Short Sleep Duration in Prevalent and Persistent Psychological Distress in Young Adults: The DRIVE Study

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Objectives: Young people are sleeping less. Short sleep duration has a range of negative consequences including a hypothesized link with psychological distress, which has yet to be studied

Design: Prospective cohort study

Setting: Community-based sample from Australia

Participants: Twenty thousand (20,822) young adults (aged 17-24) identified through the state vehicle licensing authority. A random sample (n = 5000) was approached for follow-up 12-18 months later, with 2937 providing full data.

Main Outcome Measure: Psychological distress, determined by a Kessler 10 score > 21, at baseline; and as both onset and persistence of distress at follow-up.

Results: Shorter sleep duration was linearly associated with prevalent psychological distress: relative risk (RR) 1.14 (95%CI 1.12 to 1.15). Only the very short (< 5 h) sleepers among those not distressed at baseline had an increased risk for onset of psychological distress (RR 3.25 [95% CI 1.84, 5.75]). Of 945 cohort participants reporting psychological distress at baseline, 419 (44%) were distressed at follow-up. Each hour less of sleep increased the risk of psychological distress persisting after adjustment for potential confounding variables: RR 1.05 (95%CI 1.01 to 1.10). Long sleep duration showed no association with distress at any time point.

Conclusions: Self-reported shorter sleep duration is linearly associated with prevalent and persistent psychological distress in young adults. In contrast, only the very short sleepers had a raised risk of new onset of distress. Different approaches to sleep duration measurement yield different results and should guide any interventions to improve subjective sleep duration in young adults.

Keywords: Sleep, psychological distress, cohort, young adult

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ABOUT 25% OF YOUNG ADULTS ARE AFFECTED BY PSYCHOLOGICAL DISTRESS, A MEASURE OF POOR MENTAL HEALTH COMPRISING COMMON SYMPTOMS of low mood and anxiety, at any one time.[1] A considerable proportion of those with distress go on to develop more severe mental disorders, recurrent episodes[2] and the associated negative sequelae, including suicide attempts and welfare dependence.[3,4] There appears to have been an increase in the rates of psychological distress in young adults over the past few decades which remains unexplained.[5] However the persistence and recurrence of such distress in young adults is a strong predictor of a more chronic course of depression[6] and as such a target for early intervention approaches, as the majority of these problems emerge in the years following puberty.[7]

There are a great range of social, psychological, and biological shifts occurring in modifiable risk factors for mental disorder over the adolescent years, including the onset of substance use and changes in physical activity.[8] One potential risk factor that has attracted recent attention is sleep disturbance, of which short sleep duration is a significant component. Sleep duration decreases from birth,[9] such that by age 17 years, it averages 7.6-8 h sleep on weeknights, a figure that falls by half an hour by age 24. On average, adolescents and young adults sleep longer on weekends, but many young people frequently get less sleep than needed over the week.[10] Furthermore there is evidence of temporal trends towards shorter sleep duration: In Australia young people report getting a half-hour less sleep per night over the past decade or so, particularly in those from lower socioeconomic groups.[11] In the US, an increase in the proportion of people reporting short sleep is reported by all groups, but again particularly in those from disadvantaged social groups.[12] Shorter sleep duration in younger age groups is associated with a number of factors, including increased television viewing, computer gaming, and internet use,[13] all of which appear to be becoming more commonplace and associated with later bedtimes while waking times remain stable.[13]

Subjective short sleep duration is a common clinical complaint amongst people with mental disorder and a component of several diagnoses. Self-reported short sleep has been associated with psychological distress in cross-sectional studies in general adult populations,[12,14] although the association of polysomnographic measured sleep duration with distress is weaker.[14] Short sleep duration and later bedtimes have been shown very recently to be associated with current depressed mood and suicidal ideation in adolescents.[15] Sleep disturbance in adults, often characterized as insomnia, has consistently been shown to increase the likelihood of the onset of future mental disorder in those currently without disorder[16-18] and confirmed recently in both

