger) and ActigraphCorp® (Actisleep+)

1195
ACCURACY OF A NEW WIRELESS PORTABLE MONITORING CHIP TO DETERMINE BODY POSITION AND TIME OF USE DURING SLEEP
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Introduction: Most in-lab polysomnograms and home sleep tests include monitoring sleep position during the night by the use of a tilt accelerometer. However, none of these devices are designed to be used nightly on a therapeutic positional device to measure effectiveness and to determine compliance. We evaluated the accuracy of a new wireless monitoring chip that can be worn on a positional device to determine sleep position and time of use.

Methods: Twenty-one patients (48 ± 13 yrs, 8 males, BMI 38 ± 10 kg/m2) who were referred for an overnight polysomnogram for suspected obstructive sleep apnea were included in the study. Patients had their sleep position and time in bed manually scored based on review of the video. In addition, all patients wore a motion sensor monitor chip H(7) X W(40.5) X L(47) mm with a weight of 11 grams centered anteriorly 2 inches off the surface of the rib cage inductive plethysmography belt. The sensor transmitted data near real time to a server for review.

Results: There was a significant correlation between the manually scored and motion sensor monitor chip data as it pertains to the percent of the time spent in the supine position (41 ± 22% and 40 ± 20%, respectively, r = 0.93, p < 0.001), the right side (31 ± 17% and 33 ± 16%, respectively, r = 0.95, p < 0.001), and the left side (28 ± 14% and 28 ± 13%, respectively, r = 0.95, p < 0.001). There was basically no time spent prone when scored manually and with the chip (0 ± 0% and 0.2 ± 0.2%, respectively). In addition, there was a significant correlation for the total time of the study between the manually scored data and the motion sensor monitor chip (7.3 ± 0.4 hrs and 7.8 ± 0.6 hrs, respectively, r = 0.6, p < 0.01).

Conclusion: A portable motion sensor monitor chip can accurately monitor sleep position and time of use during night while it uploads the data near real time.

1196
AGREEMENT AMONG RATERS FOR CONFIDENCE IN DISCRIMINATION OF PHASIC AND TONIC EMG ACTIVITY
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Introduction: Machine learning approaches for detection of phasic EMG activity in human sleep require comparison with expert visual consensus, particularly for differentiation from tonic EMG activity. In this study, an expert panel determined the relative likelihood of phasic and tonic EMG activity in a series of preselected segments of digitally acquired, single-channel, low impedance, surface EMG recordings, each segment approximating 3–5 seconds in length.

Methods: Six board certified sleep specialists rendered independent judgments of the relative likelihood of both phasic and tonic activity in 60 separate extracted segments of NPSG recordings. Four-tier segment ratings ranged from high or moderate certainty for PRESENCE of activity to moderate or high certainty of ABSENCE of activity. Each
segment was rated for both phasic AND tonic activity by each rater, i.e., a segment could contain phasic, tonic or both types of activity.

**Results:** Raters were moderately reliable both for tonic (Kendall’s coefficient of concordance = 0.59, p < 0.0001) and phasic (0.47, p < 0.0001) activity using 4-tier ratings. On segments where 4 or more raters agreed, a significantly higher proportion of phasic ratings were classified with moderate/high certainty for presence of activity compared to tonic ratings. (27/28 [96.4%] vs 15/24 [62.5%], chi-square = 9.58, p = 0.002). Statistically significant individual differences existed among raters in certainty ratings across all 60 segments (chi-square = 69.8 (phasic) and 167.7 (tonic), both df 15, p < 0.0001), arguing for importance of a panel approach to achieve criterion consensus.

**Conclusion:** These results indicate that although raters can achieve agreement on the presence of muscle activity, agreement is more likely when framed in terms of phasic, rather than tonic, activity, perhaps because of difficulty defining baseline. These data imply that validation of machine learning by visual scoring consensus is probably better achieved by focus on the former, rather than the latter.

### 1197 HOW DO CONSUMER SLEEP TRACKING DEVICES COMPARE TO POLYSOMNOGRAPHY (PSG)?
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**Introduction:** An estimated 50–70,000,000 American adults suffer from chronic sleep problems with an economic burden of ~ $16,000,000,000. Consumer devices are being designed to measure different sleep stages and wake activity, however, there are no validated studies that demonstrate the accuracy of these devices. The aim of this study is to compare four consumer sleep tracking devices to polysomnogram (PSG).

**Methods:** With IRB approval, a nonrandomized prospective study comparing four sleep tracking devices to PSG was performed (Gear 4 Renew Sleep Clock [G4], the Lark [L], Axbo Sleep Phase Alarm Clock [Ax], SleepTracker Watch [ST]). Subjects > 18 years, undergoing a PSG and able to give informed consent were included. Each device was paired with a patient before initiation of the study. The device was used during the PSG and started prior to “Lights Out” and stopped after end of PSG. Subjects were surveyed on the comfort level of each device using a questionnaire. Parameters included were hypnogram, sleep latency (SL), total sleep time (TST), deep sleep, wake after sleep onset (WASO), and sleep score.

**Results:** SL was not significantly different between devices and PSG (G4 5.3; L 12.4; Ax 22.2; ST 9.6). TST was significantly different for all devices (p < 0.05; difference from PSG = G4 52.4; L 48.2; Ax 93.3; ST 32.2). Other parameters varied by device (G4 deep sleep NS; L WASO 36.8, p < 0.05). Patient comfort varied by device (Comfortable: G4 = 67%; L = 90%; Ax 75%; ST 67%). Only 42% patients were interested in buying a device.

**Conclusion:** Consumer sleep tracking devices significantly over estimate TST when compared to PSG. In addition, data for specific parameters such as SL, sleep efficiency and WASO were variable by device. Little information is available about the internal scoring of these devices and consumers should be aware of these limitations.

### 1198 A NEW METHOD OF MEASURING SLEEPINESS: MEMPHIS SLEEPINESS SCORE
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**Introduction:** The assessment of sleepiness is an integral part of the clinician’s comprehensive sleep evaluation. Objective measures, such as the psychomotor vigilance test (PVT), fail to account for the patient’s own sense of sleepiness. Subjective measures, such as the Epworth Sleepiness Scale (ESS), are inherently prone to bias. Our goal is to evaluate the feasibility of a new sleepiness assessment tool that incorporates both subjective and objective measures, the Memphis Sleepiness Score.

**Methods:** A single subject was followed for two weeks with actigraphy and sleep diary. Three times daily (7:00, 11:00, 22:00), sleepiness was assessed using a combination of subjective measures (ESS and Stanford Sleepiness Scale [SSS]) as well as objective measures (two-minute PVT and five-minute Driving Simulation [DS]). Software was developed to plot the value of each measure (ESS from 0–24; SSS from 1–7; PVT response time in milliseconds; total number of DS collisions) in each of four quadrants on a graph. The area of the polygon formed by the four data points is calculated as the Memphis Sleepiness Score.

**Results:** The subject achieved a mean of 450 minutes (SD 97) of sleep and mean 88% sleep efficiency (SD 5.7). PVT times ranged from 249–302 ms; mean 278.8 ms. DS collisions ranged from 0–3; mean 0.44. ESS scores ranged from 2–5; mean 3.25. SSS scores ranged from 1–7; mean 4.4. A Memphis Sleepiness Score reference value of 10 results from PVT of 250 ms, DS with 1 crash, SSS of 2, and ESS of 8. The utility of the Memphis Sleepiness Score (MSS) in balancing the subjective and objective data is exemplified by four random testing times: Time A (PVT: 278 ms; DS: 3 crashes; SSS: 6; ESS: 2) yields MSS of 26.36; Time B (PVT: 298 ms; DS: 0 crashes; SSS: 7; ESS: 3) yields MSS of 4.29; Time C (PVT: 259 ms; DS: 2 crashes; SSS: 1; ESS: 3) yields MSS of 8.79; Time D (PVT: 266 ms; DS: 0 crashes; SSS: 6; ESS: 5) yields MSS of 6.49.

**Conclusion:** The Memphis Sleepiness Score is a new sleepiness assessment tool combining both objective and subjective measures. The administration of the tool can be completed in less than 10 minutes. It may offer clinicians a more balanced assessment of patient sleepiness than a single assessment tool alone.

### 1199 RELIABILITY AND VALIDITY OF THE TURKISH VERSION OF THE PITTSBURGH INSOMNIA RATING SCALE IN HIGHER EDUCATION STUDENTS IN ESKISEHIR, TURKEY
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**Introduction:** The purpose of this study was to standardize and validate a Turkish version of the PIRS-20.

**Methods:** We translated the PIRS-20 into Turkish and then translated it back into English to check its accuracy. The 447 students of the 1st, 2nd and the 3rd classes of Eskişehir Osmangazi University Medical Faculty were enrolled in this study. Language validity of the scale was done by the linguists, while the content validity was done by the experts. The validity of the construct structure factor was tested by analyzing the Kaiser-Meyer Olkin (KMO) which was calculated with the coefficient of Barlett test results. Mann-Whitney test was performed to test the internal validity criteria and to compare the mean scores of the upper and lower groups. According to the hypothesis that the students with less...
sleep and with diagnosis of a sleep disorder would have higher scores, the medians from the scale were compared with each other by Mann Whitney U test. To test the internal consistency, the Pearson Product Moment Correlation coefficient and Cronbach alpha reliability coefficient were calculated. In the analysis of the data Mann-Whitney and Kruskal-Wallis tests were performed.

**Results:** The median value and the end points of the PIRS-20 were 22 and 1–56 respectively. Sign-concept validity of the PIRS-20 was evaluated by factor analysis. PIRS-20 was found to contain a single dimension. According to the results of item-total correlation review which was done to test the reliability of the scale, no item received less than 0.20. KMO coefficient of the PIRS was found as 0.91 and the Bartlett test was found to be significant (p < 0.001). When the distribution of scores were evaluated, a significant difference was found (p < 0.001) between the median of the 25% bottom and the median of the 25% top. The median of the PIRS-20 of the students with a sleep disorder was found higher than the others (p < 0.001). The total item correlations were between 0.281 and 0.674 in the connection of the PIRS-20 questions and the correlation coefficients were found to be significant (p < 0.05). Cronbach’s alpha coefficient was used to determine the internal consistency of the PIRS-20 and was calculated as 0.906.

**Conclusion:** The Turkish version of PIRS-20 was found to be a valid and reliable scale for insomnia. We conclude that the scale should be used in wider and different groups.

**1200**

**A UTILITY OF REMOTE NETWORK POLYSOMNOGRAPHY**

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**Introduction:** The purpose of this study is to examine about a utility of remote network polysomnography (PSG) to compare the incidence of poor recording data among three different procedure of PSG, attended, unattended or remote network PSG.

**Methods:** Subjects were collected the following different periods. Patients suspected sleep related breathing disorders studied using remote network PSG were 40 adults from April of 2004 to December of 2005, and 45 patients were studied by unattended PSG from November of 1999 to July of 2001 and 50 patients by standard attended PSG in October of 2005. Subjects were categorized three groups due to the quality of recording data, not having any problems of scoring in Group A, having poor data induced some trouble of scoring it more than 30 minutes in Group B and having poor data of 25% in total study time in Group C. It was compared an incidence of three groups.

**Results:** 15.0% of patients using remote network PSG classified group B lower than 33.3% using unattended PSG and higher than 4.0% using attended PSG. 2.5% of patients using remote network PSG classified group C lower than 8.9% using unattended PSG and higher than 0% using attended PSG.

**Conclusion:** It was shown that the incidence of poor data in remote network PSG was lower than in unattended PSG and higher than standard PSG. Remote network PSG would be useful to acquire high quality data patient safety compared to unattended PSG.

**1201**

**SMARTPHONE SLEEP DIARY APP: PILOT TESTING**

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**Introduction:** The purpose of this pilot study was to test the feasibility and acceptability of a smartphone sleep diary application. Diaries that capture daily activities and sleep are essential instruments frequently used in paper-and-pencil format. We developed and pilot tested a smartphone application, designed for use with an Android platform that records information routinely incorporated in standard sleep diaries.

**Methods:** A convenient sample of 21 adults (mean age 49.9 years [11.9], 3 males) participated and completed the smartphone diary twice daily for one week. Specific time intervals were set (wake-up 3 am–12 pm; bed-time 8 pm–3 am) and data were saved immediately upon entry to a UW server. Set times prohibited ‘back filling’ of diary entries. Participants completed a 9 item acceptability survey with items rated ‘strongly agree’ to ‘strongly disagree’ and provided open ended written comments.

**Results:** Participants rated the smartphone diary application easy to use; instructions were adequate; they would use the application downloaded to a personal phone; and would use feedback from a diary recording to improve sleep. The prompt to record data was not disruptive; entering data was not a hassle; they would not prefer using a paper and pencil diary; using a loaned phone did not cause concern about loss; and they did not have concerns about others seeing their recorded information. Seventy-one percent (15/21) had at least 6 days of recorded data (matching bedtime/waketime diary time stamps); 3 subjects had complete data for 5 days and 3 for four days.

**Conclusion:** Participants in this pilot study found using a smartphone application for recording daily entries in a sleep diary highly acceptable. Using set entry intervals provides potential for complete and accurate recordings.

**Support (If Any):** UW Center for Research on the Management of Sleep Disturbances; School of Nursing RIFP fund.

**1202**

**VALIDATION OF SLEEP IN A MULTI-SENSOR CONSUMER GRADE WEARABLE DEVICE**

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**Introduction:** The consumer biometric wearable device (WD) market is rapidly expanding. The ability to track daily patterns, such as activity and sleep, can potentially benefit the research community by allowing the collection of larger sample sizes at a substantially lower cost than traditional actigraphy (ACT) or Polysomnography (PSG). The aim of this study was to examine the capability of a consumer grade WD, which uses additional sensors beyond accelerometry, to detect sleep stages. We hypothesized that WD would have a strong correlation to Total Sleep Time (TST), wake after Sleep Onset (WASO) and REM vs. NREM when compared to PSG in healthy adults.

**Methods:** Clinically healthy adults (n = 18, 5 males; mean age 26.8 ± 3.4 years) underwent three consecutive nights of monitoring with PSG, ACT, and WD (Basis B1) in a controlled hospital setting. 41 nights had usable data for PSG and WD measures and were used in this analysis.

**Results:** Percent agreement between PSG and WD for sleep vs. wake was 98% with an associated Kappa score of 0.95. The Pearson correlation for TST and WASO were 0.66 and 0.40 respectively. There was...
1203 EVALUATIONS OF EFFECTS OF HIGH REBOUND AND LOW REBOUND MATTRESS TOPPERS ON ATHLETIC PERFORMANCE IN YOUTH
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Introduction: Use of airweave (a high rebound [HR] mattress with a structure that facilitates breathability) induces effective heat loss (i.e., a larger decline in core body temperature) and enhances deep sleep compared to low rebound [LR], pressure-absorbing mattresses during the initial phase of nocturnal sleep in healthy males (Sleep, 2013 & 2014). Sufficient, restorative sleep is essential to maximize athletic performance of advanced athletes, and this was experimentally demonstrated by a recent study (Mah et al., 2005); sleeping longer improved physical performance of University-level male basketball team members. We therefore examined if sleeping on airweave mattresses will improve sleep and athletic performance of young athletes.

Methods: The study was conducted in 51 healthy male athletes (who provided signed informed consent) from various sport programs in IMG Academy, with a randomized eight week crossover design with HR or LR mattress toppers. The athletic performance and subjective sleep quality were evaluated twice a week throughout the study. The quantitative measures of athletic performance include a 40-meter sprint (SP), long jump (LJ), and star drill (SD). Subjective self-rating (1 to 10) at practice (SSRP) and games (SSRG) were evaluated. Subjective sleep evaluations using the Epworth sleepiness scale (ESS), visual analogue scales (sleep [VAS-S], performance [-P], muscle pain [-MP], back pain [-BP]) was also used as well as profile of mood states (POMS). Objective measures of sleep habits and psychomotor vigilance was evaluated with actiwatch and a standardized psychomotor vigilance test (PVT).

Results: Among the 51 participants, 47 subjects participated in the both sessions and paired data were obtained from 31 to 47 subjects, depending on the measures. There was no significant difference in objective (actigraph and PVT) and subjective (ESS and VASs) sleep and mood (POMS) measures between HR and LR sessions. There were also no significant differences in subjective ratings (SSRP and SSRG) between HR and LR sessions. We however, observed tendencies of improved performance in all 3 objective athletic measures ([HR vs. LR] SP (n = 32): 6.96 ± 0.14 vs. 7.28 ± 0.13 sec, LJ (n = 39): 182 ± 5 vs. 180 ± 5 cm, SD (n = 31): 20.28 ± 0.37 vs. 20.38 ± 0.48 sec) with HR use. In particular, a 0.3 sec improvement was seen in 40-meter sprint with HR.

Conclusion: There is a possibility that sleeping with HR improved athletic performance in youth at a sport academy. We are currently increasing the number of subjects to raise the power to detect statistical differences.

Support (If Any): The study was supported by airweave.
B. Clinical Sleep Science

1206
MEMPHIS SLEEPINESS SCORE: A COMPOSITE EVALUATION TOOL FOR DAYTIME SLEEPINESS ESTIMATION

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Introduction: Estimation of daytime sleepiness-burden by questionnaires (Epworth, Stanford) is challenged by the subjective nature of the instruments. They are susceptible for bias and can be manipulated upon, by the interest, of the individuals tested (i.e. drivers).

Methods: We developed a composite tool using four parameters (software Visual Basic.exe program) that integrates both questionnaires and 2 test of vigilance (PVT, Driving) available to anybody/anywhere with internet access. The composite “optimal” value of the 4 parameters was assigned a “normal” burden value of 10% (load of 1 x). The composite worst possible score in the four parameters was assigned a 100% sleepiness burden (load of 10 x the optimal value). Our tool calculates the area under the 4 anchor points obtained by an individual perform the test and calculates its percentage equivalence in comparison to the anchors (worst/best). It also calculates the magnitude of burden in comparison to the optimal (1 x) up to a possible maximum of (10 x). Our tool can be used sequentially (follow-ups), for screening (i.e. with STOP-BANG) or as a point assessment to complement other tools (i.e. Sleep Diary, Actigraphy).

Results: The figure provides a snap-shot of the application including the individual’s: a) percentage estimation of sleepiness burden, and b) Magnitude variation (Max = 10 x) in comparison to the optimum (1 x = Normal).

Conclusion: We created a composite score (using 4 parameters) to estimate objectively the sleepiness burden in an individual. It can be used either for patient care (as a screening or for sequential evaluations) or for epidemiological assessments of sleepiness.

XIII. Instrumentation and Methodology

1207
HOW WELL DOES A COMMERCIAL FITNESS-TRACKING WRISTBAND MEASURE SLEEP?

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Introduction: In recent years, fitness-tracking wearable technology has exploded and it has become normal to track one’s daily activity and sleep. Similarly to standard actigraphy, fitness trackers mainly use an accelerometer to detect motion. The low-cost, easy interface and availability of these products make them an attractive option for monitoring sleep in large populations. We aimed to evaluate the accuracy of Jawbone UP® compared to polysomnography (PSG) in assessing sleep in an adult sample.

Methods: Twenty-six midlife women (mean age ± SD: 50.0 ± 4.1 y), 11 of whom had an insomnia diagnosis, had one or two laboratory overnight recordings. Jawbone UP and PSG data were simultaneously collected. Agreement between Jawbone UP and PSG measures was analyzed using Wilcoxon signed-rank tests and Bland-Altman plots.

Results: Jawbone UP overestimated PSG total sleep time (21.3 ± 26.4 min), sleep efficiency (4.8 ± 6.1%), and sleep onset latency (5.8 ± 8.4 min), and underestimated wake after sleep onset (26.4 ± 23.9 min) (all p’s < 0.01). However, the Bland-Altman analysis shows the differences to be consistent and predictable. In a subsample of fourteen women with a second overnight recording, night-to-night Jawbone UP and PSG mean discrepancies were significantly different for wake after sleep onset (p = 0.030), with a larger discrepancy on the first night when women had a greater amount of wake-time.

Conclusion: Jawbone UP has good agreement with PSG in estimating sleep and, similarly to standard actigraphy, limited accuracy in detecting wake. These initial results show promise, however further validation in different clinical populations is needed before recommending widespread use of inexpensive wearable devices for clinical or research applications.

