ORIGINAL ARTICLE

Insomnia, hypnotic use, and road collisions: a population-based, 5-year cohort study

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Abstract

Study Objectives: The study objectives were to examine accidental risks associated with insomnia or hypnotic medications, and how these risk factors interact with sex and age.

Methods: A population-based sample of 3,413 adults (M_{age} = 49.0 years old; 61.5% female), with or without insomnia, were surveyed annually for five consecutive years about their sleep patterns, sleep medication usage, and road collisions.

Results: There was a significant risk of reporting road collisions associated with insomnia (hazard ratio [HR] = 1.20; 95% confidence interval [CI] = 1.00–1.45) and daytime fatigue (HR = 1.21; 95% CI = 1.01–1.47). Insomnia and its daytime consequences were perceived to have played some contributory role in 40% of the reported collisions. Both chronic (HR = 1.50; 95% CI = 1.17–1.91) and regular use of sleep medications (HR = 1.58; 95% CI = 1.16–2.14) were associated with higher accidental risks, as well as being young female with insomnia and reporting excessive daytime sleepiness.

Conclusions: Both insomnia and use of sleep medications are associated with significant risks of road collisions, possibly because of or in association with some of their residual daytime consequences (i.e. fatigue and poor concentration). The findings also highlight a new group of at-risk patients, i.e. young women reporting insomnia and excessive daytime sleepiness.

Statement of Significance

Although sleep apnea and excessive daytime sleepiness have been associated with significant risks of road accidents, there is little information about accidental risks associated with insomnia and hypnotic medications, and how these risk factors interact with sex and age. In this longitudinal study, insomnia and its daytime consequences (fatigue and poor concentration) were reported to have played some contributory role in 40% of reported road accidents. Both chronic and regular use of sleep medications were also associated with higher accidental risks. A new group of at-risk patients was identified, i.e. young women reporting insomnia and excessive daytime sleepiness. Given the potential driving hazards of insomnia and hypnotics, it is important to inform patients with insomnia of these driving hazards and discuss such hazards when discussing risk benefits of different treatment options.

Key words: insomnia; sleep disorders; road and traffic accidents; crashes; collisions

Introduction

Sleepiness at the wheel is a leading cause of traffic collisions [1] and sleep disorders are associated with near misses and a higher rate of collisions [2]. Age and sex are classical risk factors for road accidents with a higher prevalence of accidents in young male drivers. Assessment of accidental risks can be stratified by identifying typical medical conditions associated with sleepiness and behavioral or lifestyle factors increasing the risk. Estimating accidental risk involves recognizing potential sleep disorders and inappropriate behavioral and sleep hygiene practices [3]. Sleep deprivation and nocturnal driving have been associated with significant accidental risk and largely concern young male drivers [4].

Insomnia is the most prevalent of all sleep disorders, affecting predominantly women and older adults, and it is presumably associated with increased risk of traffic collisions. Insomnia disorder is a heterogeneous condition that is typically associated with daytime consequences such as impaired attention and fatigue, both of which can contribute to increasing accidental risks on the road. In addition, it can present different manifestations (i.e. with or without excessive daytime sleepiness or with or without objective sleep reduction) and different treatments (i.e. hypnotics vs. cognitive behavioral therapy) [5]. Insomnia can be transient or chronic and associated or not to other chronic diseases (i.e. mental disorders). Medications commonly used for treating insomnia (e.g. benzodiazepines, zolpidem, and zopiclone) have different durations of actions, with long-acting drugs typically producing more residual daytime effects than short-acting ones [6, 7]. This heterogeneity has led to contradictory results in the literature and the potential role of CNS drugs versus that of insomnia disorder per se has not been delineated clearly in previous studies. Only one study [8] carefully excluded people with insomnia taking drugs to study drug-free individuals in estimating the driving risk associated with insomnia. Even if that study confirmed the risk related to insomnia it was a cross-sectional study and it did not address the chronic dimension for this sleep disorder. Because insomnia symptoms wax and wane over time it is very important to run longitudinal studies to better understand if a cumulative risk of road collisions exists or not for a population of individuals reporting insomnia symptoms. It is also worth considering the impact of sex and age because both factors influence the accidental risk and are not equally represented in the population with insomnia. It makes sense for sleep clinicians evaluating patients to know if the driving risk is different between sex and age groups according to their disease. Young men are considered at higher risk for road accidents but the presence of a sleep disorder can modify the profile of risky drivers. Likewise, older adults take longer to metabolize drugs and their use of hypnotic medications may place them at greater risk for motor vehicle accidents, particularly when using long-acting hypnotic medications. Risk over time is also a key issue in patients and a prospective approach would be informative in this domain. Indeed a long-term prospective study is missing in the literature to confirm the risk of accidents over time in individuals reporting insomnia complaints. This study aimed to estimate the association between insomnia and its daytime impairments and the risk to report a car collision over a 5-year period in a population-based Canadian sample.