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self-report and polysomnographic data in the Wisconsin Sleep Cohort.[19] None of these longitudinal studies of sleep disturbance and future mental disorder included participants aged under 20, yet this is an age group in which major changes take place both in rates of mental disorder and sleep patterns.[7] All of the above studies compared a group of very short sleepers with the rest of the sample and so could not evaluate to what extent any observed association held across the range of sleep duration. This has implication for targeting interventions. Further there are no prospective studies evaluating the impact of short sleep duration in younger adults on the onset or persistence of the broader phenotype of psychological distress. Nor are there any studies addressing the impact of long sleep duration, although in clinical samples of people with psychiatric disorder hypersomnia is not uncommon. This study aimed to answer whether self-reported sleep duration, defined both categorically and continuously, is independently associated with psychological distress and predicts its onset and persistence in young adults.

METHODS

A prospective cohort study examining risk factors for young driver crash and injury recruited 20,822 young Australians, aged 17-24 years; full baseline data on sleep duration and psychological distress were available for 94.4% (19,648). The methods and characteristic of the sample are described in detail in an earlier publication.[20] In brief, drivers aged 17-24 years holding their first-stage provisional motor-vehicle driver's license in the State of New South Wales (NSW), Australia, were invited to complete a confidential survey that could be completed either on-line or via a printed questionnaire. The survey included questions on psychological distress and sleep (described below), as well as a range of other demographic and driving related risk factors, such as sensation seeking, risky driving behaviors, and substance use.

Measures

Subjective sleep duration was assessed through self-report of the number of hours slept on weekday and weekend nights separately over the past month. The weighted average of weekday and weekend sleep hours was used to determine average sleep duration. Such a measure is a standard assessment of perceived hours slept used in a number of large epidemiological studies that have reported the consequences of sleep duration, such as the National Health and Nutrition Examination Survey,[21] and shown there to be associated with objectively reported bedtimes in this age group.[15] For the descriptive univariate analyses, this was then grouped into an ordinal variable. Only 157 participants reported sleeping > 11 h on average; and as the same proportion (31%) of this group had psychological distress as the 10- to 11-h group, these groups were merged. Participants reporting impossible sleep duration, e.g., 150 hours per weekend (n = 297) or missing sleep duration data (n = 795) were excluded. The a priori main analyses were based upon log binomial models using a continuous measure of average sleep duration to retain information.

Several potential confounders were evaluated. Drug use was measured using 2 questions from the Centers for Disease Control and Prevention (CDC) Youth Risk Behavior Surveillance System on the use of marijuana (cannabis) and other recreational drugs in the past 12 months (coded as ever /never).[22] Alcohol use was measured using a 3-item subscale of the Alcohol Use Disorders Identification Test (AUDIT-C), with a score > 6 indicating harmful use.[23]

Self-harm was assessed with an open-ended question as in previous Australian adolescent and young adult research: "In the past 12 months have you deliberately hurt yourself or done anything that you knew might have harmed you or even killed you? (yes/no), followed by a clarification question "If yes, what was it that you did?" These questions were based on the Beck Suicide Inventory and have been previously used in studies in young adults in Australia.[24,25] Two trained research assistants then coded the open responses to evaluate whether the reported action constituted "deliberate self-harm" (DSH), rather than engagement in such commonly reported risk-taking activities as driving over the speed limit. Initial training and review of the first 100 positive responses were conducted by a consultant psychiatrist. All discrepancies were reviewed in further training before completing the rest of the sample. The inter-rater reliability of the trainers for a post-training random sample of 20% of these codes was a κ of 0.97.

Demographic and other routine data were also recorded and categorized as gender, age (17, 18, 19+), and occupation (secondary /tertiary student, working, and not working). Given the purported effects of local environment and socioeconomic status upon mental disorders, this included a measure of socioeconomic status derived from Socio-Economic Indexes for Areas (SEIFA) scores based on small-area statistics from the Australian 2001 population census.