Support (If Any): Grant HL103688 to Fiona C. Baker.

1208
ADHERENCE TO A NOVEL SELF-CARE SLEEP INTERVENTION: A RCT WITH COLLEGE STUDENTS

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Introduction: Trials of novel interventions that can translate into everyday health practices are needed to reduce the prevalence of sleep issues amongst young adults.

Methods: A double-blinded randomized controlled trial of college students (N = 79) with self-reported sleep issues compared the impact of use of Lavender inhalation patch vs. a placebo patch. The inhalation patch was worn for five consecutive nights and good sleep hygiene was practiced in their usual sleep setting. Lavender (Lavandula angustifolia), confirmed my mass spectrometry, was selected for its sedative properties. Measurements were taken at baseline, during intervention, post intervention, and at two week follow-up using Fitbit® tracker, daily sleep diary, sleep hygiene survey, PSQI, and the PROMIS® sleep disturbance short form. Participants received daily reminder texts.

Results: A high adherence rate was reported for wearing the inhalation patch (93%). Mean sleep hygiene scores improved at post intervention and remained improved at follow up but less so (42.7, 23.2, and 31.5 respectively). There were statistically significant findings for...
sleep quality between groups at post intervention and follow-up (PSQI p = 0.01, < 0.001 and the PROMIS p = 0.04, 0.007 respectively). The sleep hygiene only group also had significant findings for sleep quality but to a lesser degree (PSQI p = 0.02, 0.06 and PROMIS p = 0.03, 0.03 respectively). The study remained well-powered throughout.

**Conclusion:** The success of this study included a high adherence rate to the self-care protocol. Factors which contributed to this include; self-selected participants who were potentially motivated for change, an easy to apply patch that was acceptable to the participants, a specific list of sleep hygiene practices, and reminder texts. At follow-up, sleep hygiene practices continued to be improved over baseline without the reminders and technology, however less improved than at post intervention.

**Support (If Any):** Boynton Health Service, University of Minnesota, Wyndmere Naturals, Inc, Bioesse Technologies, LLC, Sigma Theta Tau, Zeta Chapter, Funding through the Center for Spirituality and Healing, A. Marilyn Sime Scholarship, Funding through School of Nursing, Wladimir and Paulina Zenkovich Nursing Fellowship, and Sophia Fund

### 1209

**OBSERVABLE MOVEMENT PATTERNS AND SENSORIMOTOR SENSATIONS OF PATIENTS/PARENTS WITH FAMILIAR WILLIS-EBKOM DISEASE (WED) DURING THE SUGGESTED CLINICAL IMMOBILIZATION TEST (SCIT)**


Ipsiroglu OS

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**Introduction:** Diagnosis of WED is challenging in young children and children with neurodevelopmental-conditions (NDCs). To overcome current diagnostic challenges, we investigated an office-based clinical test, the SCIT, to compare described sensorimotor sensations (SSs) and observable movement patterns (OMPs) of patients and attending family members with a history of WED.

**Methods:** Patients: 31 pediatric patients with chronic early-onset insomnia and NDCs were seen together with their mothers, who presented with a history of WED and iron deficiency and/or anaemia. WED was diagnosed clinically by sleep and family history, and OMPs during the SCIT. SCIT: Clients get up, shake out, sit bare-foot on an appropriately sized chair, try to relax and remain motionless. OMPs accompany descriptions of SSs.

**Results:** SCIT of mothers: 26/31 (84%) could participate actively: 100% described SSs (38% in legs; 15% in toes/feet; the remaining could not specify) and 69% had OMPs (13% twitched their toes/feet; 13% raised their heels; 6% rubbed or clenched; 6% showed repetitive stereotype movements of their toes/feet and/or legs). However, only 18/26 (69%) described SSs and had OMPs. The remaining 31% suppressed OMPs with increasing tension and were able to articulate that.

**SCIT of the children:** 17/31 (55%) could participate actively: 82% described SSs (41% in legs, 6% in toes/feet; the remaining could not specify) and 76% had OMPs (41% twitched their toes/feet, 29% raised their heels; 18% rubbed or clenched; 18% showed repetitive stereotype movements of their toes/feet and/or legs). However, only 10/17 (59%) described SSs and had OMPs; 4/17 described only SSs, and 3/17 had OMPs, but could not explain any SSs.

**Conclusion:** The SCIT captures, aside from descriptions of SSs, OMPs as a new structured diagnostic criterion; this initiates collaborative discussions about SSs resulting in an urge to move, OMPs, and also non-OMPs for being able to sit still.

**Support (If Any):** Treatable Intellectual Disability Endeavour, B.C., Vancouver, Canada; B.C. Children’s Foundation, Vancouver, Canada; Children’s Sleep Network, Vancouver, Canada.

### 1210

**CLINICAL VALIDATION OF BODY AREA NETWORK SURROGATE FOR POLYSOMNOGRAPHY**

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**Introduction:** The aim of this study is to validate a body area network (BAN)-based system as a surrogate to polysomnography for the diagnosis of sleep apnea.

**Methods:** The system consists of a cost-effective, mobile, non-invasive, and flexible real time heart and activity monitor and a pulse oximeter. The system employs an algorithm for the detection of sleep apnea, which uses the Daubechies 4 and Daubechies 6 wavelet transforms for the extraction of the LQT intervals. In previous work this algorithm has been validated for cardiac arrhythmias with an online database (MIT-BIH arrhythmia database). In this study a clinical validation of the algorithm has been performed alongside in-lab attended polysomnography. The corrected QT interval (QTc) is computed based on the RR interval for one hour of actual sleep time. We consider the combination of the LQT and the SpO2 intervals in the calculation of the AHI.

**Results:** Eight participants constituted this study. Age ranged from 32–64 years, 4 were women and the BMI ranged from 26–40. The mean AHI during PSG was 11.3 [1–42], while the mean AHI obtained by the BAN was 8.71 [5–19]. The major discrepancy observed was in the participants with severe sleep apnea. The validation overall Kappa was 0.6634 and a sensitivity of 88.11% and a specificity of 80.55% to detect sleep apnea.

**Conclusion:** The validation showed that the scheme performed well in the detection of mild to moderate sleep apnea.

### 1211

**OBJECTIVE AND SUBJECTIVE SLEEP DURATION AMONG WHITES, BLACKS, HISPANICS, AND CHINESE ADULTS IN THE UNITED STATES**

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**Introduction:** Few studies have investigated the extent to which self-reported sleep duration reflects objectively measured sleep duration among racially/ethnically diverse populations. Identifying any systematic biases across groups and subgroups (e.g. sex, insomnia, sleep apnea, depression) in sleep measured objectively compared to by questionnaire could inform research aimed at understanding sleep health disparities.
**Methods:** We investigated the concordance of self-reported habitual sleep duration compared to actigraphy-measured sleep duration across Whites, Blacks, Hispanics and Chinese in the US. We analyzed data from a racially/ethnically diverse sample of participants in the Multi-Ethnic Study of Atherosclerosis Sleep Study. Self-administered questionnaires were used to measure habitual sleep duration (based on self-reported bed and wake times) and 7-day wrist actigraphy objectively measured sleep duration and sleep continuity. Spearman correlation coefficients, Kappa statistics, Bland-Altman plots, and linear regression models were used to determine concordance of actigraphy-determined and self-reported sleep duration.

**Results:** Among 1,912 adults (ages 54–93), 37% were non-Hispanic Whites, 28% Blacks, 24% Hispanics, and 11% Chinese. Forty-six percent were males, 8% had doctor diagnosed sleep apnea, and 6% insomnia. Actigraphy-determined time interval in bed vs. sleep time more closely correlated with self-reported sleep duration across race. Moderate correlations of self-reported and objective measures of sleep duration were observed (ρ = 0.40 overall; 0.49 for Whites; 0.28 Blacks; 0.41 Hispanics; and 0.38 Chinese). When sleep duration was classified categorically as short (≤ 6 hours), recommended (7–9 hours), and long (≥ 10 hours), fair agreement was observed among Whites (κ = 0.27) and Blacks (κ = 0.21) with slight agreement among Hispanics (κ = 0.16) and Chinese (κ = 0.13). Each race/ethnicity overestimated their sleep duration, and non-Hispanic Whites (27 minutes [95% confidence interval (CI): 23–31]) overestimated more than Blacks (13 [8–19]) and Chinese (16 [8–23]) but not Hispanics (23 [18–29]). Sex, insomnia, sleep apnea, and depression did not significantly modify the relationships.

**Conclusion:** Correlations between self-reported and actigraphy-based sleep duration as well as biases in measurements varied by race/ethnicity. The highest correlations but greatest over-estimation of sleep duration occurred among non-Hispanic Whites. Further research is needed to understand the implications of differences in sleep measurement properties on assessments of sleep in multi-racial populations.

**Support (If Any):** Dr. Jackson was supported by Harvard Catalyst (grant 1UL1 TR001102-07). Dr. Redline was supported by the Multi-Ethnic Study of Atherosclerosis Sleep Study (R01HL098433).

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**1212**

**SLEEP DYNAMICS PREDICTION BY MULTIDIMENSIONAL PHYSIOLOGICAL VARIABILITIES**

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**Introduction:** Sleep is a systematic behavior. We propose a novel signal-processing algorithm to integrate the multi-channel polysonography signals and achieve a more accurate sleep stage prediction.

**Methods:** Different features are extracted from the respiratory signal, ECG, EMG, EOG, and EEG. The breathing pattern variability and non-rhythmic-to-rhythmic ratio (NRR) are extracted from the respiratory signal by Synchronized transform; suitable heart rate variability indices are evaluated from ECG; the dynamical features underlying the EMG and EOG are evaluated by the graph connection Laplacian. These features are called the auxiliary feature (AF). The features from the EEG are called the cortical features (CF). The concatenated features are called the global feature (GF). The sleep stages determined by experienced scorers are viewed as ground truth. To avoid the curse of dimensionality, we nonlinearly reduce the dimension of AF and CF by diffusion maps. The kernel SVM classification is applied to predict the sleep stage based on AF, CF, and GF. To prevent over-fitting, we repeatedly (25 times) randomly partition the data into the training dataset (80%) and the validation dataset (20%) and report the averaged result.

**Results:** We have 20 subjects (AHI < 5). There are 78 features in AF and 14 features in CF for each 3-second window and 7318 ± 617 AF, CF and GF. The dimension of AF (resp. CF) is reduced to 8 (resp. 4). The result is comparable to human expert classification -- the proposed classification of awake, REM, N1, N2 and N3 sleeping stages based on AF (resp. CF and GF) has the overall accuracy 85.7% (resp. 76% and 90.3%). The Mann-Whitney test confirms that the AF contains information complementary to EEG.

**Conclusion:** The integrated feature, AF, from the respiratory signal, ECG, EMG and EOG contains information complimentary to EEG, which allows an accurate automatic classification and indicates the potential to combine AF with EEG signal to stage the sleep dynamics.

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**1213**

**SUGGESTED CLINICAL IMMOBILIZATION TEST WITH A SMARTPHONE-BASED ELECTROMYOGRAPHY SYSTEM FOR SCREENING WILLIS-EKBOM DISEASE**

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**Introduction:** Willis Ekbom Disease (WED) might often be missed/misdiagnosed due to diagnostic criteria, which are based on the patients’ ability to vocalize the experienced sensorimotor discomfort. Our goal has been to develop a smartphone-based electromyography (sb-EMG) system that can provide objective information during the Suggested Clinical Immobilization Test (SCIT).

**Methods:** A student-team of the Capstone Design Project, an interdisciplinary program offered by the UBC Department of Electrical and Computer Engineering [http://www.ece.ubc.ca/courses/capstones], was assigned to develop the sb-EMG. The goal was that the completed sb-EMG system should be small, non-invasive, user-friendly, fast, accurate, low-cost (under $500), and applicable in clinical practice.

**Results:** The combination of an Android-based software and a Bitalino-based hardware was chosen as the most suitable solution: (a) Android [https://source.android.com/] was chosen to be the software platform of choice due to the wide range of open-source resources. (b) Bitalino [http://www.bitalino.com/] is a hardware platform designed for acquiring physiological signals and was selected based on an evaluation of overall system design, application development support, feasibility, sustainability, and value for its cost with respect to other hardware options. A functional prototype was implemented, which can acquire EMG data, transfer it via wireless Bluetooth interface to a smartphone, and graph the EMG signal on the mobile phone’s screen. The prototype consists of a 25 g (without battery), 4x2x1.5 cm, single-channel hardware component and a software application usable on any mobile phone running Android 4.0 or higher. With the addition of more sensors, the system is scalable to acquire data from up to five different channels. The system also features a 3.7 V, 700 mAh rechargeable battery that can be interchanged with higher capacity alternatives.

**Conclusion:** The sb-EMG prototype showed excellent potential to enable the acquisition and analysis of objective EMG signals during SCIT. Currently, we are validating the prototype with a standard EMG system.

**Support (If Any):** Treatable Intellectual Disability Endeavour, British Columbia, Children’s Sleep Network, and BC Children’s Foundation.
THE FEASIBILITY OF MOBILE HEALTH (mHealth) APPLICATIONS IN BEHAVIORAL SLEEP INTERVENTIONS FOR MILITARY POPULATIONS

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Introduction: Sleep disturbances are prevalent among Active Duty Service Members (ADSM) and Veterans, and threaten psychological health, resilience, and the military mission. Hypnotics remain the most common sleep treatments among ADSM and Veterans, despite substantial concerns regarding their safety (particularly in operational settings), side effects, and potential for abuse. Behavioral sleep treatments have been shown to be safe, effective, and are associated with durable improvements. However, the use of evidence-based, resilience-focused, behavioral treatments to promote healthy sleep pre-deployment and to treat sleep disturbances post-deployment remains scarce among ADSM, Veterans, and the clinicians who serve them. Mobile health (mHealth) has the potential to increase access to these behavioral treatments and to improve their effectiveness by tailoring and adapting the sleep interventions based on each individual’s needs.

Methods: We developed a cross-platform mHealth solution called iREST (interactive Resilience Enhancing Sleep Tactics) which consists of (1) a smartphone application (app) that records sleep data, shows feedbacks and related education materials, and provides cues and notifications (2) a Web-based portal that allows therapists to monitor sleep information, to prescribe treatment, and to engage participants in real-time via secure messages, and (3) a communication protocol that allows real-time bidirectional data exchange between the app and the portal. A pilot study with 12 ADSM and Veterans examined the feasibility, usability, and acceptability of iREST.

Results: iREST was found to be capable of supporting behavioral sleep treatments in ADSM and Veterans. Participants rated the app as highly usable (SUS mean = 81.3, score above a 68 would be considered above average) and on average completed 96.6% (SD = 7.45) of 4 weeks sleep diary entries. iREST was found to be capable of supporting behavioral sleep treatments in ADSM and Veterans. Participants rated the app as highly usable (SUS mean = 81.3, score above a 68 would be considered above average) and on average completed 96.6% (SD = 7.45) of 4 weeks sleep diary entries.

Conclusion: A smartphone app is feasible within sleep intervention for ADSM and Veterans. Integrating an mHealth platform may facilitate involvement in treatment and dissemination of effective tools in military and civilian samples.

COMPARING DIFFERENT METHODS OF ASSESSING HABITUAL SLEEP DURATION FOR EPIEMIOLOGIC RESEARCH

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Introduction: Large-scale survey studies tend to use single, non-validated items to assess sleep duration. It is unclear to what extent the different items produce different estimates of sleep duration and whether they predict outcomes in the same way.

Methods: Data from the Sleep and Healthy Activity, Diet, Environment, and Socialization (SHADES) study was used. SHADES is a community-based study of adults in southeastern Pennsylvania (N = 1007). Habitual sleep duration was assessed in four ways. The question from the National Health and Nutrition Examination Survey (NHANES) assessed hours of sleep on a typical weekday, the question from the Behavioral Risk Factor Surveillance System (BRFSS) assessed typical hours of sleep in 24 h, the question from the Pittsburgh Sleep Quality Index (PSQI) assessed sleep duration on a typical night, and the Sleep Timing Questionnaire (STQ) computed typical weeknight sleep from self-reported bed and wake times. These were evaluated continuously and categorized as short (≤ 6 h), normal (7–8 h), and long (≥ 9 h). Correlations among continuous (Pearson r) and categorical (Spearmann R) variables were computed. Further, all variables were used to predict obesity (BMI ≥ 30; N = 236), sleepiness (ESS ≥ 10; N = 325), and depression (PHQ9; N = 332) using logistic regression.

Results: All sleep duration items were significantly correlated (all p < 0.001): NHANES-PSQI (r = 0.78; R = 0.59); BRFSS-PSQI (r = 0.51; R = 0.36); PSQI-STQ (r = 0.49; R = 0.31); NHANES-BRFSS (r = 0.47; R = 0.48); NHANES-STQ (r = 0.42; R = 0.32); and BRFSS-STQ (r = 0.30; R = 0.21). Of those who identified as normal sleepers on NHANES, most also identified as normal sleepers on PSQI (89%), BRFSS (78%), and STQ (71%). Short sleep was associated with obesity using questions from NHANES (OR = 2.35; p < 0.0001), BRFSS (OR = 2.32; p < 0.0001), PSQI (OR = 2.45; p < 0.0001), and STQ (1.66; p < 0.0001). Short sleep was associated with sleepiness using questions from NHANES (OR = 2.30; p < 0.0001), BRFSS (OR = 2.14; p < 0.0001), PSQI (OR = 2.33; p < 0.0001), and STQ (2.29; p < 0.0001). Short sleep was associated with depression using questions from NHANES (OR = 2.09; p < 0.0001), BRFSS (OR = 1.98; p < 0.0001), PSQI (OR = 2.08; p < 0.0001), and STQ (1.59; p < 0.001).

Conclusion: Sleep duration items were correlated only moderately, but they similarly associate with outcomes when categorized. Thus, even though they do not overlap perfectly, they may be interchangeable in some cases.

Support (If Any): The SHADES study was funded by R21ES022931. Dr. Grandner is also supported by K23HL110216.

1216 PEDIATRIC SLEEP ESTIMATES IN HIGH- AND LOW-RISK SAMPLES: COMPARISONS BETWEEN VIDEOSOMNOGRAPHY AND PARENT-REPORT DIARIES

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Introduction: Practitioners and researchers often depend on parent-report diaries of children’s sleep behaviors. Within the home setting, it can be difficult to assess the accuracy of these reports, especially in families raising children with developmental disabilities (e.g., Autism Spectrum Disorder; ASD). Given the potential for elevated stress/chaos in these homes, parent-report estimates may not be as accurate. The present study compared child sleep estimates across parent-report sleep diaries and home-based videosomnography (i.e., video-recordings of sleep).

Methods: As a part of a larger longitudinal study, families from two groups were assessed when their child was 24 or 36 months of age. These groups included families raising at least one child with ASD (high-risk, n = 22) and families raising children with no known diagnosis (low-risk, n = 37). Families completed at least three nights of videosomnography and parent-report diaries. Analyses included paired-sample t tests, Wilcoxon rank-sum tests, and independent-group t tests.

Results: Using all available nights in both groups, mean estimates of sleep duration, sleep onset/offset, and number and duration of night awakenings were slightly different across videosomnography and parent-report diaries (p range 0.03 to 0.09). Although many of these differences were statistically significant, they were not meaningful in practical terms (e.g., parents on average reported night awakenings that were 4 minutes longer). Group comparisons revealed comparable variance estimates and levels of parent-report inaccuracy were not significa-
1218

VALIDATION OF THE ALLIANCE SLEEP QUESTIONNAIRE (ASQ) RESTLESS LEGS SYNDROME MODULE IN SLEEP DISORDERED PATIENTS

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Introduction: In 2012, the Stanford Sleep Disorders Clinic (SSDC) adopted the Alliance Sleep Questionnaire (ASQ) as standard of care for new patients. The ASQ is an on-line questionnaire designed by a multi-disciplinary team to evaluate sleep disorders and complaints. It uses branching logic to deliver validated measures and novel questions for research or clinical purposes. It outputs a customizable Summary Report to streamline clinical appointments. In this study, we validated the ASQ’s ability to predict individuals with Restless Legs Syndrome (RLS) in SSDC patients.