Methods

Study context and procedure

Data from this study were derived from a larger population-based epidemiological study conducted in Canada. The study context and sample selection have been described previously [9, 10]. Briefly, the aim of the parent study was to document the natural history, prevalence, risk factors, and treatment of insomnia over a 10-year period. The study began with a telephone survey of 12,000 adults using random digit dialing and the Kish method [11]. At the end of the telephone interview, aimed at estimating the prevalence of insomnia and its treatments, responders were invited to participate in the longitudinal phase of the study that involved the completion of postal questionnaires. Baseline assessment was completed 1 month after the telephone interview and the remaining assessments were completed 6 months later and then annually over the next 5 years. The study was approved by the Université Laval Ethics Committee and all participants provided written consent.

Participants

Of the 3,419 respondents who agreed to participate in the study, six were excluded because they did not answer the question about car accidents, leaving 3,413 participants for the analyses. There was no exclusion criteria for this study. The final sample was composed of 3,413 adults (M_{age} = 49.0 years old, SD = 15.1; range = 18–96; 61.5% female), including 3,001 (87.9%) who completed their first sleep questionnaires at baseline and 412 who completed their first questionnaires at the 6-month assessment (12.1%). Retention rates over the 5-year period were 78.9% at year 1, 74.8% at year 2, 74.9% at year 3, 70.4% at year 4, and 68.7% at year 5.

Road collision data

At each assessment from baseline to 5-year follow-up, participants had to answer ("yes" or "no") to the following question: "During the last six months, have you been involved in a motor vehicle accident while driving?" For those who gave a positive answer, a second question was asked: "To what extent insomnia or some of its associated daytime consequences (e.g., fatigue, poor concentration) was responsible for that accident?" The response format for that question was 0% ("not at all") to 100% ("entirely").

Other measures

Sleep/insomnia survey.
Participants completed a comprehensive survey that included questions about sleep and insomnia, lifestyles and work schedules, physical and mental health, medication, and substance use. There were several standardized questionnaires embedded in the survey, including the *Insomnia Severity Index* (ISI) and the *Pittsburgh Sleep Quality Index* (PSQI) (described below). Utilization of prescribed and over-the-counter (OTC) sleep medication was evaluated with the following questions: "During the past year, have you used medication to promote sleep?" For those who answered yes, there were two follow-up questions: (1) "During the past month, how many nights per week have you taken

prescribed medication to help you sleep?" and (2) "During the past month, how many nights per week have you taken OTC medication (e.g., Nytol, Sominex) to help you sleep?" Participants were asked to indicate the name of the product they had used in the previous month.

Insomnia Severity Index.

The ISI [12] is a seven-item, self-rated questionnaire used to asses perceived severity of three insomnia symptoms (i.e. sleep onset, sleep maintenance, and early morning awakening), sleep satisfaction, interference of sleep difficulties with daytime functioning, noticeability of sleep problems, and distress caused by sleep difficulties over the past month. Each item is rated on a five-point Likert scale and summed to yield a total score (range: 0–28), with higher scores indicative of severe insomnia. The ISI has excellent psychometric properties [12].

The Pittsburgh Sleep Quality Index.

The PSQI [13] is a 19-item questionnaire assessing sleep quality over the past month. Seven subscales (sleep quality, latency, duration, habitual sleep efficiency, sleep disturbances, daytime dysfunction, and use of sleep medication) are derived (each weighted equally from 0 to 3) and summed to obtain a global score (range: 0–21), with higher scores (>5) indicating poorer sleep quality [13].