Outcome

Psychological distress was assessed using the Kessler 10 (K-10).[26] This 10-item self-report measure asks: "The following questions are about your feelings in the past 4 weeks: in the past 4 weeks how often did you feel tired out for no reason?" Further questions ask about feeling: nervous, hopeless, restless, depressed, that everything is an effort, very sad, and worthless, but no somatic features. There are 5 response options ranging from "None of the time" to "All of the time," and scores range from 10 to 50. Those scoring > 21 were considered to be experiencing significant levels of psychological distress and likely to represent cases of mental disorder in Australian populations, as reported in government surveys of young people.[1]

Resurvey

A random sample of 5000 of the initial respondents was recontacted 12-18 months after completing the baseline survey by text message, email, and/ or letter. It was not possible to resurvey the full cohort due to resource limitations. Resurvey respondents were invited to complete a second questionnaire and were reimbursed for their time with a cinema ticket. A total of 3344 (67%) resurveyed individuals responded, of whom 2937 had full baseline data and follow-up K10 data. Of these, 1992 (67.8%) did not report psychological distress at baseline and responded with one of 2 outcomes: a Kessler-10 (K10) score > 21 at resurvey, termed "onset of psychological distress," or repeated lower levels of distress (K10 $\leq$ 21). Of the 2937 respondents with complete data, 945 (32.2%) had high levels of distress at baseline and were coded into one of 2 outcomes: again reporting a K10 score > 21 at resurvey, termed "persistent psychological

distress," or of "remission" to lower levels of distress (K10 ≤ 21). Those not responding to the resurvey were more likely to be male (43% vs 34% in follow-up sample), have finished education (17% vs 11%), and be substance misusers (e.g., harmful alcohol users 20% vs 13%) and high sensation seekers (43% vs 35%) (P values for each χ^2 test < 0.001). Mean sleep duration did not differ between the responders (7.7 h) and non-responders (7.6 h). There was no response bias from psychological distress, self-harm reporting, socioeconomic status, or age.

The University of Sydney Human Research Ethics Committee and the NSW Health Ethics Committee approved the study.

Analysis

The associations of demographic, behavioral and psychological characteristics with categories of sleep duration and psychological distress were examined using χ^2 tests, and for trend if necessary, in the baseline data. The association of sleep duration with prevalent, onset and persistence of psychological distress was analyzed using both the grouped sleep duration for interpretation and using the continuous measure of average sleep duration. The modal sleep duration of ≥ 8 to 9 hours was used as the reference group for descriptive analyses.

After confirmation of the log-linearity of the relationship, log binomial models examining the association of sleep duration (using an ordinal measure of hours) with psychological distress were constructed, first unadjusted and then adjusting sequentially for a priori demographic (model 1) and behavioral (model 2) factors. Given the log linear effect of the sleep values used for the ordinal variable then this should be an appropriate summary of the log linear effect of categorical groups.

This analysis was repeated for the association of sleep duration with onset of psychological distress in the sample of those with no distress at baseline (n = 1992) and persistence in those with baseline psychological distress at baseline (n = 945), who formed 2 mutually exclusive cohorts. Baseline severity (K10 score) was additionally entered (as quartiles) to allow for the consistent finding in studies of baseline symptom severity as a predictor of poorer outcome. A third model weighted those variables associated with non-response, with weights based upon the degree of potential bias. As an additional check, the final model was also adjusted for an offset according to length of time in the study.

RESULTS

Association of Sleep Duration with Current Psychological Distress

Overall, 18% of the 19,648 with full data in this study reported sleeping < 7 h per night on average, and a further 30% slept between 7 h and 8 h. On average this sample slept 20 min more on weekends (8.1 h, SD 1.98) than during the week (7.8 h, SD 1.35). Almost one-third (32.5%) scored > 21 on the K10, indicating high levels of current psychological distress.