Methods: The population was patients (treated and untreated) seen at the SSDC. Individuals had to consent to participate in research, complete the ASQ RLS section and have clinical information in the electronic medical record (EMR) to be included in analysis. Using the ASQ, we selected two patterns of responses a priori to indicate RLS using the first four 2012 Revised International Restless Legs Syndrome Study Group (IRLSSG) Diagnostic Essential Criteria (urge to move, worse during rest and evening and improved with movement) as a starting point. Since our population includes treated patients, the ASQ primary definition for RLS was either positive endorsement of the 4 IRLSSG essential criteria or self-reported previous RLS diagnosis. To avoid missing severe cases, a frequency criteria of symptoms occurring at least 3 times/week was added to the primary ASQ definition. The ASQ score cannot be calculated with a “don’t know” response on whether

XIII. Instrumentation and Methodology

1217

ACCURACY OF THE ODDS-RATIO-PRODUCT OBTAINED FROM FRONTAL ELECTROENCEPHALOGRAPHY

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Introduction: Odds-Ratio-Product (ORP) is a recently introduced continuous index of sleep state. It ranges from 0 to 2.5. In validation studies an ORP2.0 was found in wakefulness. The ORP scale was developed from central electroencephalography electrode signals. Because of its potential utility in home studies and the greater ease of applying frontal electrodes in such studies we wondered if the ORP derived from frontal electrodes agreed with values obtained from central electrodes.

Methods: Forty-two clinical polysomnography records were digitally analyzed in order to obtain ORP in consecutive 30-second epochs. Analysis was performed once using C3/M2 and C4/M1 electrodes and again using F3/M2 and F4/M1 electrodes. Twenty-five studies showed a range from mild to severe OSA, eleven had no pathology and four showed insomnia. Intra-class correlation was used to compare 30-second frontal and central ORP values on the same side (700–900 data pairs per side per record). Average ORP values across the whole record (ORPAVE) were also compared.

Results: C4 and F3 electrodes were not used in one and 3 studies, respectively, because of excessive beta noise. For the remaining 80 comparisons, ICCs averaged 0.93 ± 0.07 for C3 vs. F3 and 0.95 ± 0.05 for C4 vs. F4. ORPAVE was 1.02 ± 0.36 in all four electrodes with a range of 0.44 to 2.05, reflecting the range of overall sleep quality among patients. The difference between average ORP in the two electrodes being compared was 0.00 ± 0.11 for both C3 vs. F3 (n = 39) and C4 vs. F4 (n = 41) comparisons.

Conclusion: Odds-Ratio-Product measured from frontal electrodes is nearly identical to that measured from central electrodes. This should facilitate obtaining sleep information in home studies.

Support (If Any): YRT Ltd

1218

VALIDATION OF THE HYPERSOMNIA SEVERITY INDEX (HSI)

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Introduction: Hypersomnia is common in psychiatric disorders, yet there are few self-report measures that characterize this sleep disturbance. The objective of this study was to validate the Hypersomnia Severity Index (HSI), a tool designed to measure severity, distress and impairment of hypersomnia in psychiatric populations.

Methods: Psychometric properties were evaluated in an undergraduate scale development sample (N = 380) and two psychiatric validation samples: euthymic bipolar participants with a range of sleep complaints (N = 103), and unmedicated unipolar depressed participants (N = 19) meeting operational criteria for hypersomnia disorder derived from epidemiologic survey data of the US the general population. Construct validity was established against the Epworth Sleepiness Scale (ESS), Pittsburgh Sleep Quality Index (PSQI), and measures of functional impairment, along with two weeks of sleep diaries and actigraphy from which total sleep time (TST) and time in bed (TIB) were extracted.

Results: The HSI demonstrated good internal reliability (development sample Cronbach α = 0.82, combined psychiatric sample α = 0.85). Convergent validity was supported by significant correlations with ESS total scores (development r = 0.41, p < 0.001; psychiatric r = 0.41, p < 0.001) and the PSQI daytime dysfunction subscale (development r = 0.39, p < 0.001; psychiatric r = 0.31, p < 0.01). Construct validity was further supported by correlations between the psychiatric sample and actigraphy-determined TST and TIB (r ≥ 0.40, p < 0.05 for both) and diary-reported TIB (r = 0.26, p < 0.01). HSI scores correlated with functional impairment measures in both the development (r = 0.59, p < 0.001) and bipolar (r = 0.59, p < 0.01) samples. One-month test-retest reliability (ICC) in the bipolar sample was 0.69.

Conclusion: The HSI shows promise as a measure of hypersomnia that is commonly seen in psychiatric disorders, and may be of use to both researchers and clinicians.

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symptoms improve with movement, so 129 people were removed from the dataset. The gold standard was defined as individuals with an RLS diagnostic code in the EMR. Everyone else was considered negative for RLS.

**Results:** 1646 patients met our inclusion criteria (949 males, 697 females; mean age 47 ± 15.7, range 18–90). Using the primary definition, the ASQ correctly identified 111 of 161 true positive individuals, resulting in Sensitivity of 70%. The ASQ correctly predicted 1354 of the 1485 true RLS negative patients resulting in a Specificity of 91%. Using stricter ASQ criteria, we identified 48 of 153 RLS patients for a Specificity of 31%. The ASQ identified 1432 of 1469 RLS negative patients, for a Specificity of 97%.

**Conclusion:** The primary ASQ algorithm had moderate sensitivity and strong specificity. We are exploring the reason for the lower sensitivity (RLS patients diagnosed with RLS by clinicians but did not meet the IRRLSG/ASQ criteria). Possibilities include: over-diagnosis by clinicians, treatment effects and/or inaccurate self report.

**Support (If Any):** Phillips Respironics Foundation

### 1220

**POLYSOMNOGRAPHY IN CIGARETTE SMOKERS AFTER SMOKING AND DURING A QUIT ATTEMPT**

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**Introduction:** Relapse rates in smokers attempting to quit are high, but the factors that drive relapse risk are not well understood. Nicotine is a psychostimulant known to reduce sleepiness but also cause sleep disruption. Self-report data have suggested that disturbed sleep during abstinence may prompt individuals to resume smoking to mitigate daytime sleepiness. Here we used polysomnography (PSG) to investigate sleep in smokers before and during a quit attempt without treatment (“cold turkey”).

**Methods:** N = 14 moderate cigarette smokers (16.2 ± 6.2 cigarettes per day; ages 27.6 ± 5.6 y; 1 woman), healthy and free from drugs besides nicotine, were in the laboratory for three consecutive nights (18:00–09:00) with PSG recordings (10 h time in bed, 22:00–08:00). On the morning after night 1, subjects initiated a quit attempt without treatment. During nights 2 and 3, carbon monoxide (CO) and urine cotinine were measured to verify abstinence. PSG records were scored visually (AASM 2007) and differences in sleep architecture between night 1 (smoking), and nights 2 and 3 (abstinence) were investigated. Sleep variables were also compared between smokers and an age- and sex-matched control group of non-smokers from another study with three consecutive PSG recordings (10 h time in bed, 22:00–08:00). Statistical analyses employed mixed-effects ANOVA controlling for age.

**Results:** Following the quit attempt, subjects showed significant decreases in CO (F = 58.4, P < 0.001) and urine cotinine (F = 24.0, P < 0.001). A significant change across nights was observed for sleep latency (SL; F = 3.62, P = 0.041), which dropped from 44.9 ± 9.0 min (mean ± SEM) after smoking to 27.7 ± 8.0 min during abstinence. When compared to controls, smokers had more disrupted sleep on all 3 nights—more N1 (F = 8.6, P = 0.005), less N3 (F = 6.3, P = 0.016), more arousals (F = 7.6, P = 0.008), longer latency to N3 (F = 7.7, P = 0.008)—despite no differences in total sleep time (F = 0.54, P = 0.47).

**Conclusion:** SL decreased from night 1 (after smoking) to nights 2–3 (abstinence). This likely reflects the psychostimulant effect of nicotine rather than a first-night effect, because the change in SL was not observed in controls and there was no group difference when both groups were not smoking. Regardless of smoking or during abstinence, smokers had more disturbed sleep (more N1, less N3, more arousals, greater N3 latency). Whether this persistent sleep disturbance during abstinence contributes to the high relapse rate in smokers quitting without treatment remains to be determined.

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### 1221

**MEASURING TREATMENT OUTCOMES IN COMORBID INSOMNIA AND FIBROMYALGIA: CONCORDANCE OF SUBJECTIVE AND OBJECTIVE ASSESSMENTS**

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**Introduction:** In insomnia, actigraphy tends to underestimate wake time compared to diaries and PSG. When chronic pain co-occurs with insomnia, sleep may be more fragmented, including more arousals accompanied by movement. However, individuals may not be consciously aware of these arousals. We therefore hypothesized that in comorbid insomnia/fibromyalgia, actigraphy and PSG would be relatively concordant, while actigraphy would overestimate WASO and underestimate TST and SE compared to diaries. Accordingly, we expected actigraphy to be less sensitive than diaries to detecting treatment-related changes following cognitive behavioral treatment for insomnia (CBT-I).

**Methods:** Adults with insomnia and fibromyalgia (N = 113) were randomized to waitlist control, CBT-I, or CBT for pain. At baseline and post-treatment, participants completed 1 night of PSG and 2 weeks of diaries/actigraphy.

**Results:** We examined baseline concordance and treatment-related changes in TIB, TST, SOL, WASO, and SE. At baseline, ANOVAs showed that the discrepancy between actigraphy/PSG was significantly less (p < 0.05) than the difference between actigraphy/diary. As expected, the difference in concordance was significant for TST, WASO, and SE. Repeated measures ANOVAs were performed for the CBT-I group, and significant method by time interactions indicated that the assessment methods differed in their sensitivity to detect treatment-related changes. Post-hoc analyses showed that PSG values did not change significantly for any sleep parameters. However, diaries showed improvements in SOL, WASO, and SE, and actigraphy also detected the WASO and SE improvements (p < 0.05).

**Conclusion:** In the context of comorbid insomnia/fibromyalgia, actigraphy is generally more concordant with PSG than it is with diaries, which are the recommended assessment for diagnosing insomnia. However, actigraphy showed greater sensitivity to treatment-related changes than PSG; PSG failed to detect any improvements, but actigraphy demonstrated changes in WASO and SE, which were also found with diaries. In comorbid insomnia/fibromyalgia, actigraphy may therefore have utility in measuring treatment outcomes.

**Support (If Any):** R01AR055160
SLEEP RESEARCH CONTENT AND USE ANALYSIS FROM AN ONLINE DOCUMENT MANAGEMENT SYSTEM
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Introduction: With continually enhanced technology, research study management has similarly evolved. Our team developed and tested an electronic data management system during the course of a multicenter clinical trial: Apnea Positive Pressure Long-term Efficacy Study (APPLES).

Methods: During the initial design phase, a requirement was identified to provide a secure, on-line portal for accessing important study documents. For APPLES, a total of 1,105 obstructive sleep apnea patients were randomized to Active CPAP or Sham CPAP (558 Active, 547 Sham) between December 2003 and July 2007 from five clinical centers (Stanford, CA; University of Arizona, Tucson, AZ; St. Mary Medical Center, Walla Walla, WA; St. Luke’s Hospital, Chesterfield, MO; Brigham and Women’s Hospital, Boston, MA).

Results: The APPLES document management system (DMS) was launched in September 2004. By the time the last document was uploaded in October 2010, a total of 1,375 documents were available for review. Content were categorized into three main groups based on the purpose of the document (meeting agenda, report, review, etc.) and the group receiving access to the documents (Steering Committee, Quality Assurance/Quality Control Committee, Data and Safety Monitoring Board [DSMB], etc.). In April 2006, an automated email reminding feature improved efficiency and began logging whether content was downloaded. A total of 3,719 email messages were delivered: Over 50% of documents were loaded by 12% of personnel (132 members). Strategic documents were downloaded by 42% of personnel (63 members) and Administrative documents were downloaded by 34% of personnel (31 members).

Conclusion: Following a design phase for the Comparative Outcomes Management with Electronic Data Technology (COMET) Study, the desired features of this DMS evolved to include a password-protected access website, search capability, version control, tracking logs, and the ability to archive diverse content types (e.g., documents, spreadsheets, images).

Support (If Any): APPLES was funded by contract 5-U01-HL-068060 from the National Heart, Lung and Blood Institute (NHLBI). COMET is funded by grant 1-RO1-HS-019738 from the Agency for Healthcare Research and Quality (AHRQ).

BIG DATA COLLECTION: A PRACTICAL METHOD OF COMBINING PATIENT CARE WITH OUTCOMES RESEARCH
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Introduction: We optimized our EMR (Epic) by creating structured clinical documentation support (SCDS) tools that standardize initial and annual follow up visits of Sleep patients according to Best Practices. The SCDS tools write notes and electronically capture data and prompt enrollment of eligible subjects into research studies. We are sequentially enrolling 1,000 patients with Willis-Ekbom disease (WED) into a research study that includes consenting and DNA sampling. We will associate genotypes with the repeated measures captured by the SCDS tools over 10 years, and identify DNA variations that predict outcomes and treatment responses.

Methods: All patients referred for a sleep evaluation in the Department of Neurology at NorthShore University HealthSystem were evaluated at initial and annual follow up visits using our SCDS tools. Up to 1,000 cascading fields of discreet data were captured per office visit. Assessments included the GAD-7, CES-D, ESS, PSQI, and ISI questionnaires. For patients diagnosed with WED, we were electronically prompted to also perform the International RLS Scale (IRLS) and to approve enrollment into our study. We tracked progress and cleaned data using monthly enrollment and data quality reports.

Results: We performed 184 initial visit assessments of WED patients over two years. All of the subjects had DNA stored. We captured and cleaned hundreds of thousands of discreet data for these patients. We are in the process of conducting our first annual follow up visits, creating descriptive reports of the cohort, and performing pairwise correlations and principle component analyses of the score test measures.

Conclusion: The use of SCDS tools is time neutral, improves note writing, and captures data for quality improvement and research projects, with little disruption to our community health system-based Sleep Neurology practice.

Support (If Any): Auxiliary of NorthShore University HealthSystem and by additional philanthropic gifts.
ASSOCIATION OF SLEEP DURATION WITH TYPE 2 DIABETES IN TAIWANESE ADULTS: A POPULATION-BASED STUDY

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Introduction: Experimental sleep study indicated sleep loss was a novel risk factor for insulin resistance and metabolic; however, little was known about the metabolic effects of sleep time curtailment in population of community in Taiwanese. We assessed the cross-sectional relation of sleep duration to type 2 diabetes in Taiwanese adults.

Methods: The analysis of data was obtained from Nutrition and Health Survey in Taiwan (NAHSIT) during 2005–2008. This survey was conducted by stratified three-staged probability sampling design. Participants were 739 men and 809 women, aged 19 to 64 years. The relation of sleep duration to DM was examined using logistic regression model.

Results: The average sleep duration was 7.0 ± 1.3 hours per night, with 35.1% of subjects sleeping less than 7 hours per night. After adjusted confounders (age, sex, body mass index, waist circumferences, total cholesterol, sleep disturbances, hypertension). Compared with those sleeping 7 to 8 h per night, subjects sleeping 5 h had adjusted odds ratio for DM of 2.04 (95% CI 1.05–3.95). Among subjects aged 19 to 44 years with sleeping 5 h had adjusted odds ratio for DM of 5.24 (95% CI 1.17–23.475), compared with those sleeping 7 to 8 h per night.

Conclusion: Our results showed that short sleep duration is associated with high prevalence of diabetes, especially among in young adults with sleeping 5 h had high risk for DM.

EARLY DIAGNOSIS AND TREATMENT OF SLEEP DISORDERED BREATHING IN PATIENTS ADMITTED WITH CHRONIC OBSTRUCTIVE PULMONARY DISEASE EXACERBATION REDUCES READMISSIONS

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Introduction: COPD exacerbation is an important cause for healthcare utilization. Concomitant sleep disordered breathing (SDB) may worsen prognosis. We hypothesize that early diagnosis and treatment of SDB in hospitalized patients with COPD exacerbation will reduce readmissions.

Methods: The data collected by a formal inpatient sleep consultation program over a period of one year at the Jefferson University Hospital was reviewed. Of the 410 patients consulted during this period, 24 patients admitted with COPD exacerbation were analyzed. Compliance was defined as positive airway pressure (PAP) usage more than 4 hours per night, 70% or more of the time. Composite end point of hospital admissions and Emergency Room (ER) visits during 6 months and 12 months following therapy was compared to encounters prior to therapy.

Results: Of the 24 patients admitted with COPD exacerbation, 12 were compliant (50%). Baseline characteristics were similar between compliant and non-compliant groups. Mean age, BMI and AHI between compliant and non-compliant were 60.1 vs 60.7, 40.3 vs 38.5 and 21 vs 29, respectively. There were no differences in the comorbidities. Mean decrease in the composite ER+hospital admissions at 6 months was −0.8 (SD = 1.5, 95 CI: −1.7, 0.2) for the non-compliant group, compared to −2.1 (SD = 1.2, 95 CI: −3.8, −1.5) for the compliant group, p = 0.03. Mean decrease in ER+hospital admissions at 12 months was −0.8 (SD = 1.9, 95 CI: −2.0, 0.4) for the non-compliant group, compared to −2.7 (SD = 1.8, 95 CI: −3.8, −1.5) for the compliant group, p = 0.03.

Conclusion: Among the patients admitted with COPD exacerbation, a significant reduction in the composite end point of ER visits and hospital admissions was observed in those who were compliant with PAP therapy, compared to those who were not compliant. The study suggests that early diagnosis of SDB and intervention in patients hospitalized with COPD exacerbation may result in reduced healthcare utilization.

Support (If Any): Unrestricted research grant from Resmed to mentor (Dr. Sharma)

THE SOCIAL PATTERNING OF SLEEP IN AFRICAN AMERICANS: ASSOCIATIONS OF SOCIOECONOMIC POSITION AND NEIGHBORHOOD CHARACTERISTICS WITH SLEEP IN THE JACKSON HEART STUDY

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Introduction: African Americans have poorer sleep quality and lower mean sleep duration compared to other racial groups. Individual-level social and environmental factors may contribute to poor sleep outcomes in this population but have not been studied. Using baseline data from the Jackson Heart Study (JHS), we studied associations of individual-level socioeconomic position (SEP) and neighborhood characteristics (social cohesion, violence (frequency of violent acts), problems, disadvantage (lower socioeconomic position)) with sleep duration and sleep quality in 5,301 African Americans.

Methods: All measures were self-reported. Sleep duration was assessed as hours of sleep; sleep quality was reported as poor (1) to excellent (5). SEP was measured by categorized years of education and income. Multinomial logistic and linear regression models were fit to examine the associations of SEP and neighborhood characteristics (modeled dichotomously) with sleep duration (short vs. normal, long vs. normal) and continuous sleep duration and quality after adjustment for demographics and risk factors.

Results: The sample was 63% female, with a mean age of 54.7 years. The mean sleep duration was 6.4 ± 1.5 hours, 54% had a short (< 6 hours) sleep duration, 5% reported long (> 9 hours) sleep duration, and 24% reported poor sleep quality. Lower education was associated with greater odds of long sleep (odds ratio (OR) = 2.35, 95% confidence interval (CI) = 1.53, 3.60) and poorer sleep quality (β = −0.19, 95% CI = −0.29, −0.09) compared to higher education after adjustment for demographics and risk factors. Findings were similar for income. High neighborhood violence was associated with shorter sleep duration (−10.4 minutes, 95% CI = −3.61, −17.25) and poorer sleep quality (β = −0.11, 95% CI = −0.22, −0.00) after adjustment for demographics and risk factors. Results were similar for neighborhood problems.

Conclusions: Social and environmental characteristics are associated with sleep duration and quality may contribute to adverse sleep outcomes in African Americans.

Support (If Any): This research was supported in part by the Michigan Center for Integrative Approaches to Health Disparities (P60MD002249) funded by the National Institute on Minority Health and Health Disparities; The National Heart, Lung, And Blood Institute of the National Institutes of Health under Award Number R01HL071759; and the Robert Wood Johnson Foundation Health &
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PSYCHOSOCIAL STRESS AND SLEEP AMONG AFRICAN AMERICANS IN THE JACKSON HEART STUDY

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Introduction: Studies have shown that psychosocial stressors are related to poor sleep. However, studies of African Americans, who may be more vulnerable to the impact of psychosocial stressors, are lacking. Using the Jackson Heart Study (JHS), we examined cross-sectional associations of psychosocial stress with sleep duration and quality in 4,863 African Americans.