The Multidimensional Fatigue Inventory [14] measured the severity and degree of impairment produced by fatigue with a total score derived from the summation of all items. The General Fatigue score (4–20) was used in this study to identify participants reporting a significant level of fatigue, using clinical scoring by gender and age groups [15, 16].

The Epworth Sleepiness Scale (ESS) [17] is an eight-item self-rated questionnaire to assess, on a four-point scale (0–3), usual chances of dozing off or falling asleep while engaged in eight different activities. The ESS score ranges from 0 to 24, and a score of 16 or higher is indicative of severe excessive daytime sleepiness.

Statistical analyses

The current dataset presents several challenges to standard survival analysis: (1) the event (a car accident) is not unique in the temporal trajectory of a participant, so the survival model has to allow for the occurrence of multiple events. (2) The precise timing of the occurrence of the event(s) is unknown, because participants did not provide specific date(s) (i.e. they were asked whether they were involved in a car accident in the last 6 months). Therefore, the timing of the event(s) in this study is a discrete ordinal variable (i.e. what year the event(s) occurred during follow-up). (3) Predictors were time-varying covariates that were allowed to change at each assessment (observations are person-year units). Thus, Cox proportional hazard survival analysis was performed following the recommendations of Allison [18] and Singer and Willett [19]. Specifically, two design variables were added to capture (1) the sequence of the event (whether it is a first or a second event for a specific participant and (2) the time (number of years) since the last event (i.e. time is reset to 0 after each event) and an analytic model of generalized

estimating equations (GEE) that provided efficient parameter estimates and robust estimates of standard errors (to insure proper control of cluster effects due to repeated events) was selected. Finally, because of the wording of the question about accident occurrence, the unit of measurement was the number of 6-month assessment period with a report of at least one accident; however, it was not possible to determine whether more than one accident occurred during any of the 6-month assessment periods.

GEE models, using a complementary log–log link function (to estimate hazard ratios [HRs]) and an exchangeable correlation matrix (SAS PROC GENMOD), were then used to estimate the cumulative hazard of a car accident, overall and according to gender and age groups, and the contribution (HR) and significance of demographics and sleep variables to predict the risk of a car accident. Design variables were included to control for repeated events sequence and timing. Poststratified and normalized (summing to N, the sample size) weights, based on the 2006 Canadian census according to the province of residence, administrative region, gender, and age groups, were included in all inferential analyses. Analyses were performed using SAS/STAT 9.4 TSM2 software [20] and significance was set at a standard bilateral level of 5%.

Results

Point and cumulative prevalence of road collision report during a 5-year follow-up

Table 1 provides the number of collision reports at each assessment, as well as 6-month estimates, from a GEE logistic model taking into account missing data and poststratification weights (estimated working correlation = 0.034). Since a significant year effect was observed, $X^2(5) = 12.19$, $p = .03$, exploratory trend analysis revealed a quadratic (curvilinear) relationship between year and 6-month collision rate, $X^2(1) = 5.73$, $p = .02$, suggesting higher rates at year 0 and 5.

A total of 456 accidental events (i.e. a 6-month assessment period with at least one accident) were reported throughout the study. Of those, 363 participants reported one event or assessment period with at least one road collision, 36 participants reported two events or assessment periods with at least one collision, and 7 participants reported three events or assessment periods with at least one collision. Figure 1 shows the probability (weighted for poststratification) of reporting at least one road

Table 1. Number of Accident Reports and 6-Month Prevalence, for Each Study Year

Year	No. of observations	% Total	No. of accidents	6-Month rate* (95% CI)
0	3,406	99.8	130	3.84 (3.24, 4.54)
1	2,694	78.9	63	2.41 (1.89, 3.07)
2	2,554	74.8	64	2.58 (2.03, 3.28)
3	2,556	74.9	68	2.81 (2.21, 3.56)
4	2,404	70.4	63	2.73 (2.13, 3.48)
5	2,347	68.7	68	3.04 (2.40, 3.84)