Shorter sleep duration was associated with psychological distress (χ^2 test for trend P ≤ 0.0001) (Table 1). Over half of those reporting < 6 h sleep per night had high levels of current psychological distress, compared to about one quarter of those sleeping the recommended level in young adults of 8-9 h per night: (relative risk [RR] for ≤ 5 h, 2.22 [95%CI; 2.02, 2.44], > 5 to < 6 h [RR 1.95], 95%CI; 1.79, 2.13). Modeling the continuous measure of sleep duration rather than using grouped data demonstrated a linear association of reported average sleep duration with psychological distress (RR 1.14; 95%CI 1.12,1.15), indicating 14% greater risk of higher levels of distress for every hour less slept. There was no such association with longer sleep duration.

Table 1—Association of self-reported average sleep duration with psychological distress in the baseline sample of 19,648 young adults

Average sleep duration (categories)	High or very high psychological distress K10 > 21		No or moderate psychological distress K10 ≤ 21		
	N (6386)	% (row)	N (13,262)	% (row)	Relative risk (RR and 95%CI)
≥ 10 h	317	30.6	718	69.4	1.16 (1.05, 1.28)
≥ 9 to < 10 h	676	25.3	2001	74.7	0.96 (0.89, 1.03)
≥ 8 to < 9 h	1653	26.4	4608	73.6	REF
≥ 7 to < 8 h	2045	34.1	3955	65.9	1.29 (1.22, 1.36)
≥ 6 to < 7 h	1154	43.2	1520	56.8	1.63 (1.54, 1.74)
≥ 5 to < 6 h	329	51.5	310	48.5	1.95 (1.79, 2.13)
≤ 5 h	212	58.6	150	41.4	2.22 (2.02, 2.44)
Average sleep duration (decreasing hours)					1.14 (1.12, 1.15)

Self-reported sleep duration was associated with a number of baseline characteristics (Table 2): Older age, being employed, recent deliberate self-harm, and reported use of marijuana, other drugs, and drinking at harmful levels were all associated with shorter sleep duration (P < 0.001 in each case for test for trend). Male gender and being unemployed showed U-shaped associations with sleep duration. In this sample, high psychological distress was associated with female gender (40% vs 28% in males), unemployment (33% vs 28% in the employed), drug use (45% vs. 32%), harmful alcohol use (38% vs 32%), high sensation-seeking behavior (44% vs 22% in lowest category) and recent deliberate self-harm (70% vs 31%) (P < 0.001 in each case). The area level socioeconomic status score had no such association (P = 0.8779).

Effect of Short Sleep Duration upon Onset of Psychological Distress

Amongst the 1992 participants in the resurvey who did not report high levels of stress at baseline and had follow up data, 239 (12%) reported high levels of distress one year later (Table 3). Although the ordinal categorization of sleep duration suggested a reverse J-shaped curve, with only those in the very shortest category having a higher risk (RR 3.25 [(95% CI 1.84, 5.75]), when modeling the data, there was a linear association (RR 1.12 [95% CI 1.01, 1.24]) of shorter sleep duration increasing the likelihood of onset of psychological distress. There was no effect of long sleep duration upon new onset of distress.

In a multivariable model (Table 4), although adjusting for demographic factors had no effect, the linear association was apparently confounded by subthreshold levels of distress and behavioral factors (1.06 [95% CI 0.96, 1.17]). Of note was that only these lower levels of distress symptoms (and possibly, being unemployed) predicted the onset of distress in these models.

Effect of Sleep Duration upon Persisting Psychological Distress

Of the 945 participants in the resurvey who reported a K10 score > 21 at baseline, 419 (44%) of these reported experiencing high or very high levels psychological distress one year later. These were considered the "persistent" cases and were compared to those (n = 526) whose distress had "remitted." Shorter sleep duration showed a significant effect of being associated with a greater risk of persisting psychological distress in all sleep duration groups less than the recommended reference group duration (Table 3).