Methods: Sleep duration was assessed as self-reported hours of sleep, and sleep quality was assessed as self-reported rating of sleep quality (1 = poor-5 = excellent). Three measures of psychosocial stress were investigated: the Global Perceived Stress Scale (GPSS); Major Life Events (MLE); and the Weekly Stress Inventory (WSI). Multinomial logistic and linear regression models were used to examine the association of each stress measure (in quartiles) with sleep duration (≤ 6 hours, or “short” vs. 7 or 8 hours, or “normal”; ≥ 9 hours, or “long” vs. “normal”) and continuous sleep duration and sleep quality after adjustment for demographics and risk factors (BMI, hypertension, diabetes, physical activity).

Results: Mean age of the sample was 54.6 years and 64% were females. Mean sleep duration was 6.4 ± 1.5 hours, 54% had a short sleep duration, 5% had a long sleep duration, and 34% reported a “poor” or “fair” sleep quality. Persons who reported high scores on the GPSS had higher odds of short sleep (odds ratio: 1.89, 95% confidence interval: 1.55, 2.30), shorter average sleep duration (Δ = –33.6 minutes (95% CI: –41.8, –25.4), and reported poorer sleep quality (Δ = –0.73 (95% CI: –0.83, –0.63) compared to those in the lowest quartile of GPSS after adjustment for demographics and risk factors. Results were consistent for WSI and MLE. Psychosocial stressors were not associated with long sleep.

Conclusions: Psychosocial stressors are associated with higher odds of short sleep, lower average sleep duration, and lower sleep quality in African Americans. Psychosocial stress may contribute to adverse sleep outcomes in African Americans.

Support (If Any): This research was supported in part by the Michigan Center for Integrative Approaches to Health Disparities (P60MD002249) funded by the National Institute on Minority Health and Health Disparities; The National Heart, Lung, And Blood Institute of the National Institutes of Health under Award Number R01HL071759; and the Robert Wood Johnson Foundation Health & Society Scholars program. The content is solely the responsibility of the authors and does not necessarily represent the official views of the National Institutes of Health.

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SLEEP MEDICINE SERVICE ACCESS FOR AN UNDERSERVED POPULATION IN A GEOGRAPHICALLY REMOTE AREA OF LOS ANGELES COUNTY (LAC)

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Introduction: Telemedicine can improve sleep healthcare access in communities distant from sleep centers, and may be useful for underserved populations with limited transportation. LAC healthcare system patients residing in Antelope Valley (AV) travel at least 50 miles for sleep services at Olive View-UCLA Medical Center (OVMC). To determine a potential role for sleep telemedicine, we compared current access and outcomes between patients residing in AV vs the OVMC-San Fernando 91342 zip code area (SF).

Methods: We developed a database from referral, medical, sleep laboratory and clinic records of 274 AV and 103 SF patients referred for sleep testing during January 2013-June 2014. The groups were compared regarding completion and timeliness, CPAP acceptance, and hospitalization rates before and after testing using Bonferroni corrected student-t tests, normally approximated Z-tests and counts assuming Poisson distribution.

Results: AV vs SF patients were similar in age, BMI, daytime symptom scores and co-morbidities, but AV had a higher proportion of men (52% vs 35%). The proportion of referrals that completed the initial pre-test intake assessment at OVMC was significantly less for AV (146 (53.1%) vs SF (77 (74.8%)) (p = 0.0007). Average days from referral to intake were greater for AV than SF (59.9 ± 107.2 vs 35.0 ± 54.7, p = 0.02), but similar from intake to sleep study and CPAP set-up. Proportions of patients prescribed CPAP (59% vs 58%), patients that accepted CPAP (82% vs 72%) and sleep clinic follow-up visits (42% vs 44%) were similar. In both groups, hospitalizations/yr decreased during the 18 months after testing compared to the year before testing, from 26 (CI: 17–38) to 10 (CI: 4–10) for AV and from 23 (CI: 15–35) to 4 (CI: 1–10) for SF (p < 0.001).

Conclusion: These findings suggest an access barrier for AV patients at initiation of the testing process. A sleep telemedicine program targeting intake and testing may improve access.

Support (If Any): ASMF Humanitarian Award

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AMBULATORY AT HOME PAP THERAPY IN AN UNDERSERVED POPULATION: FACTORS INFLUENCING COMPLIANCE

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Introduction: Carolinas Sleep Services has an Ambulatory Sleep program in which uninsured patients in Mecklenberg County, NC are provided both diagnostic and treatment options at either no or minimal charge. We retrospectively reviewed the chart data for 236 patients at the Carolina Sleep Services Ambulatory Clinic to assess patient adherence to PAP therapy in this low-income/underserved population.

Methods: The CSS program followed the following protocol: Patients with a prior diagnosis of sleep apnea were sent directly to Healthy at Home for initiation of PAP therapy. Patients with suspected sleep apnea were referred to CMC-Mercy for a daytime sleep study with a limited channel hook up. Patients diagnosed with significant obstructive sleep apnea were then placed on an auto-titration PAP device to determine
proper home settings. A refurbished or low cost PAP machine was then provided to the patients.

Results: Relatively few compliance reports were found for the patients who were referred to PAP therapy. The presence or absence of compliance reports was not entirely due to patient characteristics. Although there were some problems that were due to patient lack of adherence – e.g., 55% of patients failed to show for follow up appointments. Another major limitation of the study was the number of compliance reports available from the electronic databases. However out of 236 patients 30 compliance reports were found and only 14 patients (47%) of the 30 with compliance reports complied with their PAP therapy.

Conclusion: Enhancing compliance with PAP therapy will increase the treatment rate of OSAS, in turn improving an underserved community’s health. In the future, programs addressing issues of affordability, tracking compliance, providing education on the hazards of sleep apnea, and training patients to use PAP devices and masks in this population will be key in cultivating PAP adherence.

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EFFICACY OF SLEEP EDUCATION IN A DOMINICAN REPUBLIC NEIGHBORHOOD THROUGH TRAINING OF COMMUNITY HEALTH PROMOTERS

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Introduction: The Children’s Hospital of Philadelphia (CHOP) Global Health Allies program in the Dominican Republic provides opportunities for CHOP employees to deliver health training to community members who lack access to health education. The program trains ten health promoters (HPs) with the goal of becoming the bridge between a health provider and the community. We evaluated the effectiveness of the HPs in teaching sleep concepts to the community and identified areas of improvement.

Methods: Ten HPs received a 4-hour training session in sleep medicine including sleep disorders, consequences of sleep deprivation and the importance of sleep. 100 questionnaires were randomly administered to adult community members during a health fair. The questions assessed basic knowledge of sleep disorders, sleep deprivation and the importance of sleep. HPs were then instructed to educate the community on these topics, using the knowledge gained from an educational session with CHOP employees. 100 questionnaires will be administered to random adult community members 3 months later to assess for changes after the HPs educated the community members.

Results: 93 adults responded to the questionnaire. 92 (99%) stated that sleep is important. The most known sleep disorder was insomnia 59 (63%) followed by restless legs syndrome 26 (28%), obstructive sleep apnea 17 (18%) and narcolepsy 11 (12%). 40% of the respondents believed that excessive daytime sleepiness can be caused by a medical or sleep condition. In terms of sleep deprivation, 78% believed it can produce car accidents and 70% answered that it can cause behavioral problems.

Conclusion: Community education and prevention is the goal of many outreach programs. In ours, many respondents were unfamiliar with sleep conditions such as OSA and narcolepsy. Our results show the feasibility of community education about sleep medicine through the training of a small group of HPs.

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IMPROVING OBSTRUCTIVE SLEEP APNEA HEALTH LITERACY AND TREATMENT ADHERENCE: A STRATIFIED MULTILEVEL PROCESS IMPROVEMENT INITIATIVE

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Introduction: Poor adherence to positive airway pressure is a challenge. Many strategies to monitor patient compliance through the development of CPAP adherence programs have been employed. Inadequate health literacy has been associated with poor clinical outcomes and reduced compliance. Patients in military health face unique challenges with adherence after initiation of PAP treatment. We developed a stratified PAP adherence program consisting of 4 interventions in the initial 8 weeks of PAP therapy. Verbal and written education regarding OSA health literacy, therapy options, short-term goals, and potential impact of compliance was provided.

Methods: This is a single military center observational process improvement project, with 24 participants in a stratified multilevel PAP adherence program. The patients completed pre-intervention 5 item questionnaire assessing OSA and PAP health literacy. This was followed by an educational group session and an individual evaluation by a sleep physician. Patients then completed a post-intervention questionnaire. Written instructions, care plan, and follow up appointment were provided. A telephone consult was performed after one week of utilizing PAP. At 6 weeks a follow up evaluation to assess compliance and retained health literacy will be attempted.

Results: Initially 4.5% (1/22) answered all five items correctly, improving to 63.2% (12/19) on the post-intervention questionnaire. The mean number of questions correct was 45.5% (2.27/5) and 89.5% (4.47/5) (median 60% (3/5) and 100% (5/5)) for the respective groups. Initial phone follow-up thus far has been 85.7% (6/7). Overall compliance, health literacy, follow-up, residual AHI, and change in ESS scores are being compared.

Conclusion: Room for improvement exists in patient understanding of OSA and its treatment along with timely follow-up and treatment compliance. Participation in a multi-stratified treatment program has led to improved patient health literacy and follow-up in our center. Program completion is also predicted to improve overall compliance and treatment outcomes.

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SLEEP DATA MINING ALLOWS IN DEPTH UNDERSTANDING OF SLEEP PATTERNS AND PROBLEMS

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Introduction: Sleep problems are prevalent and affect quality of life, health, and performance. Evaluation and treatment are restricted due to high costs and limited availability of clinical sleep facilities. The need to close the gap between the needs and the solutions stimulates new technological developments to allow simple sleep self-evaluation, and possibly adequate help, in the personal sleep environment. Large scale solutions using mobile communication and off the shelf sensors provide initial sleep assistance. At the same time, sleep data acquisition facilitates better understanding of the sleep process itself and continuous improvement of the initial technologies. SleepRate application offers users sleep evaluation and personalized sleep improvement using
**B. Clinical Sleep Science**

**1233 PREVALENCE OF SUBJECTS WITH CHRONIC SLEEP INSUFFICIENCY IN SOUTH KOREA**

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**Introduction:** To investigate the prevalence of subjects with chronic sleep insufficiency in Korean adults and to explore their characteristics.

**Methods:** A total of N = 2,762 participants from 2011 to 2012 answered questions about the sleep-wake habit and sleep quality. According to sleep time over weekdays, subjects were divided into group of short sleep (SS, < 5 h), normal sleep (NS 5–9 h) and long sleep (LS, > 9 h).

**Results:** 219 subjects (7.9%) were pertinent to SS. Their total sleep time was significantly shorter over weekdays (mean 4.5 h, 01:06–05:54) than weekends (5.7 h, 00:54–06:48, p < 0.001). NS and LS did not sleep longer over weekends. Only 31.5% of SS (n = 69) were satisfied with their sleep (71.3% of NS, 92.1% of LS). 9.1% of SS (n = 20) had a history of sleeping pills (1.7% of NS, 3% of LS). SS were the sleepiest during daytime (Ephwo sleepiness scale 6.4 in SS vs. 5.5 in NS, 5.4 in LS), slept the worst (Pittsburgh Sleep questionnaire index 7.7 in SS vs. 4.3 in NS, 3.9 in LS), and had the most trouble with sleep (Insomnia severity scale 7.2 in SS vs. 4.3 in NS and 4.8 in LS). 17.8% of SS scored ≥ 2 of Berlin questionnaire (risk of obstructive sleep apnea), significantly higher than others (9.2%). Demographics (age, gender, shift worker, monthly income, and education) were not different among groups. Hypertension tends to be higher in SS (16.4%) than NS (11.7%) or LS (8.9%).

**Conclusion:** 7.9% of Korean adults sleep less than 5 h over weekdays and their sleep time is the least even over weekends (5.7 h). The poor sleep quality and higher insomnia scales of SS suggest that chronic sleep insufficiency may result from sleep disorders rather than lack of time for sleep.

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**XIV. Health Care Services, Research and Education**

**1234 COMMUNICATION ERROR ANALYZES OF SLEEP/WAKE-BEHAVIOUR ASSESSMENTS: THE NEED FOR OPTIMIZING COMMUNICATION AND DATA GATHERING WITH NEW TECHNOLOGIES**


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**Introduction:** In complex chronic-care, patients’ functional co-morbidities (such as sleep problems) often remain unreported or unrecognized, and can lead to a cascade of diagnoses and inappropriate medications; one contributing factor is that documentation lacks an overview accessible to patients/stakeholders. We are investigating and developing concepts for facilitating overview of complex patient data.

**Methods:** (1) We investigated required information for providing an overview of patient history, through semi-structured interviews and chart analysis, then visualized communication pathways of five paediatric complex chronic care patients (PCCCP, referred to a sleep/wake-behaviour clinic and needing at least five interventions by multi-professional teams). (2) Additionally, four PCCCPs’ medical/narrative-based diagnoses and interventions were visualized in life-trajectory graphs. (3) Results were presented and discussed with representatives of service-providing non-governmental organizations (NGOs).

**Results:** (1) The visualization of communication pathways revealed that patient families were often not included in report distribution. (2) Life-trajectory graphs revealed, in addition to results presented in #1, that physicians targeted sleep problems with a significant average delay, up to 7 years. (3) NGO representatives suggested collective data gathering for reducing communication errors and quality control purposes. In consequence, utilizing the Vancouver-Polar-BEARS concept (which adds information on family ecology and prescription/non-prescription medications to the standard BEARS questions), we developed a prototype for a web-based sleep/wake-behaviour app (SWAPP). Printed results facilitate immediate quality control by patient/families and professionals and allow patients/families to share data easily with other care providers. The life-trajectory graph, gathering medical information and patient/parent comments into a timeline, was also developed into a prototype app that enables interactive visualized presentation.

**Conclusion:** Modern technology can enable bi-directional communication between professionals and patient families. Data ownership-based challenges, optimal visualization of collected data and the design of apps that are accessible and useful for both clinicians and patients are the subject of ongoing research.

**Support (If Any):** The SWAPP prototype was developed by Shift Health Paradigms Inc. (Toronto, Canada); The Life-Trajectory-App prototype was developed at the Hackathon of the eHealth Conference with support of Engage Data (Vancouver, Canada). Supported by Treatable Intellectual Disability Endeavour-British Columbia, Neuro-
INTRODUCTION: Sleep, sedentary behavior (i.e., sitting), and physical activity are distinct lifestyle behaviors associated with increasing rates of chronic diseases, including obesity, diabetes, and cardiovascular disease. These behaviors are linked within the circadian cycle; thus, increasing time in one behavior inevitably requires decreasing time in another behavior. Personal technologies, such as smartphones, may be an ideal route to deliver health interventions to the over 5.5 million Veterans given their access to the existing mHealth portal. The goal of this study was to develop and test BeWell24, a multi-component smartphone “app” targeting sleep, sedentary behavior, and physical activity for use as a lifestyle intervention for the growing US Veteran population.

METHODS: Content, developed from evidence-based behavioral strategies for sleep (stimulus control therapy), sedentary behavior (self-regulatory strategies), and physical activity (goal setting), used a Veteran client-centered design process for app development. Preliminary paper and functional prototypes were tested by five interdisciplinary VHA clinical teams (N = 22) and Veterans (n = 7) for which the BeWell24 app is intended. Veterans were re-engaged up to 3 additional times throughout app development for further iterative testing. Currently, Veterans (N = 50; 35–64 years of age) are being recruited into a trial to test BeWell24 and its components using a multi-phase optimization strategy (MOST) design. The study showed that work stress has greater impact on sleep quality in male workers than in female workers. Among the eight domains of work stress, linear regressions recognize that organizational climate (β = 0.298, p < 0.001) can significantly predict sleep quality in male workers, and hassles (β = 0.197, p = 0.013) can significantly predict sleep quality in female workers.

Support (If Any): This study was supported by the Institute of Labor, Occupational Safety and Health of Taiwan (IOSH103-R326), Taiwan.

Methods: Participants (230 males & 156 females) were recruited from a telecommunication company and an electronics company in Taiwan. A package of questionnaires, including Pittsburgh Sleep Quality Index (PSQI), a work stress scale (WSS) from the Occupational Stress Indicator-2 (OSI-2), and Perceived Stress Scale (PSS) were administered to 410 workers. A total of 386 valid questionnaires were obtained.

Results: Pearson’s correlations show that total scores of both WSS and PSS correlate significantly with sleep quality in all participants (WSS: r = 0.254, p < 0.001; PSS: r = 0.432, p < 0.001) and when data from male (WSS: r = 0.294, p < 0.001; PSS: r = 0.482, p < 0.001) and female (WSS: r = 0.186, p = 0.021; PSS: r = 0.368, p < 0.001) participants were analyzed separately. Overall, work stress correlates higher with sleep quality in male workers than in female workers. Among the eight domains of work stress, linear regressions recognize that organizational climate (β = 0.298, p < 0.001) can significantly predict sleep quality in male workers, and hassles (β = 0.197, p = 0.013) can significantly predict sleep quality in female workers.

Support (If Any): This study was supported by the Institute of Labor, Occupational Safety and Health of Taiwan (IOSH103-R326), Taiwan.
a sleep diary for one week (n = 13). Both day shift and night shift workers were included in the study. 

Results: When surveyed about sleep habits both day and night shift RNs reported a decrease in sleep time prior to a 12 hour hospital shift (avg. 6 hours) compared to an average night (avg. 6.9 hours). Sleep diary results showed day shift RNs sleeping an average of 2 hours less prior to a shift than on a non-work night, while night shift RNs slept on average 46 minutes more prior to a shift.

Conclusion: The existence of sleep deprivation and fatigue in night shift hospital workers is increasingly supported by the literature, but the results of this pilot study suggest that the prevalence of fatigue related to short sleeping in day shift workers requires additional study.

1238
THE EFFECTS OF MIND-BODY INTERVENTIONS ON SLEEP QUALITY: A SYSTEMATIC REVIEW

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Introduction: To evaluate the effect of mind-body interventions (MBI) on sleep.

Methods: We reviewed randomized controlled MBI trials on adults (prior to 12/31/13) with at least one sleep outcome measure. We searched eleven electronic databases and excluded studies with interventions not considered mind-body medicine and trials without a proper control group. Studies were categorized by type of MBI, whether sleep was a primary or secondary outcome measure, and type of outcome measure.

Results: 1323 non-duplicate abstracts were screened, and 112 out of the 149 reviewed papers were included for analysis. Overall, 67 (60%) of studies with a variety of MBI reported a beneficial effect on at least one sleep outcome measure. Of the most common interventions, 13/23 studies using relaxation, 21/30 using movement mind-body therapies and 14/25 using relaxation reported at least one measure of improved sleep. There were clear risks of bias for many studies reviewed, especially when sleep was not a primary outcome for the study.

Conclusion: From a clinical perspective, MBI should be considered as a treatment option for patients with sleep disturbance. From a research perspective, the benefit of MBI needs to be better documented with objective outcomes as well as the proposed mechanism of action. There is some evidence that MBI has a positive benefit on quality of sleep. Since sleep has a direct impact on many other health outcomes, including sleep outcome measures in future MBI trials is recommended.

1239
THE EXPERIENCE OF A POWER NAP CENTER IN THE LARGEST CITY OF BRAZIL - PRELIMINARY STUDY

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Introduction: Opened in January 2014 and located in downtown area of the São Paulo, the largest (~12 million inhabitants) city of Brazil, “Cochilo” (the Portuguese word for “nap”) is a company prepared to receive subjects interested in taking a nap during the day. The Power Nap Center has 20 soundproofed cabins, blue lighting and headphones playing relaxing soundtracks. The cabins are automated and, when the nap scheduled time ends, the exclusively designed bed vibrates and flashes of white lighting for the “nappers” to wake up. Opened from 7 am to 7 pm, Monday to Friday, the customers can choose their nap time duration: 15, 30, 45, 60, and 90 minutes. The price charged depends on the nap duration, ranging from US$5 to US$10. The aim of this preliminary study was to evaluate the features of “nappers” population and of the naps in the period from January to October 2014.