*Estimated from a GEE model taking into account missing data and poststratification weights.
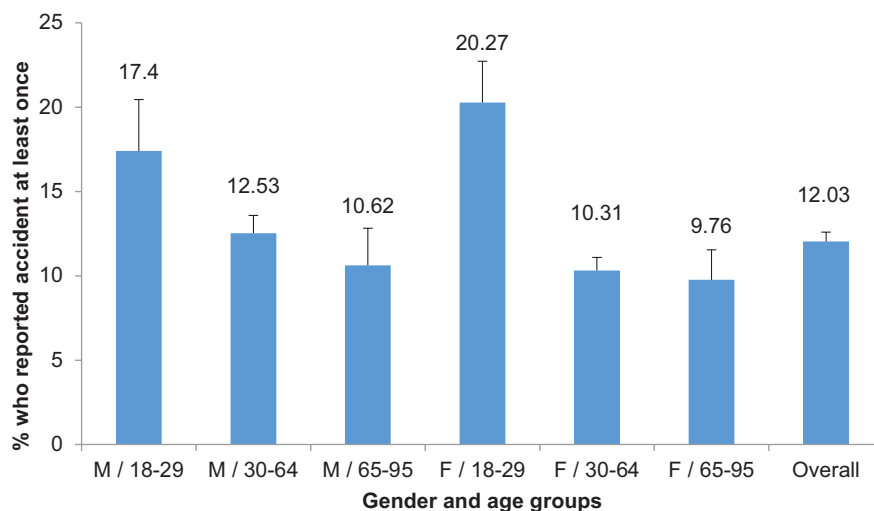
Figure 1. Percentage of participants who reported a car accident at least once during the 5-year follow-up, overall and according to gender/age groups.

collision during the 5-year follow-up for the total sample and according to gender and age groups.

A survival model, taking into account multiple events (road collisions) per participant and discrete assessment times, was computed to estimate the cumulative probability to report a collision (i.e. 1- cumulative survival function), according to gender × age groups. The six curves are displayed in Figure 2. These results revealed an initial higher probability to report a collision for females aged 18–29 years, compared to other gender × age groups (8.2% vs. 2.3–4.3%). By year 3, males aged 18–29 years exhibited a similar cumulative probability to young females group, and both groups were at greater risk of a road collision than older groups from year 3 to year 5. However, a comparison between the two survival curves (males vs. females, both aged 18–29) failed to reach significance, log-rank test $X^2(1) = 0.56$, $p = .46$. Males and females older than 30 years of age had a similar probability to report a road collision throughout the 5-year follow-up, log-rank test $X^2(4) = 4.31$, $p = .23$.

Self-reported contribution of insomnia to collision

A response as to the perceived contribution of insomnia or some of its common daytime consequences (e.g. fatigue, poor concentration, and reduced vigilance) to collisions was provided for 436 of the total 456 accidental events. Overall, the average causal attribution score on a scale of 0 (not at all) to 100% (completely) was 18.1% (SD = 23.1) for all collisions combined. For 264 collisions (60.6%), insomnia was judged to not be contributive at all, for 75 accidents (17.2%) insomnia or some of its daytime consequences was judged to be at least 50% responsible, and for the remaining 97 accidents, insomnia was estimated to play a role somewhere between 0% and 50%. Thus, insomnia or some of its associated daytime impairments was perceived to have played some contributory role in nearly 40% of the collisions.

Sleep variables as predictors of car accident hazard

A series of proportional Cox survival models, taking into account multiple events (car accidents) per participant and discrete assessment times, were computed to estimate the HRs associated with various nighttime and daytime sleep risk factors. For each model, we examined the interaction between the risk

factor and the combination of age and gender to check whether a nonsignificant overall risk factor was indeed significant for some specific age × gender subgroups (see Table 2).