Table 2—Association of demographic and psychological characteristics with sleep duration at baseline in 19,735 young adults

Characteristic	Sleep hours: 0-5		> 5 to < 7		≥ 7 to < 8		≥ 8 to < 9		≥ 9		Total		P value
	n = 363	% (col)	n = 3328	% (col)	n = 6017	% (col)	n = 6291	% (col)	n = 3736	% (col)	n = 19,735	% (col)	
Age (years)													
17	132	36.36	1378	41.41	2895	48.11	3317	52.73	1916	51.28	9638	48.84	
18-19	154	42.42	1379	41.44	2192	36.43	2206	35.07	1390	37.21	7321	37.10	
≥ 20	77	21.21	571	17.16	930	15.46	768	12.21	430	11.51	2776	14.07	< 0.0001
Sex													
Female	184	50.69	1890	56.79	3339	55.49	3364	53.47	1977	52.92	10754	54.49	
Male	179	49.31	1438	43.21	2678	44.51	2927	46.53	1759	47.08	8981	45.51	0.0012
Occupation													
1. High school student	123	34.07	1360	41.40	2992	50.34	3398	54.87	1934	52.67	9807	50.41	
2. TAFE/Uni student	104	28.81	1049	31.93	1673	28.15	1557	25.14	949	25.84	5332	27.41	
3. Employed	95	26.32	729	22.19	1092	18.37	1014	16.37	544	14.81	3474	17.86	
4. No work / benefits	39	10.80	147	4.47	186	3.13	224	3.62	245	6.67	841	4.32	< 0.0001
Alcohol harmful drink													
No	271	74.66	2731	82.06	5250	87.27	5558	88.39	3315	88.76	17125	86.80	
Yes	92	25.34	597	17.94	766	12.73	730	11.61	420	11.24	2605	13.20	< 0.0001
Marijuana use													
Never	283	78.39	2672	80.48	5184	86.30	5499	87.56	3311	88.89	16949	86.07	
Ever	78	21.61	648	19.52	823	13.70	781	12.44	414	11.11	2744	13.93	< 0.0001
Drugs use													
Never	298	82.09	2972	89.55	5586	93.27	5941	94.81	3517	94.59	18314	93.18	
Ever	65	17.91	347	10.45	403	6.73	325	5.19	201	5.41	1341	6.82	< 0.0001
Self-harm in past year													
No	312	85.95	3103	93.24	5777	96.01	6093	96.85	3607	96.55	18892	95.73	
Yes	51	14.05	225	6.76	240	3.99	198	3.15	129	3.45	843	4.27	< 0.0001

Table 3—Longitudinal association of self-reported sleep duration with onset and persistence of psychological distress one year later

Average sleep duration (categories)	Onset of psychological distress (n = 1992): Onset of psychological distress N 239	% 12	No psychological distress at follow up N 1753	% 88	Relative risk (RR and 95%CI)	Persistence of psychological distress (n = 945): Persistent psychological distress N 419	% 44.5	No psychological distress at follow up N 526	% 55.5	Relative risk (RR and 95%CI)
≥ 10 h	11	11.8	82	88.2	0.96 (0.53, 1.73)	18	34.0	35	66.0	0.91 (0.60, 1.37)
≥ 9 to < 10 h	25	8.1	283	91.9	0.66 (0.43, 1.01)	43	45.3	52	54.7	1.21 (0.92, 1.59)
≥ 8 to < 9 h	88	12.3	627	87.7	REF	98	37.5	161	62.5	REF
≥ 7 to < 8 h	68	11.7	511	88.3	0.95 (0.71, 1.28)	138	45.7	164	54.3	1.22 (1.00, 1.49)
≥ 6 to < 7 h	28	12.4	197	87.6	1.01 (0.68, 1.51)	81	49.1	84	50.9	1.31 (1.05, 1.64)
> 5 to < 6 h	11	21.1	41	78.9	1.72 (0.98, 3.01)	25	58.1	18	41.9	1.56 (1.15, 2.10)
≤ 5 h	8	40.0	12	60.0	3.25 (1.84, 5.75)	16	61.5	10	38.5	1.65 (1.17, 2.32)
Average sleep duration (decreasing hours)					1.12 (1.01, 1.24)					1.08 (1.04, 1.13)