Methods: The company database was retrospectively analyzed, which included basic information of subjects who looked for the Power Nap Center and the duration of all naps.

Results: One thousand and one subjects were registered (73% males) and 33% of these napped more than once a week. A total of 3.633 naps were evaluated. Most naps (55%) had the duration of 30 minutes. There was a progressive increase in the number of naps (110 in January to 595 in October).

Conclusion: Data showed that the population who came to the Power Nap Center, in downtown area of a big metropolis in Brazil, was predominantly (73%) male. Moreover, the number of naps during the day increased by almost 500% from January to October 2014, which might suggest an important strategy for improving the quality of life and increased productivity.

Support (If Any): Núcleo Interdisciplinar da Ciência do Sono - NICS

1240
ONCOLOGY PROVIDER KNOWLEDGE AND PRACTICE FOR SLEEP PROBLEMS IN CANCER PATIENTS AND SURVIVORS

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Introduction: There are an estimated 9.8 million cancer survivors in the United States and this number is projected to increase each year with advanced treatments. Evidence suggests that up to 90% of cancer survivors suffer from sleep complaints during post-treatment survivorship. Treating poor sleep requires a symptom assessment to guide appropriate treatment, including referrals to a sleep medicine. There is little information on how oncology providers address poor sleep during clinic visits. Therefore, our study purpose was to assess current knowledge and practices for addressing poor sleep in persons with cancer in order to identify provider needs.

Methods: Oncology providers are participating in an ongoing, online national survey. This is an interim analysis using frequencies of item responses to survey questions obtained thus far.

Results: The sample reflects 56 oncology providers, including physicians (medical oncologists 39.3%, radiologists 5.4%), nurse practitioners (21.4%), staff nurse (14.3%), and others (19.6%) who see fewer than 20 patients per day. Sleep problems were addressed sometimes to usually during clinic visits and at all points of treatment. Most providers believed they had adequate time to address sleep but that it was not within their scope of practice to fully treat the problem. Most providers (92.9%) were unaware of two practice guidelines for sleep in cancer. Common practices for sleep complaints include determining need for referral (26.8%), basic behavioral counselling (83.9%), prescription medication (58.9%), and over-the-counter medication (33.9%). The majority of providers were aware of possible treatments such as sleep hygiene counseling, relaxation, exercise, and acupuncture, but less aware of cognitive behavioral therapy. Finally, providers preferred learning about practice guidelines for sleep in a summary or formal presentation.

Conclusion: Oncology healthcare providers often address patient sleep complaints during clinic visits, but need better guidance to fully address this complex issue to improve outcomes and quality of life.
B. Clinical Sleep Science

1241 IMPLEMENTATION AND EVALUATION OF SLEEP EDUCATION IN A DOCTOR OF NURSING PRACTICE PROGRAM

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Introduction: There is growing concern regarding sleep disorders and associated comorbidities that threaten public health and health care costs. Despite this growing body of knowledge, health providers, particularly nurse practitioners, receive little to no training regarding sleep disorders and sleep health promotion. This work describes a newly developed brief training session that can be easily incorporated into a doctor of nursing practice (DNP) program for nurse practitioners.

Methods: The training session for advanced practice nurses enrolled in a university DNP program was re-engineered for advanced practice nurses and other health providers from a manual developed for lay health workers. The sleep training session explicates leading sleep disorders (OSA, snoring, insomnia symptoms, short sleep duration, RLS) and sleep hygiene/stimulus control methods developed by sleep experts in PowerPoint format. Data were derived from pre/post 10-item questionnaires regarding sleep disorders, causative factors, sleep health and misconceptions about sleep. Higher scores indicated improved learning. Data were analyzed with paired t-tests using SPSS (V20) with significance set at p < 0.05.

Results: The DNP students (N = 51; ~80% women) were from family, adult, women’s health, psychiatric and pediatric specialties. Across participants, mean scores with standard deviations showed significant differences in learning concepts from pre- (8.9 ± 1.04) to post-testing (9.7 ± 0.65, p < 0.0001). Pre-to-post item analysis indicated areas for greatest learning needs.

Conclusion: Testing of advanced practice DNP students showed significant pre-to-post learning regarding sleep disorders and sleep health promotion strategies. Pre-to-post item analysis suggested significant learning in the areas of sleep needs for adults, prevalence of insomnia by sex, and the misconception that daytime sleep can make up for lack of sleep at night. Findings suggest that this brief training session is a salient approach to introducing sleep disorders and sleep health promotion into a graduate nursing curriculum. Advanced assessment and measurement tools should be included in future training.

1242 CONCURRENT SLEEP DISORDERS AND COMORBIDITIES IN PATIENTS REFERRED TO SLEEP SERVICES

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Introduction: Current medical literature and professional society guidelines frequently view sleep disorders as existing in separate disciplines, whereas in clinical practice, multiple sleep disorders are often represented in the same patient. This has implications for team-based treatment approaches and adds to the general complexity of managing patients in both public (government) clinics and private practice. We aim to describe the prevalence of sleep disorders in new patients presenting to specialist sleep services, to describe medical and psychiatric comorbidities in these patients and to evaluate differences between patient populations presenting to a tertiary government teaching hospital sleep disorders clinic and a large private sleep medicine practice.

Methods: New patients seen at the Sleep Disorders Clinic at Western Health (WH), Melbourne, Australia between January 1, 2013 and April 30, 2013 were screened for inclusion. Patients were excluded if they were referred for a non-sleep issue, or if they were prematurely lost to follow-up. The same number of patients fulfilling the above criteria referred to the Melbourne Sleep Disorders Centre (MSDC) during the same time period was included. Electronic medical records were accessed at both sites.

Results: 164 patients were included, with 82 at each site. Average age was 48.5 years (SD 16.7) and 58% were male. The most common sleep diagnoses were obstructive sleep apnoea (70%), chronic insomnia (25%), restless legs syndrome (18.9%) and bruxism (16.5%). Circadian rhythm disorders (10%), periodic limb movement disorder (8%), hypersomnias (7%) and parasomnias (5%) were also encountered. Sixty percent of all patients had a non-sleep apnoea diagnosis (41% at WH, 80% at MSDC), with or without comorbid sleep apnoea. The most common comorbidities were obesity (42.7%), anxiety/depression (28.7%), hypertension (28.1%) and diabetes (15.2%). Comparing the WH and MSDC patient populations, sex distribution was similar although mean age higher at WH (53 vs 44). Patients at WH were more likely to have obesity (58.5% vs 26.8%), hypertension (37.8% vs 18.3%), diabetes (24.4% vs 6.1%) and other medical comorbidities.

Conclusion: Non-sleep apnoea diagnoses are common, with or without comorbid sleep apnoea, along with psychiatric comorbidities—in both government clinic and private practice settings. Greater understanding of our patient population can foster a more informed, holistic approach by clinicians when assessing patients presenting with sleep issues. These findings reinforce the need for a multidisciplinary approach to sleep medicine training and service delivery, including frameworks to foster their longitudinal care.

1243 VALIDATING THE SLEEP APNEA CLINICAL SCORE (SACS) FOR USE IN A PRIMARY CARE POPULATION

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Introduction: Screening for Obstructive Sleep Apnea (OSA) challenges busy primary care practices. A clinical prediction rule, the Sleep Apnea Clinical Score (SACS), was derived in a population referred to a sleep center. We proposed rule validation in a primary care patient population.

Methods: Adult patients of Family Medicine physicians were eligible. Those with SAC S ≥ 1 were included. Patients with known OSA, negative work up within 2 years, or life limiting clinical conditions were excluded. After an enrollment visit, subjects completed an overnight oximetry, Sleep Medicine consultation and formal polysomnography. Prevalence (pre-test probability) of OSA was determined. Sensitivity, specificity, positive and negative predictive values for various SACS cut-offs were calculated. We determined positive and negative likelihood ratios (LR) using the outcome of OSA from multiple Apnea/Hypopnea Index cutoffs and corresponding posttest probabilities (PTP).

Results: 191/312 subjects (61%) completed all steps. Prevalence of OSA was similar to the derivation cohort’s (40% vs 45%, p = 0.31). Compared to validation subjects, our patients had more hypertension (45% vs 23%, p ≤ 0.001), were female (55% vs 26%, p = 0.001), older (55 vs. 46 years old, p = 0.02) and less likely to report apnea (17% vs. 46%, p < 0.001). With OSA defined as AHI > 10, SACS > 5 had SN 74% and 73% PPV. SACS > 15 was 90% SP with 76% NPV. A SACS > 15 in our
Conclusion: This study provides external validity of the SACS as a prediction rule that can be extended broadly to primary care populations. Despite significant differences in the two patient populations, the rule provided similar ability to predict OSA. Further study will examine uptake and impact of the SACS in real world primary care practice.

1244
REMOTE VETERANS APNEA MANAGEMENT PORTAL PROJECT
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Introduction: Comprised of 150 medical centers that serve nearly 9 million veterans, the Veterans Health Administration (VA) is one of the largest integrated healthcare systems in the United States. The Remote Veteran Apnea Management Portal (REVAMP) is a personalized, interactive website that is designed to improve access to care, reduce patient wait times, and allow Veterans to receive care without needing to travel to a sleep center. Veterans complete questionnaires on the REVAMP website and perform an unattended home sleep test by viewing videos on the website. Sleep specialists review the findings with the patient during an initial phone clinic. Veterans diagnosed with OSA are treated with automatically adjusting positive airway pressure (APAP) units that transmit daily data about treatment use and its effectiveness to the website where it can be monitored by both Veterans and practitioners.

Methods: A total 109 patients with suspected OSA (mean age 43.7 ± 11.3 years and mean body mass index 32.4 ± 6.8 kg/m²) were enrolled in REVAMP at two VA sites: Philadelphia VA Medical Center and VA San Diego Healthcare System.

Results: Of the 109 enrollees, 94 completed initial questionnaires, 82 completed home sleep testing and 63 tested positive for OSA. Of those diagnosed with OSA, mean baseline AHI was 14.6 ± 13.3, ESS was 11.3 ± 5.8, and FOSQ-10 was 13.1 ± 4.3. 46 of the 63 (73%) OSA patients were prescribed APAP treatment. Over the first month of treatment, the average APAP adherence was 5.3 ± 2.6 (0–9.1) hrs/day and the average APAP residual AHI was 2.5 ± 3.5 (0–17.1) events/hr. None of the patients needed to have in-lab testing to assist in management.

Conclusion: Incorporating positional therapy into an algorithm for the treatment of OSA is cost effective.

1246
ROLE OF IN-HOSPITAL EVALUATION FOR SLEEP APNEA AND ASSOCIATED OUTCOMES AFTER DISCHARGE
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Introduction: There are limited immediate and post-hospital outcome data for patients evaluated for sleep apnea during a hospitalization. Patients may undergo monitored polysomnography (PSG) or unattended portable sleep testing (aka home sleep testing or HST) or are referred as outpatients. We hypothesized that post-hospital follow-up may be suboptimal but diagnostic yield of in-hospital PSG or HST and subsequent home PAP therapy compliance (CMS criteria) may be favorable.

Methods: Retrospective chart review of adult patients who underwent PSG or Type III HST between 2009 and 2013 was conducted. Data collection included demographic variables, PSG and HST data, discharge disposition, whether prescription for bi-level or continuous positive airway pressure (BPAP or CPAP), and clinic follow up after discharge was provided, interventions performed at follow up and compliance with positive airway pressure (PAP) therapy.

Results: Of the 119 patients included in the study, 50% were women, 94% were Caucasian, and mean patient age was 64.9 (± 15.8) years. A majority (59.6%) were discharged to skilled nursing facilities. Seventy three percent of the patients had obstructive sleep apnea and in most of them apnea was found to be severe (46%). Thirty six of the 70 patients (51%) who had a return visit scheduled, followed up as an outpatient. Most patients (72.5%) needed clinical interventions performed at the follow up visit such as; change of mask interface, pressure, humidity, or a repeat study. Apnea type, severity or PAP compliance were not predictive of the need for intervention at follow up. Compliance with PAP therapy was noted to be high (87%).

Conclusion: Inpatient PSG and HST studies have high diagnostic yield but post-hospital follow up is low. Also, a majority of the patients re-
quired interventions at follow up but a surprisingly high number were judged to be compliant with PAP therapy.

1247
MY CPAP FOR YOUR GUITAR: THE PREVALENCE AND LEGALITY OF ONLINE TRADE OF CPAP DEVICES THROUGH CRAIGSLIST
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Introduction: Obstructive sleep apnea (OSA) is a chronic condition that is debilitating if left untreated. Approximately 22 million Americans suffer from sleep apnea, though 80% of those cases remain undiagnosed. Uninsured and under-insured individuals have disproportionately higher rates of OSA. Continuous positive airway pressure (CPAP) therapy has been the most successful treatment option for OSA. However, this treatment requires a medical prescription, often necessitating thousands of out-of-pocket dollars for diagnosis and treatment. Though CPAP devices cannot legally be sold without FDA approval and the sale of medical devices is prohibited on Craigslist, a market for CPAP machines has emerged through this online trading site.

Methods: Craigslist ads for CPAP machines in eighteen U.S. cities, representing a cross-section of geographic locations, median income, population size, and accessibility to sleep clinics, were investigated. Ads mentioning “CPAP” were collected over a month interval and ad content was analyzed for device condition, hours of previous use, asking price, mention of original cost, and length of time the device remained on the market.

Results: In 15 of 18 cities, CPAPs were available for sale, with an average of 15 machines available. The average price per CPAP machine was $291 and most offers included masks, hoses, and humidifiers, but not instruction manuals. The vast majority of CPAP sellers did not meet FDA labeling requirements, mention that prescriptions were required, disclose the hours of use, or offer the reason for sale.

Conclusion: This study is the first explorative study to systematically examine the prevalence of online exchange of CPAP devices and the demographic factors that influence this trade. Healthcare professionals should be made aware of this practice, and be able to discuss the healthcare risks associated with the possibility of do-it-yourself medicine, the use of secondhand CPAP devices, and the legal risks of selling used medical devices.
1248  
**Lacrimal Ductal Air Regurgitation in a Patient on Continuous Positive Airway Pressure Therapy**

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**Introduction:** Continuous Positive Airway Pressure (CPAP) is a safe therapy for the management of Obstructive Sleep Apnea (OSA). Complications of CPAP therapy include: sinus infection, bronchitis, ear pain, nasal congestion, dryness of mucous membranes and alternobaric vertigo. Cases of Lacrimal Ductal Air Regurgitation (LDAR) in patients with Lester-Jones Tube have been reported. We describe an unusual case of LDAR secondary to CPAP therapy.

**Report of Case:** A 52-year-old woman diagnosed with mild OSA two years ago, was referred to the pulmonary clinic for non-adherence to CPAP therapy. Diagnostic polysomnogram revealed an Apnea-Hypopnea-Index (AHI) of 8.8 events/hour. Titration polysomnogram recommended a pressure of 10 cmH2O. LDAR causing redness and dryness of the right eye while on CPAP therapy limited patient’s compliance. Modifications of CPAP pressures and masks (nasal to full-face) didn’t resolve LDAR. Patient discontinued CPAP therapy which relieved her eye symptoms. Review of systems was significant for right eye LDAR while blowing the nose and sneezing. LDAR was not associated with eye problems prior to CPAP therapy. Past surgical history was negative for eye surgeries. Physical examination revealed normal vital signs with a body mass index of 34.4 kg/m². Ophthalmologic examination was unremarkable. Ophthalmology and Otorhinolaryngology referrals didn’t reveal additional abnormalities except LDAR. Right lacrimal puncta blockage using a marble or a cotton-filled chin strap didn’t improve CPAP compliance. Patient was referred for customization of an oral appliance. Repeated polysomnogram with oral appliance showed an AHI < 5 events/hour.

**Conclusion:** Positive pressure in the upper airways causes LDAR due to an abnormal valve of Hasner. Patients with newly diagnosed OSA should be questioned about previous eye surgeries and evaluated for presence of LDAR with valsala maneuvers. Early recognition of LDAR in patients with mild/moderate OSA should be considered for alternative therapies other than CPAP.

1249  
**Status Cataplecticus Precipitated by Influenza Vaccination**

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**Introduction:** Cataplexy is a manifestation of type 1 narcolepsy that represents an intrusion of REM sleep into wakefulness resulting in sudden loss of muscle tone. Status cataplecticus, or persistent cataplexy, is a rare manifestation of narcolepsy that has previously been associated with cessation of venlafaxine or clomipramine, childbirth, and initiation of prazosin. We report the first case, to our knowledge, of status cataplecticus precipitated by influenza vaccination.

**Report of Case:** A 17-year-old female with a past medical history of anxiety and fibromyalgia was referred to our sleep center after being diagnosed with narcolepsy with cataplexy by an outside sleep physician. Her narcolepsy symptoms began approximately four years prior to presentation to our clinic with excessive daytime sleepiness, sleep-related hallucinations, and cataplexy but no sleep paralysis. Subsequent overnight polysomnogram revealed an AHI < 1, PLMi 14/hr, sleep latency of four minutes, and sleep efficiency of 92%; next morning MSLT demonstrated a mean sleep latency of 2.6 minutes and 2 out of 5 sleep onset REM periods. She scored 20/24 on her Epworth Sleepiness Scale. The patient was positive for DQB1*06:02 allele and CSF hypocretin levels were not obtained. Baseline EEG did not demonstrate epileptiform activity and brain MRI was normal. In the fall of 2013, approximately four years after her first cataplexy symptoms, the patient received the seasonal influenza vaccination, and within twenty minutes she began experiencing cataplexy symptoms that lasted for approximately twenty-four hours. Her status cataplecticus manifested as episodic and instantaneous loss of tone in her lower extremities without loss of consciousness; episodes were captured on home video. Currently, her daytime sleepiness and cataplexy are much improved on sodium oxybate, armodafinil, and sertraline.

**Conclusion:** Influenza vaccination may have served as a trigger of status cataplecticus in this patient with known narcolepsy.
1251
PSEUDOCATAPLEXY AND INSOMNIA SUCCESSFULLY TREATED WITH COGNITIVE BEHAVIORAL THERAPY FOR INSOMNIA (CBTI)
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Introduction: Pseudocataplectic episodes present like cataplexy, though without a diagnosis of narcolepsy. Symptoms include precipitating negative emotions, variable duration of episodes, global weakness, absent neurological signs, and a normal sleep study. The psychological factors underlying the etiology of these attacks must be addressed through psychotherapy.

Report of Case: The patient, a 63-year-old Caucasian female, was referred for daytime “sleep attacks” occurring 1–2 hours per week for 2–4 hours. During these episodes, she was immobile and had difficulty comprehending and speaking. Although a neurologist diagnosed her with cataplexy, a diagnosis of narcolepsy was not indicated via overnight PSG and MSLT. Other sleep disorders were also ruled out by PSG. The patient was also diagnosed with insomnia; sleep diaries revealed variable sleep efficiency (average = 85.02%, range = 73–96%). Because sleep deprivation was likely contributing to her reported “sleep attacks,” CBTi was implemented, including sleep psychoeducation, sleep hygiene, stimulus control, consistent bed and wake times, relaxation, and cognitive restructuring. Sleep restriction was contraindicated, given that sleep deprivation triggered “sleep attacks.” After eight therapy sessions, self-reported sleep efficiency increased, while variability in her night-to-night sleep decreased. She reported less daytime drowsiness, fewer “attacks,” and gradually becoming able to control their onset when she felt the prodromal symptoms. Through cognitive therapy, she identified that attacks occurred when she experienced stressful events she perceived as out of her control; she worked on managing strong emotional responses to stress, anger, and sadness. At the final session, her sleep efficiency was 95% (range = 86–97%) and she had not experienced a full attack in over a month.

Conclusion: The success of CBTi tailored by a team of sleep specialists suggests a diagnosis of pseudocataplexy—a rare and poorly understood condition that warrants future inquiry. Preliminary research suggests that CBT could be effective in treating pseudocataplexy through its use of behavioral reinforcement and stress management techniques.