Overall, nighttime (insomnia and short sleep) and daytime (sleepiness and fatigue) symptoms all exhibited a positive association with reports of a car accident. However, only the presence of insomnia symptoms and daytime fatigue, considered as separate risk factors, showed significant positive HRs 1.20 (95% confidence interval [CI] = 1.00–1.45) and 1.21 (95% CI = 1.01–1.47), respectively. Sleeping less than 6 h was not significant ($p = .16$), nor was reporting excessive daytime sleepiness ($p = .06$), but both variables showed an association in the expected direction. Both factors related to prescribed sleep medications, frequency and chronicity of use, were found to be positively and significantly associated with car accidents. Specifically, participants who reported usage of prescribed sleep medications in the last year had a 50% increase of hazard (HR = 1.50, 95% CI = 1.17–1.91) to report a road collision, while those who reported frequent usage (i.e. three nights/week or more in the last month) had a 58% increase of hazard to report a collision (HR = 1.575, 95% CI = 1.16–2.14). Finally, participants who reported using OTC medications for sleep in the last year had a 41.9% increase of hazard (HR = 1.42, 95% CI = 1.02–1.98) to report a road collision. However, the frequency of OTC usage was not significantly related to a collision.

When the association between these factors and road collision was investigated according to gender and age groups, some significant associations were found. Specifically, in younger women (aged 18–29 years), the HR to report a collision was larger if they reported the presence of insomnia symptoms (HR = 1.83, 95% CI = 1.13–2.98) and excessive daytime sleepiness (HR = 2.42, 95% CI = 1.11–5.24). In females aged 30–64 years old, a positive and significant risk for a car accident was observed when the participant reported significant level of fatigue (HR = 1.35, 95% CI = 1.00–1.81), chronic usage of prescribed sleep medications in the last year (HR = 1.56, 95% CI = 1.09–2.22), frequent use of prescribed sleep medications in the last month (HR = 1.98, 95% CI = 1.31–2.98), and usage of OTC medication for sleep (HR = 1.69, 95% CI = 1.10–2.59). Finally, middle-aged men were significantly at risk to report a road collision if they were usually sleeping less than 6 h (HR = 1.45, 95% CI = 1.00–2.10), while older men were increasingly more at risk to report a collision if they were also short sleeper (HR = 2.43, 95% CI = 1.13–5.24) or if they used prescribed sleep medications in the previous year (HR = 3.29, 95% CI = 1.40–7.75).
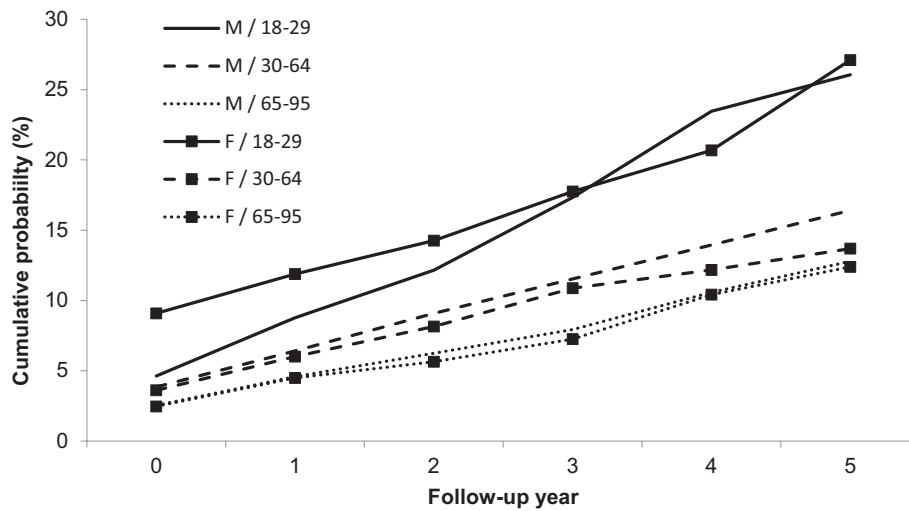
Figure 2. Cumulative probability to report a car accident in the last 6 months during the 5-year follow-up, according to gender × age groups.