"Onset of psychological distress" defined as a K10 score > 21 at follow-up but < 21 at baseline; "Persistent psychological distress" defined as a K10 score > 21 at both baseline and follow-up

Again there was a linear association of shorter sleep duration being associated with persistent psychological distress (RR for each hour less 1.08 [95%CI 1.04, 1.13]). The log binomial model results for persistence are presented in Table 5: the association was only minimally attenuated by adjusting for a range of potential confounders (RR 1.05 [95%CI 1.01, 1.10]). In the fully adjusted models, being older, having higher initial psychological distress severity, and reporting deliberate self-harm in the year prior to the baseline assessment also increased this risk. Behavioral factors such as harmful levels of drinking and marijuana use showed no independent effect on the persistence of psychological distress.

Weighting those variables associated with potential attrition bias (gender, higher education, sensation seeking, and substance misuse) by the degree of non-response in the resurvey, individually and in combination, had no substantial effect upon the adjusted association of sleep duration with either onset or persistence of psychological distress (Tables 4 and 5). Forcing other factors such as socioeconomic status into the model also had no significant effect. There was no interaction with either age or gender. Finally, there was no effect of adjusting for differential amounts of time in the study.

Table 4—Multivariable longitudinal log binomial models of the association of self-reported sleep duration, measured at baseline, with onset of psychological distress 12-18 months later, sequentially adjusted for confounders (n = 1922)

Characteristics	Model 1 (+ demographics) RR (95%CIs)	Model 2 (+ behavioral factors) RR (95%CIs)	Model 3 (+ weighted for non-response) RR (95%CIs)
Sleep duration (decreasing hours)	1.11 (1.01, 1.23)	1.06 (0.96, 1.17)	1.06 (0.96, 1.17)
Age (17 vs ≥ 18)	0.90 (0.65, 1.24)	0.94 (0.69, 1.29)	0.97 (0.71, 1.32)
Gender (female vs male)	1.18 (0.92, 1.50)	1.16 (0.91, 1.49)	1.15 (0.91, 1.46)
Occupation (vs school student)			
Higher education	0.97 (0.68, 1.38)	1.04 (0.73, 1.47)	1.06 (0.74, 1.52)
Employed	1.09 (0.74, 1.61)	1.20 (0.82, 1.75)	1.18 (0.82, 1.71)
Not working or student	1.65 (0.94, 2.90)	1.63 (0.94, 2.83)	1.82 (1.10, 3.01)
K10 baseline distress (quartiles)		2.76 (2.03, 3.75)	2.69 (1.98, 3.67)
Harmful drinking (yes vs no)		0.73 (0.47, 1.15)	0.95 (0.74, 1.24)
Marijuana use (yes vs no)		1.20 (2.03, 3.75)	1.12 (0.78, 1.61)
Deliberate self-harm (yes vs no)		1.07 (0.51, 2.24)	1.02 (0.48, 2.17)

Model 1, Demographic factors in table all simultaneously entered; Model 2, Additional behavioral factors in table all simultaneously entered; Model 3, Variables associated with non-response weighted by degree of non-response (gender, age, risk taking, and alcohol misuse)

Table 5—Multivariable longitudinal log binomial models of the association of shorter sleep duration, measured at baseline, with persistent psychological distress 12-18 months later sequentially adjusted for confounders (n = 945)