1252
THE EMERGENCE OF CENTRAL SLEEP APNEA AFTER SURGICAL TREATMENT OF OBSTRUCTIVE SLEEP APNEA
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Introduction: New-onset central sleep apnea (CSA) has been described with use of CPAP but also with use of other treatments for OSA, including tracheostomy, maxillofacial surgery, nasal surgery, and mandibular advancement device. We present a patient with emergence of CSA after soft palatal and nasal surgery in the setting of moderate OSA.

Report of Case: A 50 year old male presented with a history of snoring, frequent night-time awakenings, daytime somnolence and persistent nasal obstruction. Patient did not have any history of cardiac or neurologic diseases nor was he taking opioids. Physical examination: BMI 29.2, Friedman II, 2+ tonsils, no septal deviation and turbinates hypertrophy bilaterally. Polysomnography revealed an AHI of 18 (central apnea 2.0; obstructive apnea 0.7; mixed apnea 9.1; hypopnea 6.0) with oxygen nadir of 69%. He was diagnosed with OSA. He refused a trial of CPAP or oral appliance. He subsequently underwent uvulopalatopharyngoplasty with tonsillectomy and partial resection of the inferior turbinates bilaterally. Four months after surgery his nasal congestion improved, but excessive daytime sleepiness worsened. There was no interval weight gain and no new cardiopulmonary symptoms. The only medication change over this time was addition of Norco 5–325 mg for 2-weeks after the surgery. Physical examination near the time of follow-up PSG showed well healed uvulopalatopharyngoplasty site with no strictures, inflammation. A follow-up polysomnogram demonstrated severe sleep apnea with AHI of 35 and oxygen nadir of 78%. Although obstructive hypopneas were found to persist, the majority of respiratory events were now central in nature (central apnea 18, obstructive apnea 0.4, mixed apnea 0.2, hypopnea 15.3). It should be noted that the baseline PSG and the follow-up PSG were done at different institutions.

Conclusion: The development of central sleep apnea postoperatively may be due to persistence of an augmented response to pCO2 and persistence of OSA.

1253
REM SLEEP BEHAVIOR DISORDER (RBD) IN A MULTIPLE SCLEROSIS PATIENT
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Introduction: REM sleep behavior disorder is characterized by dream-enactment behavior. Patients exhibit motor activity or vocalization during REM sleep in the setting of loss of REM atonia. Polysomnography is needed to diagnose RBD. As a presenting symptom, idiopathic RBD predicts future risk for neurodegenerative disorder in otherwise asymptomatic patient. RBD is also associated with pre-existing neurological disorders that affect brainstem REM generators. We present a case of RBD in a multiple sclerosis (MS) patient with radiographic evidence of brainstem lesions.

Report of Case: A 27-year-old Caucasian female with a 7 year history of relapsing-remitting MS presented with history of recurrent verbalizing and punching during sleep which occurred after 2:00 am. She denied recollection of dreams in the morning. She also endorsed hypnopompic tactile, auditory and visual hallucinations, and sleep paralysis. Her bed partner reported loud snoring worse in supine sleep. Her examinations was notable for Mallampati Class II with elongated uvula. Polysomnography demonstrated mild obstructive sleep apnea (AHI 8.8) and loss of REM atonia, verbalization noted during sleep. MSLT demonstrated mean sleep latency of 16.1 minutes and two episodes of sleep onset REM period (SOREMP). She was started on CPAP treatment for her obstructive sleep apnea.

Conclusion: Demyelinating brainstem lesions in MS can increase risk of RBD. Clinicians should be reminded to screen MS patients for RBD. Although our patient carried a preceding diagnosis of MS, the presence of RBD in an otherwise asymptomatic young patient should also alert the clinician to investigate for secondary neurological causes such as MS.

1254
AN UNUSUAL CASE OF MUSCLE PARALYSIS
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Introduction: Familial periodic paralysis (FPP) is a rare disease with an estimated prevalence of 1:100,000, characterized by episodic flaccid...
weakness with intervals of normality. We present a patient whose presentation suggested narcolepsy and was ultimately diagnosed with FPP.

**Report of Case:** A 39-year-old-male complained of excessive daytime sleepiness (EDS) and fatigue for ten years. Polysomnography revealed an AHI of 5.45. Despite CPAP therapy, EDS continued (ESS = 17) with episodes of total body paralysis twice per month, induced by stress, and anger. A full medical and neurological workup was WNL. He denied a history of sleep paralysis or hypnagogic hallucinations. Polysomnography on CPAP revealed a normal AHI of 0.4, and MSLT revealed a sleep latency of 5.3 minutes with one SOREMP. Levels of the following antibodies were WNL: Acetylcholine receptor, voltage gated calcium channel, anticardiolipin and MuSK; levels of creatinine kinase, TTFs, and nerve stimulation studies were also WNL. Upon further careful questioning, he revealed an association between these episodes with rest or sleep and ingestion of carbohydrate-rich foods. He also noted that episodes would last up to 2 hours and were accompanied by muscle pain. Notably, all of these symptoms are not characteristic of cataplexy. He was diagnosed with FPP. Symptoms improved after he was placed on acetazolamide.

**Conclusion:** FPP is a disorder of Na, Ca and K channels, subtypes including Andersen syndrome, hyperkalemic, and hypokalemic; the last is the most common, occurring mainly in young, Caucasian males. Attacks are precipitated by rest, sleep, and carbohydrate rich diet. Dyskalemia during a paralytic attack can lead to cardiac arrythmias and respiratory muscle weakness which can be fatal. Treatment includes avoiding precipitating triggers, acetazolamide, among others. Sleep specialists should have a high index of suspicion in the right clinical setting for this rare disease as lack of recognition of this entity can lead to potentially fatal outcomes.

**1255**

**TAKE MY BREATH AWAY: CENTRAL SLEEP APNEA IN A CHILD WITH MURCS ASSOCIATION PRESENTING AS BREATH HOLDING SPELLS**

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**Introduction:** The brainstem is the primary source for generating ventilatory patterns and processing respiratory afferent information from chemoreceptors and intrapulmonary receptors. Disruption of neural pathways from the medulla to the ventilatory motor neurons affects breathing. Any disease process in this area will affect ventilation both during sleep and during wake periods and ventilation during sleep is often affected before waking ventilation.

**Report of Case:** A three year old female with MURCS association (Mullerian duct hypoplasia, one kidney, and spinal fusion) presented with breath holding spells. Her symptoms started sporadically once per week but progressed to multiple times per day. Initially the episodes were related to anger, frustration or pain, and parents were able to distract her to resolve these episodes. The episodes progressed to loss of consciousness, convulsions and urinary incontinence. Complete neurologic evaluation including EEG was normal. PSG revealed central sleep apnea (CSA 36 per hour) with desaturations resolved with 1L of O2, although central events remained. MRI showed crowding and compression of craniovertebral junction with associated syrinx likely secondary to multilevel cervicothoracic vertebral anomalies. A posterior surgical decompression was performed with improvement of central apneic episodes.

**Conclusion:** The pathophysiological basis for central sleep apnea in craniovertebral junction abnormalities is compression of the structures in the medulla that control respiration. Treatments primarily involve surgical decompression. Surgical treatments showed a symptomatic improvement in 78% of cases. Other treatments reported in the literature include caffeine, theophylline, oxygen, noninvasive ventilation, and tracheostomy. Although MURCS association is a relatively rare condition, it is a manifestation of a larger group of disorders consisting of congenital and acquired craniovertebral junction abnormalities. Patients with craniovertebral junction abnormalities (shortened necks or brain stem pathology) who present with breathing issues in the daytime or sleep issues at night should undergo a formal sleep evaluation with polysomnography.

**1256**

**REM SLEEP BEHAVIOR DISORDER (RBD) IN A PATIENT WITH ACUTE INFLAMMATORY DEMYELINATING POLYNEUROPATHY (AIDP)**

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**Introduction:** Acute inflammatory demyelinating polyneuropathy (AIDP) is the most common form of Guillain-Barré syndrome (GBS). The effects of AIDP on the peripheral nervous system (PNS) are well described. However, the effects on the central nervous system (CNS) are not well understood. GBS has been associated with abnormalities of sleep including REM dysfunction. We are presenting a case of REM Sleep Behavior Disorder (RBD) in a patient with AIDP who has an intact CNS as evidenced by normal MRI of the brain.

**Report of Case:** A 38-year-old Caucasian female with past medical history of anxiety, cervical cancer and depression. She was diagnosed with Guillain-Barré syndrome (GBS) 2010 when she presented with sub-acute quadriparesis. Treatment included intravenous immunoglobulin (IVIG) and plasma exchange (PLEX). She underwent physical therapy and slowly regained the ability to perform basic daily functions but had an incomplete recovery. She presented with a second episode in 2014 and was treated with IVIG, PLEX, and rituximab. This episode was complicated by respiratory failure requiring mechanical ventilation, and prolonged weaning from the ventilator requiring tracheostomy. After liberation from the ventilator she underwent a polysomnogram to evaluate for sleep disordered breathing and hypoventilation. The polysomnogram demonstrated obstructive sleep apnea (OSA). In addition to the OSA the polysomnogram demonstrated prominent loss of REM atonia associated with complex motor behavior characterized by vocalization and thumping of the right arm on the bed.

**Conclusion:** This case illustrates the relationship between AIDP and REM dysfunction. To our knowledge this is the first reported case of RBD in AIDP. This relationship suggests either AIDP does affect more than PNS with autonomic dysfunction being the common denominator or is a product of AIDP treatment (i.e. IVIG or plasma exchange).

**1257**

**AN ATYPICAL CASE OF CATAPLEXY AFTER STROKE**

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**Introduction:** Cataplexy is the sudden loss of voluntary muscle control typically elicited by strong emotions and associated with narcolepsy. Isolated cataplexy without narcolepsy is uncommon. Cases of narcolepsy following brain injury have been reported, with proposed damage to hypocretin secreting neurons as the hypothesized mechanism. We present an atypical case of cataplectic-type episodes without narcolepsy following stroke.

**Report of Case:** A 58 y/o female presented to the sleep clinic to evaluate for “body shutdowns”. She describes these episodes as a feeling of whole body weakness accompanied by aphasia, nausea, and an inability to process information. These episodes varied in length from minutes to hours, depending on the trigger. Her strongest trigger was...
The patient is a 48-year-old male who was working as a PFT. She felt weak and could not open her eyes or move from the exam table while the therapist was shouting at her to do so. She retained consciousness throughout the episode. Similar episodes have occurred numerous times for the past 7 years. She has limited her social interactions to avoid triggers. She was evaluated by multiple neurologists and her EEGs were normal. Polysomnography was not consistent with narcolepsy: Total Sleep 144 minutes, AHI 0.4, Sleep Latency 101 minutes, REM Latency 98 minutes. Epworth score was 1. She was started on imipramine for the cataplexy without success. Imipramine was switched to venlafaxine. She had marked improvement of her symptoms and was able to resume her social activities.

**Conclusion:** We present an unusual case of symptoms that are consistent with cataplexy that followed an ischemic stroke that responded to venlafaxine. She had no other symptoms to suggest narcolepsy. Further research on hypocretin may help clarify the association between isolated cataplexy, narcolepsy, and cerebral vascular injury.

**1258**

**NOCTURNAL EVENTS: RESPIRATORY RELATED, MOVEMENT DISORDER, SEIZURE OR ALL THREE?**

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**Introduction:** Nocturnal seizures comorbid with sleep disordered breathing and sleep-related movement disorders are difficult to diagnose due to symptom overlap and limitations of electroencephalographic monitoring during polysomnography. Thus, thorough clinical history obtained from the patient and bed partner is essential for diagnosis and treatment.

**Report of Case:** A 72-year-old man with severe obstructive sleep apnea (AHI; apnea hypopnea index 114/hr) diagnosed two months prior to presentation was referred for evaluation of nocturnal events that persisted despite positive airway pressure (PAP) therapy. The referring provider was specifically concerned for periodic limb movement disorder given frequent periodic limb movements of sleep (index of 61 movements per hour) observed during his initial study. The patient had no recall of nocturnal events, however his wife reported onset of symptoms that began 10 months prior to presentation, occurring shortly after a possible transient ischemic attack. About once monthly, beginning four hours after sleep onset, the patient would whimper followed by whole body stiffening for several minutes with tongue biting. He typically remained asleep during these episodes, but if awoken was confused and took 24 hours to return to baseline. His memory had concurrently worsened and he exhibited attentional deficits on exam. Per his wife, snoring, witnessed apneas and limb movements had greatly improved with regular use of AutoPAP 15–20 cm of water, however his download revealed an elevated residual AHI (> 20 events/hr) despite excellent objective adherence. His routine EEG did not reveal any epileptiform abnormalities, but he was subsequently started on levetiracetam for presumed nocturnal seizures along with increased PAP pressures. He was seen in follow up two months later with no further nocturnal events, reduced AHI and improved attention.

**Conclusion:** Clinical history and a high degree of suspicion are critical in diagnosing nocturnal seizures in the setting of comorbid sleep disorders.

**1259**

**DIFFICULTY UTILIZING CPAP THERAPY FOR OBSTRUCTIVE SLEEP APNEA IN HIGH ALTITUDE**

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**Introduction:** Altitude has a marked effect on respiration during sleep. Several studies done at different altitude indicate that an increase in central apneas occurs even among healthy individuals when in high altitude. Central Sleep Apnea related to high altitude may contribute to difficulty utilizing CPAP in patients with Obstructive Sleep Apnea.

**Report of Case:** A 58-year-old female with history of well-controlled asthma, allergic rhinitis, obstructive sleep apnea (OSA) on CPAP 11 cm and restless leg syndrome (RLS) returned from Jackson Hole, WY (8000 feet above sea level) and presented with complaints of excessive daytime sleepiness and fatigue while in Jackson Hole despite continuing CPAP therapy nightly. OSA was originally diagnosed with polysomnography with AHI 9.1, RDI 31.6; REM AHI 35.7; Supine AHI 25.3; SaO2 nadir of 88%. The patient did report more difficulty keeping her CPAP mask on while in Jackson Hole. The patient had no trouble with CPAP use upon returning to Houston. Flow tracings obtained from the CPAP device showed central sleep apnea while at high altitude that resolved when the patient came back to Houston (sea level). PAP download showed excellent adherence and excellent response during the week after returning to Houston with AHI < 2; central apnea index < 1, obstructive apnea index < 1, hypopnea index < 1.

**Conclusion:** In our patient the reported difficulty with CPAP use while in Jackson Hole, WY was likely related to high altitude central sleep apnea which resolved with return to sea level. This was easily recognized when reviewing the recorded flow tracings on the patient’s CPAP device.

**1260**

**ZOLPIDEM WITHDRAWL INDUCED SEIZURES**

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**Introduction:** Zolpidem is in the group of non-benzodiazepine sedative hypnotics medications mainly used for sleep initiation called the “Z” drugs which include zolpidem, eszopiclone and zaleplon. It is considered that the primary site of action of these groups of medications is the alpha-1 specific site of the GABA-A receptor which is similar to the effect of benzodiazepines. Although these medications are not structurally similar to benzodiazepines a similar long term effect of tolerance and escalation of dose for effect is often seen. Withdrawal seizures are common occurrences after benzodiazepines are abruptly discontinued after tolerance has been built up. In this case we discuss a patient who developed high tolerance to zolpidem with subsequent withdrawal symptoms and eventually seizures.

**Report of Case:** Patient is 48 year old male who was working as a family medicine physician who presented to a substance abuse treatment center due to being reported by his local medical board for abuse of zolpidem including getting dismissed from his practice for writing multiple illegal prescriptions for his own use. Prior to his dismissal from the practice there were two incidents where he developed spontaneous seizures which he described were in the context of abruptly stopping daily zolpidem use after developing a tolerance to the point that he was using up to 50 to 100 mg per day. The reasoning for abruptly discontinuing zolpidem was an attempt at a self-taper. His use of zolpidem was daily for the past 5 years and escalated to about 100 mg in the 6 months prior to the seizures. He had no previous history of seizure.
prior to his use of zolpidem and had no subsequent seizures after going through the withdrawal process from zolpidem.

Conclusion: One study cited that zolpidem at high doses potentially loses selectivity to α1 subunits and binds to lower-affinity α1 units, leading to a benzodiazepine effect therefore abrupt discontinuation would produce withdrawal such as a seizure similar to those seen with benzodiazepine withdrawal.

1262
OBSURCITIVE SLEEP APNEA IN PATIENTS WITH AN LVAD DEVICE – A CASE SERIES
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Introduction: Advanced heart failure is a common cause of mortality. For mechanical circulatory support in CHF, Left Ventricular Assist Devices (LVADs) were developed as a bridge to heart transplantation. LVADs have shown better survival and QOL outcomes than maximum pharmacological support. Little is known about the quality of sleep, the prevalence of SDB or the effect of PAP in patients with LVADs. We report a case series of three LVAD patients with OSA.

Report of Case: A 38 y/o male with previously diagnosed OSA (2006), obesity, pacemaker, DM, HTN, s/p LVAD placement 2013. A split night study showed severe OSA (AHI 69), with poor sleep efficiency and sleep fragmentation. CPAP was titrated to 10 cm H2O with improved sleep efficiency (SE), decreased sleep fragmentation and REM rebound. 67 y/o male s/p ICD, atrial fibrillation, DM, HTN, hypothyroidism s/p LVAD placement 2012 underwent PSG for snoring, EDS, nocturia. PSG showed severe OSA (AHI 35.1), poor sleep efficiency and sleep fragmentation. CPAP at 13 cm H2O demonstrated improved SE and reduced sleep fragmentation. 61 y/o male with previously diagnosed OSA (> 15 yrs) not currently treated; HTN, DM, obesity, s/p LVAD placement 2013. PSG showed OSA (AHI 6.2, RDI 23.4). CPAP at 8 cm H2O led to control of OSA with improved SE and decreased sleep fragmentation. Of note, most of the PSG’s showed intermittent dropout of oximetry signal complicating the scoring of SDB events.

Conclusion: This is the first case series documenting OSA in patients with LVADs. All had OSA (not CSA); poor SE and sleep fragmentation. Oximetry signal was problematic. CPAP treatment led to improved sleep with decreased sleep fragmentation. Despite concerns of preload reduction with CPAP, it was well tolerated.

1263
ACQUIRED CENTRAL HYPOVENTILATION SYNDROME IN A CHILD WITH MEDULLOBLASTOMA
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Introduction: Central hypventilation can be congenital or acquired and represents disorders that affect central ventilatory control. We present a unique case of acquired central hypventilation post medulloblastoma resection and brain stem radiation.

Report of Case: This is a 17 year female (BMI17.5) with past medical history of hypothyroidism, cerebellar dysphonia and posterior fossa medulloblastoma post surgery resection and radiation therapy at the age of 6. Repeat MRIs did not show any tumor recurrence. She presented to the pulmonary clinic with history of worsening baseline ataxic breathing pattern, apnea and cyanosis over the last year. She was found to have low baseline oxygen saturation (75–80% in room air). End-tidal CO2 (ETCO2) values were 75–85 mm Hg. Physical exam was notable for ataxic breathing, in addition to clubbing and cyanosis. Laboratory values showed chronic respiratory acidosis with compensated metabolic alkalosis and serum bicarbonate level of 43 mMOL/L. Inpatient portable polysomnogram showed severe, sleep-disordered breathing characterized by profound hypercapnia, frequent hypopneas, and persistent hypoxemia (70–75%) with oxygen desaturation nadir of 66%. ETCO2 values were between 85–90 mm Hg. Apnea hypopnea index was 92 events per hour. The patient failed noninvasive ventilation of both Bi-level positive airway pressure with spontaneous timed breathing mode and average volume assured pressure support (AVAPS) and presented with acute on chronic respiratory failure requiring tracheostomy and mechanical ventilation. The most recent ventilatory support settings were in PC/AVAPS mode with transcutaneous CO2 levels maintained below 40 mm Hg.

Conclusion: Acquired central hypventilation can result from posterior fossa tumors or brain stem radiation and should be monitored closely. PC/AVAPS mode can be effectively utilized with good patient tolerance to treat severe hypventilation with normalization of carbon dioxide values.