Table 2. Hazard Ratios (95% Confidence Intervals) to Report a Car Accident in the Last 6 Months, Overall and According to Gender × Age Groups, for Each Sleep Risk Factor

| Factor | Overall | Gender × age groups | | | | | |
		Male; 18–29 years	Male, 30–64 years	Male, ≥65 years	Female, 18–29 years	Female, 30–64 years	Female, ≥65 years
N	15,961	522	4,548	986	1,063	7,400	1,442
Presence of insomnia symptoms(ISI ≥8)	**1.202** (1.00–1.45)	0.975 (0.39–2.46)	1.137 (0.82–1.59)	1.528	(0.69–3.41)	**1.834** (1.13–2.98)	1.121 (0.84–1.50)	1.054 (0.53–2.10)
Being a shortsleeper (total sleep time ≤6 h)*	1.172 (0.94–1.47)	1.265 (0.39–4.11)	**1.452** (1.00–2.10)	**2.431** (1.13–5.24)	1.493 (0.70–3.17)	0.856 (0.60–1.23)	1.002 (0.47–2.13)
Excessive daytime sleepiness (ESS ≥16)	1.341 (0.99–1.82)	1.261 (0.30–5.32)	1.521 (0.93–2.48)	1.814 (0.63–5.25)	**2.415** (1.11–5.24)	0.837 (0.47–1.49)	1.950 (0.62–6.16)
Significant fatigue (MFI-GEN ≥9–14)†	**1.213** (1.01–1.47)	1.177 (0.57–2.45)	0.993 (0.70–1.41)	1.674 (0.58–4.84)	1.314 (0.79–2.20)	**1.347** (1.00–1.81)	1.256 (0.56–2.84)
Use of PSM in the last year (Y/N)	**1.497** (1.17–1.91)	1.223 (0.17–8.64)	1.130 (0.71–1.79)	**3.293** (1.40–7.75)	1.923 (0.85–4.34)	**1.560** (1.09–2.22)	1.263 (0.59–2.70)
Use of PSM in the last month (≥three nights/week)	**1.575** (1.16–2.14)	n/e	0.800 (0.38–1.69)	1.717 (0.54–5.44)	1.827 (0.53–6.33)	**1.980** (1.31–2.98)	1.413 (0.66–3.04)
Use of OTC in the last year (Y/N)	**1.419** (1.02–1.98)	2.236 (0.62–8.04)	1.256 (0.64–2.47)	0.803 (0.12–5.28)	1.337 (0.43–4.14)	**1.689** (1.10–2.59)	n/e
Use of OTC in the last month (≥three nights/week)	1.308 (0.67–2.56)	n/e	0.919 (0.19–4.35)	n/e	3.043 (0.41–22.47)	1.897 (0.85–4.24)	n/e

Ratios in bold are statistically significant at alpha = 5%. n/e = not estimable because of cell with 0 frequency.
PSM = prescribed sleep medication; OTC = over-the-counter medication for sleep; ISI = Insomnia Severity Index; ESS = Epworth Sleepiness Scale.
*From the PSQI, Pittsburgh Sleep Quality Index.
†Clinical score varies according to age group and gender. MFI-GEN = Multidimensional Fatigue Inventory—General score.

Relationship between sleep duration and road collision

To further explore the relationship between sleep duration and accidental risk, usual total sleep time in the last month (from the PSQI) was broken down into five categories: 5 or less, 6, 7, 8, and 9 or more hours. A proportional Cox model for discrete times and multiples events was estimated, including two-way interactions with age and gender subgroups. The sleep duration × age groups failed to reach significance, $X^2(8) = 3.88$, $p = .87$, but the sleep duration × gender was near significance, $X^2(4) = 7.61$, $p = .107$, and thus was further explored. Simple effects according to gender revealed a significant sleep duration effect for men, $F(4,12310) = 2.33$, $p = .05$ but not for women ($p = .25$). The prevalence of road collisions according to sleep duration and gender is reported in Figure 3. This figure indicates a decreasing trend to report a collision with longer
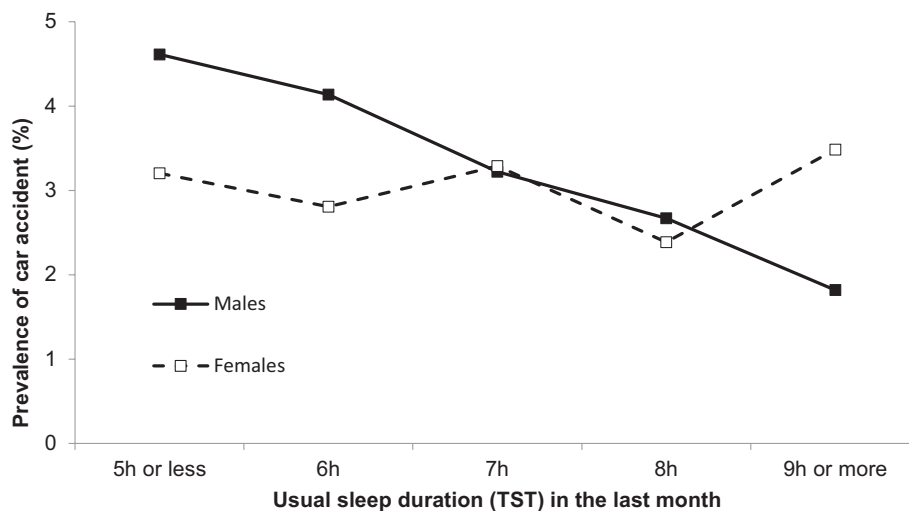
Figure 3. Prevalence of car accidents in the last 6 months according to sleep duration and gender. The duration effect is only significant for the men curve.