Characteristics	Model 1 (+ demographics) RR (95%CIs)	Model 2 (+ behavioral factors) RR (95%CIs)	Model 3 (+ weighted for non-response) RR (95%CIs)
Sleep duration (decreasing hours)	1.09 (1.03, 1.14)	1.06 (1.02, 1.10)	1.05 (1.01, 1.10)
Age (17 vs ≥ 18)	0.70 (0.57, 0.86)	0.71 (0.59, 0.86)	0.70 (0.58, 0.84)
Gender (female vs male)	1.17 (1.00, 1.37)	1.12 (0.97, 1.31)	1.14 (0.99, 1.31)
Occupation (vs school student)			
Higher education	0.98 (0.79, 1.20)	0.97 (0.81, 1.16)	0.95 (0.79, 1.14)
Employed	0.97 (0.75, 1.25)	0.94 (0.74, 1.19)	0.91 (0.73, 1.14)
Not working or student	1.08 (0.77, 1.52)	0.96 (0.69, 1.33)	0.90 (0.66, 1.23)
K10 baseline distress (quartiles)		1.24 (1.17, 1.32)	1.23 (1.15, 1.30)
Harmful drinking (yes vs no)		0.88 (0.71, 1.11)	0.97 (0.84, 1.11)
Marijuana use (yes vs no)		1.07 (0.89, 1.28)	1.05 (0.88, 1.25)
Deliberate self-harm (yes vs no)		1.22 (1.05, 1.41)	1.29 (1.12, 1.49)

Model 1, Demographic factors in table all simultaneously entered; Model 2, Additional behavioral factors in table all simultaneously entered; Model 3, Variables associated with non-response weighted by degree of non-response (gender, age, risk taking, and alcohol misuse)

DISCUSSION

The results from this large prospective cohort indicate that self-reported shorter sleep duration was associated with prevalent psychological distress and was an independent risk factor for its persistence a year later, even after adjusting for severity of the distress and a range of potential confounders typically associated with poor psychiatric outcomes. Initial symptom severity, older age, and recent self-harm attempts were other factors that predicted this persistence; none of the forms of substance misuse were predictive. These results suggest that short sleep duration is a marker for a poorer outcome of psychological distress in linear fashion, independent of baseline symptom severity. The association of short sleep duration with prevalent and persistent distress was consistent over a range of different models and sensitivity analyses. The only previous study to assess the future impact of sleep disturbance in those with any current form of psychological distress was conducted in the elderly and showed a similar effect of short sleep duration predicting persistence of major depressive disorder.[27]

In contrast, any apparent association of shorter sleep duration with new onset of distress was primarily confounded by subclinical levels of distress. This result is at odds with the Wisconsin study[19] that reported PSG-measured shorter sleep duration to be a risk for later depression. This discrepancy may be accounted for by the age of the sample, outcome measure (depression vs. distress), lack of adjustment for subclinical levels of distress,

and importantly, the way sleep duration is evaluated. Objective and subjective short sleep duration are not the same thing; the latter is likely to be a proxy for a range of psychological and sociodemographic factors (including gender, socioeconomic class, and occupational demands.[28] The associations between short sleep and other outcomes such as obesity are also affected differentially by whether the duration is measured subjectively or objectively.[29,30] In elucidating any underlying pathological pathways, this distinction needs to be borne in mind. Inflammatory markers associated with psychiatric disorder are also differentially associated with subjective and objective sleep duration.[31] Our results also showed that different approaches in coding and categorizing self-reported sleep duration can have significant implications for results, even in such a large sample; this has implications for standardizing such metrics to enable comparison between studies.