1265
A TODDLER WITH SEVERE SLEEP APNEA REQUIRING SPLIT-NIGHT POLYSOMNOGRAPHY – POSITIVE AIRWAY PRESSURE THERAPY AS A BRIDGE TO ADENOTONSILLECTOMY
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Introduction: Obstructive sleep apnea (OSA) continues to rise in the pediatric population, increasing risk for neurobehavioral and cardiometabolic consequences (e.g. cognitive delay, growth retardation, biventricular cardiac hypertrophy, systemic and pulmonary hypertension). Attended polysomnography (PSG) followed by adenotonsillectomy is considered the standard of care in children. Occasionally, positive airway pressure (PAP) may be applied, but the role of split-night PSG has not been elucidated in children. We report a case of a 2-year-old toddler with severe OSA whose baseline PSG had to be converted to a split-night study.

Report of Case: A 2 year-old girl presented with an obstructive breathing pattern during sleep, including snoring, witnessed apnea, gasping, choking awakenings, restless, sweating, and mouth breathing. Associated daytime symptoms included daytime hyperactivity, neurobehavioral deficits, and speech delay. Physical examination revealed adenotonsillar hypertrophy, middle ear effusion, mouth breathing and stertor. The parent filled out the pediatric OSA-18 quality of life questionnaire with a score of 102, consistent with significant impairment in quality of life. PSG revealed an apnea hypopnea Index (AHI) of 52.9 events per hour with significant obstructive events-associated desaturations. Split-night PSG was then performed by applying supplemental oxygen and titrating CPAP to 6 cm H2O with a residual AHI of 6.3 per hour. Recommendations were made for PAP therapy as bridge to emergent adenotonsillectomy. A subsequent PSG following adenotonsillectomy revealed an AHI of 1.7 per hour, and an OSA-18 quality of life questionnaire score of 37.

Conclusion: Attended Polysomnography (PSG) is considered the gold standard for the diagnosis of OSA. However, in certain circumstances, split-night PSG, in addition to its diagnostic value, may offer a therapeutic alternative in selected cases of severe pediatric OSA across all ages including toddlers, and as a bridge to adenotonsillectomy when infrastructure, socioeconomic factors or patient’s preference preclude immediate surgery.
1266
A CASE OF MULTILEVEL SURGERY IN A PATIENT WITH SEVERE OBSTRUCTIVE SLEEP APNEA
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Introduction: Obstructive sleep apnea (OSA) is characterized by upper airway collapse during sleep. Positive airway pressure (PAP) is the gold standard therapy of this condition but surgical management may be required if intolerability to PAP occurs.

Report of Case: 38-year-old male presented with symptoms of fatigue, daytime hypersomnia and an Epworth-Sleepiness-Scale (ESS) of 18. Physical exam revealed a neck circumference of 18 inches, BMI of 30 kg/m² and Friedman scale of IV/IV. The diagnostic polysomnography (DPSG) showed an AHI of 92.5/hr sleep, supine and none-supine AHI 90.2 and 94.3/hr sleep respectively. Patient could not tolerate auto-CPAP after trials of different interfaces and close office follow up. Hypersomnia persisted despite Modafinil therapy. He had difficulty at work and fell asleep twice while driving. Since PAP, nasal EPAP device and mandibular advancement with oral appliance did not improve his daytime hypersomnia he underwent multilevel surgeries (MLS) including palate expansion with subsequent Maxillomandibular Advancement (MMA) with an 11 mm advancement as well as Genioglossus advancement in a period of 12 months with complete resolution of daytime symptoms and reduction of his ESS to 5. The DPSG after the multilevel surgeries revealed an AHI of 16.5/hr sleep, supine and none-supine AHI 90 and 5/hr sleep respectively.

Conclusion: The selection of surgical treatments in OSA remains an area of intense debate. This case demonstrates overall surgical success with curative achievement of the positional component of a patient with severe OSA who failed standard treatment.

1267
DIAGNOSING NARCOLEPSY: IT’S NEVER TOO LATE
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Introduction: We report delayed presentation of Type 2 narcolepsy in a septuagenarian.

Report of Case: A 71-year-old male CPA presented with “passing out” while driving. One episode involved pulling his car into the garage, falling asleep with the motor running, awakening to turn off the engine, and falling back to sleep for four more hours. Similar, albeit milder, episodes have occurred since his 30s, but never prompted medical attention. His wife complains of his falling asleep at the dinner table and while entertaining, whereas he acknowledges sleep ‘attacks’ while at the computer and while watching television. “Borderline obstructive sleep apnea” was diagnosed twenty years earlier by polysomnography (PSG) prompted by emergence of snoring that resolved after UPPP and turbinate reduction. He had a BMI of 28.2 and a grade IV modified Mallampati. There was mild cognitive impairment, tangential speech, poor insight, and poor recall most compatible with bilateral frontal lobe dysfunction. An extensive work-up for syncope included unremarkable CTS of head and chest, EKG, echocardiogram, 24-hour Holter monitoring, tilt table test, EEG, brain MRI with contrast, and carotid Doppler ultrasound. PSG followed by multiple sleep latency test revealed an AHI of 13.8, PLM index of 13.8, a 0.6 minute mean sleep latency and SOREMPS were present during 4 of 5 naps. Remarkably, psychomotor vigilance metrics were normal for age. Symptoms were unaffected by empiric venlafaxine dosing alone, whereas, addition of armodafinil brought benefit.

Conclusion: Narcolepsy peaks in onset in the second decade, but delayed diagnoses can occur due to mild severity, misdiagnoses, and absence of cataplexy. Awareness of healthcare professionals and the lay to narcolepsy is critical given its potential negative impacts upon patient’s quality of life and safety, as well as utilization of healthcare resources.

1268
OBSTRUCTIVE SLEEP APNEA: IS TRACHEOSTOMY A LIMITING FACTOR FOR DIAGNOSIS AND TREATMENT?
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Introduction: Before Positive airway pressure therapy, tracheostomy was the only treatment option available for severe OSA. However, recurrence of apnea (mainly central) was often noted. We present a 68 year-old male with known OSA who presented with daytime sleepiness post-tracheostomy. His symptoms were attributed to ongoing sleep apnea post-tracheostomy. This was corrected with Average Volume Assured Pressure Support (AVAPS), a novel mode of bi-level pressure ventilation.

Report of Case: 68 year-old male (BMI 32 kg/m²) presented with daytime sleepiness in 2014. He was diagnosed with OSA in 2004 and was on CPAP. In 2013 he had respiratory failure from an allergic reaction requiring emergent tracheostomy. Despite stable weight he had relapse of daytime sleepiness with mildly elevated Epworth sleepiness scale (ESS) score of 12/24 after discontinuation of CPAP. During his PSG in 2014, a transducer (p-flow) was connected to tracheostomy. It showed residual moderate-severe OSA, AHI 19.3/hr in general and 44.8/hr in REM sleep, SpO2 < 90% for 14% of the total sleep time. He underwent AVAPS titration study with the following settings: IPAP max 22 cm H2O, IPAP min 15 cm H2O, EPAP 5 cm of H2O and target tidal volume (Vt) 450 ml. AHI improved to 2.7/hr in general. After 2 months of treatment, daytime sleepiness has improved significantly (normal ESS of 4/24). A subgroup of patients, treated with tracheostomy, continue to have residual OSA perhaps due to mechanical obstruction or concomitant respiratory control dysfunction. Hypoxemia may be present. Persistence/recurrence of OSA in these patients should be addressed with PAP treatment. AVAPS is a novel self-titrating, bi-level ventilator device that can be used in an outpatient setting and hence is appropriate for patients with tracheostomy. Min and max IPAP are set along with target Vt. Inspiratory pressure changes occur smoothly from breathed-to-breath to achieve the target Vt, compensate for air leak and prevent patient-ventilator desynchrony. Thus, AVAPS offers greater control of minute ventilation compared to noninvasive ventilation with pressure support therapy.

Conclusion: This case report highlights the clinical importance of re-evaluation of OSA patients after undergoing tracheostomy. AVAPS may be a suitable mode of treatment in these patients.

1269
A CASE OF EPIC DREAMING TREATED WITH ORAL APPLIANCE THERAPY
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Introduction: Epic Dreaming Disorder refers to a pervasive complaint of excessive dreaming combined with daytime fatigue. Though this disorder has been described in the literature, there is little guidance provided regarding treatment. We report a case in which a patient presenting with EDD is managed with oral appliance therapy.

Report of Case: A 42 year old woman presented for complaints of debilitating daytime sleepiness, accompanied by the experience of “ex-
CPAP INTOLERANCE FOLLOWING DACRYOCYSTORHINOSTOMY

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Introduction: Continuous positive airway pressure (CPAP) is currently the gold standard for treatment of obstructive sleep apnea (OSA). Intolerance to CPAP may result from mask discomfort, claustrophobia, mask leak, conjunctivitis, skin irritation, pressure intolerance and oral-nasal dryness. We present an unusual case of CPAP intolerance related to ocular air regurgitation following dacryocystorhinostomy.

Report of Case: A 57-year-old male with snoring and non-restorative sleep underwent polysomnography which revealed an apnea-hypopnea index of 19.2/hour and minimum oxygen saturation of 86%. A CPAP titration study recommended 12 cm of water which the patient initially tolerated. The patient subsequently underwent treatment of epiphora (overflow of tears onto the face rather than through the nasolacrimal system) and associated nasolacrimal duct obstruction. This condition predated the use of CPAP. Following surgery he reported eye irritation with CPAP use, including frank air regurgitation beneath his closed eyelids with CPAP use. Despite ocular lubricants and an eye patch prescribed by his Ophthalmologist, his ocular symptoms persisted with CPAP use. He ultimately discontinued CPAP therapy and sought alternative treatment of his OSAs via a mandibular advancement device.

Conclusion: Use of CPAP for treatment of obstructive sleep apnea creates positive intraluminal pressure within the upper airway to maintain patency. Dacryocystorhinostomy, the treatment of choice for epiphora due to complete canalicular obstruction, involves joining the lacrimal sac to the nasal mucosa to restore lacrimal drainage. This allows regurgitation of tears into the nose via a valveless tube, but also allows for regurgitation of air through the tube onto the ocular surface. This alteration of anatomy does not cause clinically significant problems for most patients; however, patients subject to increased intraluminal pressures via CPAP may be prone to complication following dacryocystorhinostomy.

ACTIGRAPHY MASKED BY RLS AND OSA: A DIFFICULT CASE TO INTERPRET C:

ACTIGRAPHY MASKED BY RLS AND OSA: A DIFFICULT CASE TO INTERPRET C:

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Introduction: Actigraphy is a useful adjunctive tool in the evaluation of sleep disorders. However, care must be taken to interpret the results in light of the totality of the clinical presentation. We report a case of a 64-year-old man whose actigraphy shows no evidence of sleep for a continuous seven day-period despite patient reporting 3 to 4 hours of sleep/night.

Report of Case: A 64 y.o. male with end-stage renal disease and no previous history of sleep complaints reports new-onset insomnia, parasomnia and RLS, one month after hemodialysis (HD) initiation. Self-reported total sleep time (TST) was 1–4 hours/night; sleepwalking, sleep-talking and RLS were also described. The ESS was 4, STOP-BANG score was indicative of high risk for sleep apnea, BMI was 23 kg/m². Ropinirole was started due to RLS symptoms and initial 7-day actigraphy was performed revealing persistent movement 24 hrs/day with no periods suggestive of sleep. Ropinirole was up-titrated for symptom improvement and subsequent overnight polysomnography showed a TST of 131.5 minutes, 0% REM, WASO 298.5 minutes, AHI 73.9 events/hr, PLM index 2.7/hr, PLM arousal index 0.0/hr, LMI 0.8/hr, LMI arousal index 0.0/hr.

Conclusion: We present a unique case where actigraphy shows incessant activity and no sleep for 7 days despite patient’s self-report of sleep during the observation period. Even though actigraphy has been validated as a method for evaluation of sleep efficiency and patterns its interpretation may be hindered by disorders triggering nocturnal arousals or leg movements. It is important to carefully interpret these findings in light of each patient’s clinical presentation. There is no formal recommendation for—nor advice against—the use of actigraphy in the evaluation of patients with RLS and/or PLMs or other movement disorders such as Parkinson’s disease. Further studies are recommended in order to determine the validity of actigraphy in patients with RLS and/or PLMs.

A CASE OF CENTRAL APNEA REFRACTORY TO ADAPTIVE SERVO VENTILATION (ASV) DUE TO GLOTTIC CLOSURE

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Introduction: Nonvolitional glottic closure (adduction of the vocal cords) has been described in response to ventilator-induced hyperventilation. Central respiratory events have been described as a manifestation of pressure toxicity when titrating patients with obstructive sleep apnea. We describe a patient who developed pseudo-central apnea as a result of glottic closure due to pressure toxicity from positive airway pressure therapy.

Report of a Case: A 66-year-old male was referred for suspected sleep apnea. History revealed cardiomyopathy, atrial fibrillation and hypertension. Medications were tramadol (150 mg), carvedilol and warfarin. A cardiopulmonary sleep study revealed central apnea Index of 67 central apneic events hour with lowest saturation in 79% and circulation time of 28 seconds. The events were most prominent in supine sleep and non-rapid eye movement sleep. Titration with assisted servo ven-
tilation (ASV) began at 5–10 cm H2O, with persistence of pauses in breathing effort at the final pressures of 7-13 cm H2O. On close evaluation of these events, respiratory flow signal at a rate of 15 per minute (which is the ASV backup ventilation rate) was noted in the nasal cannula pressure transducer and snoring channels, but without evidence of thoracic and abdominal inflation, satisfying published criteria for glottic closure.

Conclusion: The purpose of this case report is to alert physicians that pseudo-central apneas may occur in the setting of pressure toxicity, which can promote glottic closure and failed breath delivery. Airflow signals seen at the set noninvasive ventilation backup rate along with snoring but without evidence of thoracoabdominal inflation may indicate glottic closure, and should prompt clinicians to consider pressure toxicity as a potential etiology.

1273

MISSED CHRONIC RESPIRATORY FAILURE IN A POST-POLIO SYNDROME PATIENT

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Introduction: Prior to the introduction of the polio vaccine, paralytic poliomyelitis was a major cause of morbidity and death. Twenty-five to fifty percent of the survivors are known to develop post-polio syndrome. Symptoms include fatigue, insidious respiratory failure, obstructive sleep apnea, bulbar neuropathy, central ventilatory abnormalities, hemi-diaphragmatic paralysis and progressive functional decline with new onset weakness, among others. We present a case of post-polio syndrome presenting with hypercapnic respiratory failure.

Report of Case: A 76-year-old male with polio diagnosed at age seven, requiring ventilation with “iron-lung”, presented with dyspnea, orthopnea and fragmented sleep. He had insidious respiratory decline that he attributed to his advancing age the year prior. Physical examination was significant for atrophy of the upper extremities, decreased left sided chest wall movement, scoliosis and oxygen desaturation to 83%. Chest radiograph and computed tomography were negative except for elevated left hemi-diaphragm. The arterial blood gases demonstrated acute on chronic respiratory acidosis with compensatory metabolic alkalosis. Due to hypoxemia, oxygen supplementation of 3 liters per minute was initiated. The patient later became obtunded, with worsening hypercapnia (PCO2 93.2, increased from PCO2 79.5) and was transferred to the intensive care unit where bilevel titration was initiated. His hypercapnia improved to a pressure of 24/10 cm of H2O with a back-up rate of 12. During the outpatient attended titration study, there was evidence of obstructive sleep apnea that resolved on bilevel

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SLEEP APNEA IN HURLER’S SYNDROME: LOOKING BEYOND UPPER AIRWAY

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Introduction: Hurler’s syndrome (mucopolysaccharidosis type I) is an inherited progressive multisystem lysosomal storage disease caused by deficiency of the enzyme alpha-L-iduronidase. Glycosaminoglycans accumulate due to inability to degrade them in the lysosomes. Over time, this accumulation of storage material in the leptomeninges can lead to impaired cerebrospinal fluid absorption, resulting in hydrocephalus. Patients with Hurler’s syndrome are at risk for obstructive sleep apnea, as they can have narrowed trachea with thickened epiglottis and vocal cords, causing upper airway obstruction. Although sleep apnea in these patients is frequently attributed to upper airway obstruction, hydrocephalus can also be the cause of sleep apnea in this population.

Report of Case: This case involves a 13 month old male with Hurler’s syndrome. He exhibited snoring and oxygen desaturations during sleep; therefore he was referred for polysomnography. His study revealed severe mixed sleep apnea (Apnea Hypopnea Index 72/hour). He was referred to otolaryngology for evaluation of possible airway obstruction. Prior to this evaluation, he underwent ventriculostomy and ventriculoperitoneal shunt placement for increasing head circumference, enlarged ventricles, and increased intracranial pressure. Repeat polysomnography one week after the surgery revealed only mild obstructive sleep apnea (Apnea Hypopnea Index 1.9/hour) which was a marked improvement from his initial sleep study. The etiology of his sleep apnea was likely his hydrocephalus.

Conclusion: This is the first report of a patient with Hurler’s syndrome with sleep apnea, which markedly improved with ventriculostomy and ventriculoperitoneal shunt placement. This case highlights the importance of considering neurological etiologies for sleep apnea in Hurler’s patients, despite their predisposition for airway obstruction. Hydrocephalus should be considered in the differential for sleep apnea in patients with Hurler’s syndrome, as surgical shunting can lead to marked clinical improvement.

1275

NEW-ONSET NARCOLEPSY WITH COMORBID AUTOIMMUNE DISEASE

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Introduction: Narcolepsy with comorbid autoimmune disease is an uncommon diagnosis presenting a diagnostic challenge for Sleep Physicians.

Report of Case: A 25 year old female with seronegative spondylarthropathy presented for evaluation of hypersomnolence beginning one year ago as she recovered from a URI. Despite 8–9 hours of sleep at night she feels sleepy throughout the day (ESS 12) requiring naps – up to 2–3 hours in total each afternoon. Her PCP started treatment for atypical depression yielding no improvement in symptoms. A search for alternate causes was not fruitful. The patients’ hypersomnolence improved on Adderall and referral was made to sleep clinic. She denies hypnagogic/hypnopompic hallucinations, sleep paralysis, or cataplexy. Her spondylarthropathy with back/joint pain and stiffness has improved with the addition of etanercept 3 weeks prior to sleep clinic presentation. Despite significant improvement in pain and stiffness on etanercept, her hypersomnolence is unchanged. Physical Exam reveals...
a BMI of 24, neck circumference of 12.5”, and is otherwise normal. PSG and MSLT were ordered to evaluate for Narcolepsy. PSG yielded a TST of 467.0 minutes, a Sleep Efficiency of 95.4%, and AHI of 0.2. MSLT with the patient off her alerting medication for 7 days yielded a Mean Sleep Latency of 5 minutes with 2 SOREMs in the first 2 naps. She was diagnosed with narcolepsy comorbid with her seronegative spondylarthropathy.

**Conclusion:** Narcolepsy can occur comorbid with autoimmune disease. A careful history with consideration of alternate causes of hypersomnolence, as well as objective testing, is vital for making the correct diagnosis.

### 1276

**PERSISTING PEDIATRIC CENTRAL SLEEP APNEA TREATED BY LOW CONCENTRATION SUPPLEMENTAL OXYGEN**

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**Introduction:** Breathing instability is common in new born infants often characterized by periods of central apnea. Periodic breathing is a cyclic pattern of short durations of central apneas alternating with normal breaths. Periodic breathing is considered a benign breathing pattern in premature infants. Excessive amount of periodic breathing associated with intermittent hypoxemia due to frequent oxygen desaturations may lead to neuropsychological and other morbidity. Often, no treatment is necessary and periodic breathing resolves spontaneously with maturity and rarely persists beyond 6 months of age.