One possible explanation for an association between sleep duration and psychological distress may be that short sleep duration is just a symptom of the psychological distress being assessed. Sleep disturbance is a key symptom in mental disorders such as depression,[2] although it is also a common finding in populations without mental disorder.[10] Short sleep duration may be a part of the prodrome of a mental disorder[32] or a residual symptom of a prior disorder[33] and is a marker for recurrence of depression in the elderly.[34] The attenuation of the association of short duration with onset after adjustment for subclinical symptoms severity would support this view. Without an extensive life course approach, it is difficult for studies to elucidate whether any sleep disturbance was truly "prior," part of a "prodrome," or a residual symptom of previous distress or disorder. Defining the temporal relationships between sleep disturbance and forms of psychological distress has proved complex, with bidirectional paths observed, complicated by varying definitions used for both exposure and outcome.[35] Recent research on sleep disturbance and mental disorder has shifted the traditional view of sleep disturbance invariably being part of a mental disorder to one of comorbidity,[36] with greater understanding of common and differential underlying biology.[37] The independent effect of short sleep duration upon persistent distress may also suggest that sleep disturbance is a marker for severity or that it reflects a comorbid condition that diminishes the chance of the distress resolving. Finally it raises the possibility that the increase in levels of distress reported by young adults over the past decade may reflect temporal changes in young people's sleep patterns.

The study has a number of limitations. First, the initial DRIVE study was designed to provide robust estimates of exposure-response relationships and is not population representative.[20] However this sample reported similar levels of psychological ill health to the recent Australian National Survey of Mental Health and Wellbeing,[1] in which 26% of 16- to 24-year-olds had an ICD-10 defined mental disorder. The average sleep duration and differences between weekend and weekdays are similar to those observed in the Australian Time Use survey.[38] Second, there was potential attrition bias. We weighted the binomial models for those variables associated with non-response with no effect. Further there was no association of the primary exposure in this paper (sleep duration) with attrition. Third, in terms of the outcome of persistence, we cannot say whether a person with high K10 scores at both time points was chronically distressed or whether they had fluctuations in distress, as we could only evaluate at baseline and once again after a period of a year or so. This study did not collect information on a number of potential confounders, such as psychiatric or sleep diagnoses or treatment undertaken either during or prior to the study period. However, in Australia only 23% of young people with a mental disorder have used any form of services in the past 12 months.[1]

Given the cost and logistical limitations of both polysomnography and actigraphy, the likelihood is that most clinicians outside of sleep clinics will rely upon self-report to identify short sleep duration. The finding that self-reported shorter sleep duration increased the likelihood of persistence of psychological distress in young adults has important clinical and policy implications. Short sleep duration in adolescents and young adults is consistently implicated in predicting poorer educational attainment, somatic and, interpersonal problems, weight gain, and future obesity,[29,39] and recently with depressed mood and suicidal ideation.[15] The addition of another negative outcome (persistent psychological distress and thus likelihood of future psychiatric disorder) of short sleep duration adds weight to the argument for improving sleep in this age group, as well as identifying sleep duration as a marker for early intervention.

The differential results with respect to onset and persisting psychological distress highlights tension between intervention approaches. Firstly it suggests that if prevention of onset of distress is the aim, then attempts to improve sleep should be targeted only at those in the very short duration category. Interventions in those who report even slightly longer sleep may have risks, such as establishing the sleep ruminations seen in chronic insomnia. However, attempts to improve self-reported sleep duration in those with current distress may be beneficial for across the range of sleep duration.

Although there are recent individual studies of sleep-focused interventions improving not just sleep but other psychological parameters,[40] as Roberts et al. observed, "much of the remedy for adolescent sleep deprivation lies in the broader societal context of adolescent lives, particularly as related to school, leisure, and work."[39] Modifying, or ameliorating the impact of, modern lifestyles that promote sleep deprivation in young people,[8,11,13] such as starting school later and restricting late night internet access and other bedtime prolonging activities is a challenging task. Health education in schools and colleges enable young people to be better informed about their choices. Such interventions should be guided by whether they are universal (everyone), indicated (subclinical symptoms), or selected (higher risk groups),[41] as there may be untoward consequences of targeting those with and without current psychological distress in the same way.

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