**Report of Case:** A 13 day old male baby was observed to have long periods of observed apneas occurring during sleep. Workup for the patient’s apneic spells included a chest ultrasound, which did not show diaphragmatic paralysis, an EEG and neurology consult for concern of apnea as a result of seizures. A PHOX2B test for congenital central hypoventilation syndrome was normal at 20/20. Apneic episodes were noted to be unresponsive to caffeine citrate. A polysomnogram (PSG) on post-natal day 13 revealed severe central sleep apnea with periodic breathing and moderate hypoxemia. Central apnea index (CAI) was 48 and 3% oxygen desaturation index (ODI) was 44.6. There was significant decrease in the frequency of central apneas with supplemental oxygen. Oxygen saturations improved and normalized with supplemental O2 at a low flow of 0.5 liters per minute (lpm). Patient was placed on continuous oxygen at 0.7 lpm via nasal cannula. PSG’s repeated at 21 days, 7 weeks and 3 months of age showed persisting central sleep apnea with periodic breathing responding to low concentration oxygen. Central sleep apnea was essentially noted to have resolved by 13 months after which oxygen was discontinued.

**Conclusion:** Low concentration oxygen may be utilized in pediatric patients with persistent central sleep apnea and periodic breathing to stabilize breathing patterns and resolve hypoxemia.

### 1277

**VAGUS NERVE STIMULATOR: A HIDDEN CULPRIT FOR SLEEP-DISORDER BREATHING**

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**Introduction:** Vagus nerve stimulator (VNS) is an effective adjuvant therapy for intractable seizures, but has been known to precipitate sleep-disordered breathing (SDB). Often, Obstructive Sleep Apnea (OSA) and VNS-induced SDB may occur in the same patient. We report a patient in whom OSA improved after tonsillectomy, but co-existent VNS-induced SDB persisted and improved with VNS setting adjustments.

**Report of Case:** A 14 year-old female presented in 8/2013 with a 6-month history of snoring/choking and witnessed sleep apneas. She had history of perinatal stroke, intractable seizures since infancy, and VNS implantation at the age of 8 years. On exam, she had BMI of 37 kg/m², right hemiparesis and bilateral grade 3+ tonsils. Her initial diagnostic polysomnogram (PSG) in 7/2013 showed moderate OSA (apnea-hypopnea index/AHI 19/hr, O2 saturation nadir 90%) with predominantly clustered, obstructive-type events with few airflow limitation correlating with VNS stimulations. She subsequently underwent tonsillectomy/adenoidectomy and also lost 20 lbs wt. Repeat PSG showed improvement of OSA to mild range (AHI 12/hr). However, the obstructive respiratory events occurred in a periodic pattern synchronized with VNS stimulations, suggestive of VNS-induced SDB. VNS settings were: amplitude 2.25 mAmps, frequency 30 Hz, pulse width 250 microsec, on-time 30 seconds, off-time 3 minutes. Patient underwent another PSG in 10/2014 with only reduction in VNS amplitudes from baseline to 1.75 mAmp and then to 1.25 mAmp. The frequency of flow limitation events improved with each reduction in amplitude. Eventually VNS was switched off and all respiratory events resolved. The patient’s VNS was then restarted at reduced amplitude of 1.75 mAmp at discharge. The mechanism of VNS-induced SDB is uncertain. It may be due to central mechanisms, since the vagus nerve supplies muscles of the pharynx/larynx, or may be due to peripheral mechanisms via stimulation of afferent fibers from the aortic body to the nucleus tractus solitarius. The management of VNS-induced SDB is uncertain. There have been reports of improvement with adjustments of various VNS settings and CPAP trials have been unsuccessful.

**Conclusion:** This case report illustrates that VNS-induced SDB can coexist with OSA. It is important to screen symptomatic VNS patients for possible VNS-induced SDB by PSG that include a “VNS lead” at left mid-sternocleidomastoid for VNS stimulations. Adjustment of VNS settings may considered after CPAP titration/tonsillectomy in OSA patients with residual VNS-induced SDB.

### 1278

**RESOLUTION OF SLEEP DISORDERED BREATHING FOLLOWING DEACTIVATION OF VAGAL NERVE STIMULATOR**

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**Introduction:** Management of patients with refractory seizures disorders can be very challenging. Around 1/3 of seizure patients continue to have epilepsy on medications. Untreated Obstructive Sleep Apnea (OSA) might be seizure provoking and compliance with CPAP treatment has been proposed to improve seizure control. It is very essential to rule out OSA since many epileptic patients complain of fatigue and excessive daytime sleepiness (EDS). The Vagal Nerve Stimulator Therapy System (VNS) was approved for individuals over 12 years with refractory partial-onset seizures. It has been reported that VNS may worsen OSA, which may worsen seizure control. We report three patients with refractory seizures who developed sleep apnea that resolved years after deactivation of VNS.

**Report of Case:** 40-year-old woman (BMI 23.3 kg/m²) with refractory complex partial seizures (CPS). She had a VNS placed in 2009. Latest VNS settings were current of 1 milliampere (mA), on for 30 seconds and off for 1.8 minutes. Initial Polysomnography (PSG) showed a moderate OSA with Apnea-Hypopnea Index (AHI) of 23/hour. A follow up PSG three weeks later with the VNS off showed an AHI of 3.9/hour. 48-year-old man (BMI 28.12 kg/m²) with CPS who had a VNS placed in 2002. A few months later, patients started complaining of chronic EDS. Initial PSG showed an AHI of 70/hour. He was placed on BiPAP for 11 years as a treatment for VNS induced OSA. His VNS
was deactivated lately and was removed. A repeat PSG showed an AHI of 6/6. A 43-year-old man (BMI 31.3 kg/m²) with CPS. He had VNS placed in 2010. Post VNS insertion PSG in an outside facility showed moderate sleep apnea. VNS settings were current of 0.8 mA, on for 30 seconds and off for 1 minute. Due to lack of seizure control his VNS was removed. Although he continued to complain of EDS, PSG ruled out sleep apnea.

Conclusion: Vagal Nerve stimulator induced Sleep disordered breathing is a recognized complication. Deactivation of VNS at bedtime may eliminate the need of CPAP treatment.

1279
DELAYED SYMPATHETIC CARDIAC RESPONSE IN A PATIENT WITH NIGHT TERROR
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Introduction: Contrary to rapid eye movement (REM) sleep behavior disorder, which is a more common parasomnia, a non-rapid eye movement (NREM) parasomnia like sleep terrors are relatively rare. Sympathetic nervous system activity is usually reduced during NREM sleep parasomnias except Night Terror, which is associated with intense and rapid sympathetic activity. Our patient is a unique case of sleep terror that was accompanied by a markedly delayed sympathetic cardiac response for several seconds.

Report of Case: A 48-year-old African-American woman presents with intermittent episodes of awakening at night with screaming for 12 months with no associated dream content. Shortly after falling asleep, she experiences a sensation of breathing pauses then she wakes up with palpitations. Sometimes, after awakening, she is aware of the fact that she may have been screaming. Occasionally, she has jumped out of the bed and started rushing towards the door, but then becomes conscious of her action and stops. During an overnight polysomnography with video recording, and approximately 40 minutes after sleep-onset, she sat up in bed screaming. Her heart rate remained 73 bpm for several seconds despite intense screaming. Once the screaming ceased, her heart rate increased to 132 bpm. Throughout the event, she was disoriented and did not respond to the technician’s questions. She returned to sleep after 3–4 minutes, and had no recall of the event in the morning. The episode occurred during N3 sleep (slow-wave sleep). The episode met the classical description of a sleep terror although the delayed tachycardia was puzzling. The patient was treated with clonazepam and her sleep terrors resolved.

Conclusion: The delay in heart rate increase while screaming indicates a suppressed sympathetic nervous system response during this sleep terror episode, which is consistent with the sympathetic nervous system activity decline during slow-wave sleep.

1280
WHEN DOWNLOADS LIE!
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Introduction: Data downloads are a mainstay of the management of patients with sleep apnea on positive airway pressure therapy and are often used to adjust therapy. We present a case where the download data was misleading and led to unnecessary adjustment of therapy.

Report of Case: A 92 year old gentleman was referred to our sleep disorders center for complaint of dyspnea, poor sleep and snoring. He had a history of well controlled asthma, gastro esophageal reflux disease as well compensated congestive heart failure WHO functional class I. He was active including 60 minutes of moderately strenuous exercise daily. A Type 3 Home sleep study was done confirming severe sleep apnea with an AHI of 41 primarily obstructive in nature. He was set up with auto-titrating CPAP. On follow up, he was symptomatically improved with some residual sleepiness. The PAP download confirmed 100% adherence but with residual AHI of 30. The majority of events reported on the download were obstructive apneas. The lower limit pressure for the machine were increased but on follow up the data download still showed high index. He had additional adjustments made to the CPAP pressure limits but repeat download showed no improvement in the residual AHI. An in-laboratory titration confirmed that the vast majority of the untreated events were Cheyne-Stoke type events successfully treated with adaptive servo ventilation.

Conclusion: Protocols for cost effective management of Sleep Apnea include use of auto-titrating CPAP in place of laboratory titrations. The validity of the data beyond the adherence information collected from PAP devices has not been well substantiated. Reliance on the PAP device for adjustments in therapy must be approached with caution.

1282
REM- SLEEP BEHAVIOR DISORDER PRESENTING AS HYPNOPOMPIC HALLUCINATIONS
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Introduction: Visual hallucinations have been reported as a precursor symptom in neurodegenerative diseases but can they also arise from sleep fragmentation of untreated sleep apnea or occult REM sleep behavior disorder. The following case highlights the obscurity between the two conditions of which the etiology of this patient’s hypnopompic hallucinations.

Report of Case: A 65 y/o male with history of head injury presented with visual hallucinations occurring frequently around 3 am for past 6 months. According to his wife, he visualizes images immediately upon awakening and was usually alert without executing any complex motor behaviors. His dream content usually constituted images of humans, dogs and spiders crawling down the ceiling. He had undergone a battery of neurocognitive testing and neuroimaging with MRI of brain. Polysomnogram with seizure montage was recommended which revealed AHI of 13 and SPO2 nadir of 91%. Loss of REM atonia was observed with a typical nocturnal episode observed following an arousal from REM. No concomitant epileptiform activity on EEG was noted. This episode lasted for approximately 15 minutes and ended in spontaneous sleep. Follow up telephone call confirmed that he was observing the spider crawling down the ceiling.

Conclusion: This case is an example of hypnopompic visual hallucination associated with REM sleep, which could be harbinger for occult RBD or untreated obstructive sleep apnea. Given the loss of REM atonia, behavior following an arousal form REM and mild OSA, it is likely that RBD is the likely the etiology for nocturnal hallucinations.

1283
CONGENITAL CENTRAL HYPOVENTILATION WITH NORMAL PHOX 2B
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Introduction: Congenital Central Hypoventilation Syndrome (CCHS) is a disorder of ventilatory control marked by a depressed or absent chemoreflex and hypoventilation which markedly worsens during sleep. The vast majority of CCHS cases are due to polyalanine repeat mutations (PARM) between 24–33. However, in 10% of cases, non-PARM mutations including missense, non-sense, frameshift, and stop codon mutations are causative.
Report of Case: A 6 week old female infant without significant perinatal history presented with recurrent desaturations and stridor. She was noted to have tachypnea and feeding difficulties. A venous blood gas revealed acute respiratory acidosis. Airway evaluation was significant for laryngomalacia and upper airway edema thought to be due to reflux. Due to recurrent desaturation, a sleep study was obtained which revealed mild REM-related central apneas along with persistent hypoventilation (ETCO2 > 50 mm Hg for 79% of total sleep time). Awake PaCO2 remained persistently elevated (55–71 mm Hg). Due to concern of CCHS, PHOX2B analysis was obtained which demonstrated normal 20–20 polyalanine repeats. Full gene sequencing, however, demonstrated a missense mutation at location 120 from Arginine to Serine. Evaluation of her parent's genotypes demonstrates that this is a de-novo mutation. The patient was started on positive pressure ventilation during sleep.

Conclusion: This patient's case illustrates the functional importance of arginine at location 120 on the PHOX2B protein. At location 120 the amino acid arginine is quite conserved among vertebrate species. Arginine and serine being quite dissimilar, it is quite feasible that this substitution creates a less than functional protein. De-novo non-PARM mutations are a potential cause of CCHS and must be considered when the clinical context for CCHS exists in the absence of PARM mutations.

1285

ORAL PRESSURE THERAPY: AN EFFECTIVE ALTERNATIVE FOR TREATMENT OF OBSTRUCTIVE SLEEP APNEA AFTER FAILING BOTH CPAP AND SURGICAL APPROACH

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Introduction: Obstructive sleep apnea (OSA) is a common medical condition which is primarily treated with Continuous positive airway pressure (CPAP). However, many patients are unable tolerate CPAP. Oral pressure therapy (OPT) is an emerging alternative device that uses negative pressure suction to help stabilize the tongue and increase the pharyngeal airway.

Report of Case: We report a case of a 54-year-old man with a history of OSA. He was diagnosed 17 years ago after complaining of snoring, non-restorative sleep and excessive daytime sleepiness. He was provided CPAP, but was unable to tolerate due to claustrophobia and inability to tolerate positive airway pressure. He underwent surgical correction to help with his OSA, including a genioglossus advancement, radio-frequency ablation of the soft palate and uvulopalatopharyngoplasty (UPPP), none of which improved his clinical symptoms. In 2014 he returned to try oral pressure therapy (WINX device). He completed a NOX3 home study pre- and post- treatment. Pre-treatment results showed AHI: 18.6 (supine AHI: 40.3); ODI: 16.5 and snore%: 33.5. Post-treatment showed AHI: 2.9 (supine AHI: 41); ODI: 5.9; snore%: 0.5. He reported improvement in sleep quality and felt more refreshed in the morning during post-treatment survey.

Conclusion: Oral pressure therapy may be a novel approach for patients who have failed CPAP and surgical approaches for treatment of OSA. This treatment option has been shown to improve patient compliance and does not require the traditional mask interface. Further studies are needed to show head-to-head efficacy comparable to CPAP.

1286

NEW-ONSET NARCOLEPSY WITH CATAPLEXY AND MYASTHENIA GRAVIS IN AN ELDERLY MAN


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Introduction: Narcolepsy with Cataplexy is considered an immune-mediated disorder. We present a case of an elderly with new onset Myasthenia Gravis (MG) and Narcolepsy with Cataplexy.

Report of Case: 80 yo male diagnosed MG treated with prednisone (20 mg daily) and pyridostigmine (60 mg daily) and IVIG, who concurrently presented with persistent excessive daytime sleepiness (EDS) and prolonged periods of sleep for the previous 6 months. He additionally reported sleep paralysis, visual hallucinations and daily cataplexy with anger and laughter. Overnight Polysomnography (PSG) was done showing severe obstructive sleep apnea (OSA) with an AHI of 34/hour. Bi-level PAP adequately treated the respiratory events with residual AHI of 4.1/hour. Despite optimal therapy with PAP, the patient continued endorsing hypersomnia and cataplexy. Repeat PSG with MSLT were performed 7 months after starting PAP therapy. Two MSLTs showed reduced sleep latency (mean of 2.1 minutes) but no SOREMPs. A repeat MSLT was performed, but similar results were obtained. Patient was negative for HLA DQB1*0602 and cerebrospinal fluid hypocretin-1 was not done. Based on the clinical symptoms, symptoms of oxytalan (daily dose of 7.5 mg) and Venlafaxine (75 mg daily) were started with significant improvement of EDS (ESS from 20 to 8) and resolution of sleep-wake hallucinations, sleep paralysis and cataplexy. Additionally, PAP compliance was optimal with normal residual AHI at months 3 and 6 after initiation of narcolepsy pharmacotherapy.

Conclusion: In this case of MG with Narcolepsy and Cataplexy, symptomatic improvement was obtained with sodium oxytalan, but not from the immune-modulating agents.

1287

BARIATRIC SURGERY FOR EXTREME OBESE ADOLESCENTS WITH SLEEP DISORDERED BREATHING

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Introduction: Obesity is a multifactorial epidemic disease with global impact that causes a significant health risk. It is no longer considered an adult disease: in 2012 the CDC reported that more than one third of children and adolescents in the United States are considered overweight or obese. In the last decade there have been an increased number of obese adolescents undergoing bariatric surgery with reports of significant weight loss. We present two adolescents who underwent bariatric surgery in 2011–2013 at our tertiary referral center.

Report of Case: Two female adolescents age 17 and 18 years underwent bariatric surgery. Mean preoperative body mass index (BMI) was 57 kg/m². Both patients underwent preoperative polysomnography with a mean apnea hypopnea index (AHI) of 6 ± 2. Comorbidities included obstructive sleep apnea, pseudo tumor cerebri, urinary incontinence, dyslipidemia, insulin resistance, metabolic syndrome, irregular menses, vitamin D deficiency, depression and lower back pain. Both patients had prior unsuccessful involvement with comprehensive pediatric weight management programs. Laparoscopic sleeve gastrectomy was performed without reported complications. Means of postoperative percentage for weight loss and BMI within 12 month were 30%
and 34.8 kg/m² respectively; reflecting a drop in BMI of 22.2 kg/m². Additionally dissolution of snoring, depression, and improved school performance were noted.

**Conclusion:** Adenotonsillectomy and PAP therapy are the main treatment options for sleep apnea in adolescents. However, Bariatric surgery should be considered as a viable treatment option in when other conservative measures fail to correct morbid obesity and co-morbid sleep apnea.

**1288**

**CEREBROSPINAL FLUID LEAK AFTER CONTINUOUS POSITIVE AIRWAY PRESSURE INITIATION**

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**Introduction:** Continuous positive airway pressure (CPAP) has been established as an effective and relatively safe treatment for obstructive sleep apnea (OSA). Cases have been reported of cerebrospinal fluid (CSF) leak in the context of CPAP therapy suggesting a causal relationship. We present a case of woman with a history of spontaneous CSF leak who developed recurrent CSF leak after starting CPAP.

**Report of Case:** A 64-year-old woman was evaluated with an overnight polysomnogram for symptoms of daytime sleepiness and snoring. Pertinent medical history included CSF leak repaired endoscopically one year prior to presentation. She was found to have severe OSA with an apnea hypopnea index 69.4/hour and was started on CPAP. Five months late while consistently using her CPAP, she developed rhinorrhea followed by fever and headache, CFS analysis was consistent with bacterial meningitis, and she was admitted to the hospital for intravenous antibiotics. CT cisternogram demonstrated CSF leak into her right sphenoid sinus. Her hospital course was further complicated by pneumocephalus after continued CPAP use during the first 3 days of her hospitalization. She underwent repeat endoscopic repair of her right sphenoid sinus leak without complications. She was advised against resuming CPAP therapy.

**Conclusion:** Spontaneous CSF leaks are most common among middle-aged, obese women and are associated with a high rate of recurrence after surgical repair. Recent literature suggests there may be a link between idiopathic intracranial hypertension (IIH) and spontaneous CSF leaks. CPAP is associated with transient increases in CSF pressure. Five cases have been published discussing atraumatic CSK leak in patients on CPAP. All cases involved women ages 54–77 years without a history of prior CSF leak. Demographic similarities between the cases of CPAP-associated CSF leak and spontaneous CSF leak suggest a similar pathophysiology may be involved. Further investigation is warranted.

**1289 SOMNOLENCE SYNDROME AFTER PROTON BEAM RADIATION IN PATIENT WITH CEREBRAL XANTHOASTROCYTOMA**

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**Introduction:** Somnolence syndrome secondary to radiation has been well known and described as far back as 1929 by Druckmann. It is considered a subacute effect of cranial radiation entity that is characterized by headaches, nausea, emesis, anorexia, weight loss, and a spectrum of fatigue to excessive sleep. It is well known and associated with standard ionization radiation to the whole brain.

**Report of Case:** We describe a case of a 13 year old male diagnosed with hypersomnolance after surgical treatment of a cerebral xanthoastrocytoma that was well controlled with modafinil. Regrowth of tumor 5 years later that was treated with proton beam radiation to the right thalamus was third ventricle. He developed somnolence syndrome two months after completion of the radiotherapy.

**Conclusion:** While somnolence is well described for whole brain radiation, it has not been reported with use of proton beam radiation. The theorized advantage of proton beam radiation over standard ionization radiation is the potential dose distribution benefit related to the so-called Bragg peak, wherein the protons precipitously deposit the majority of their energy at the end of their range, i.e., at the edge of the tumor, thus allowing for a steep drop-off and very little to none of the stray does to the tissue beyond the target. It is likely that the patients' somnolence syndrome is from radiation to the thalamus which is an area of the brain involved in the sleep/wake cycle.
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