sleep durations for men, but no distinct pattern is observed for women.

Association between road collisions and medical and psychiatric conditions

Exploratory analyses were run to examine HRs of car collisions associated with the presence of several self-reported medical conditions (e.g. cardiovascular, endocrine, and pain), conditional on sex × age groups strata and adjusted for the same variables as for previous analyses. These analyses yielded larger HRs for car collisions in participants with chronic pain (HR = 1.23) and neurologic conditions (HR = 1.29), but those HRs failed to reach statistical significance and were not included as covariates in the previous analyses. Similar analyses were conducted for individuals reporting psychiatric disorders (e.g. anxiety, depression, and ADHD) and significant HRs were obtained for participants reporting an anxiety disorder (HR = 1.64) and ADHD (HR = 2.16). However, the interpretation of these associations was confounded by the lack of information as to the time of occurrence of these conditions in relation to road collisions and whether it was the condition per se, or its drug treatment (for which there was no information available) that was linked with the increased risk to report road collisions; for these reasons, they were not included as covariates in the main analyses.

Discussion

This study confirms the risk of road collisions in individuals reporting insomnia and using sleep medications, both prescribed and OTC drugs. It also suggests a higher risk of collisions for young participants and especially females. The fact that individuals with insomnia can have several road crashes over time underscores the importance of addressing this complaint early on, particularly in view of the high persistence of this condition [10]. A new finding not reported previously is the higher risk of traffic collisions in females with insomnia. This risk was further increased in that specific group if, in addition to insomnia, participants also reported excessive daytime sleepiness. This finding is of interest because previous studies have typically reported

that sleep-related road collisions concerned usually young men [4] and women tended to have fewer accidents than men [3]. Previous studies have shown that a higher score at the ESS is a risk factor for traffic accidents but usually people with insomnia tend to report low daytime level of sleepiness [21]. Our results show the accidental risk of young female participants with insomnia reporting excessive daytime sleepiness and highlight the need to quantify this symptom in this group of patients.

Given the high prevalence and persistence of insomnia, its association with higher accidental risks should be taken seriously. Insomnia is the most prevalent of all sleep disorders, with estimated prevalence rates of 10% for insomnia disorder and an additional 20%–25% for insomnia symptoms. So, even a small increase in accidental risk associated with insomnia has major implications for road safety. This finding highlights the importance of screening and identifying individuals with insomnia, as well as the need to treat this condition, in order to reduce the risk of road collisions associated with insomnia and its common daytime consequences (i.e. fatigue, sleepiness, and poor concentration).

Another important finding is the additive role played by the chronic and frequent use of prescribed sleep medications (mostly benzodiazepines) in the risk of traffic collisions. Our findings confirm those previously reported [7] and, in addition, it suggests an additive risk of reporting excessive daytime sleepiness when taking sleep medication. Interestingly, reporting a short nocturnal sleep duration or taking prescribed sleep medications increased the risk in men and especially in older men. As aging is a risk factor for cognitive impairment, using sleep medications in later life can potentiate the risk of traffic accidents. Our results highlight the importance of using nonpharmacological treatments in older men reporting insomnia complaints, although caution is also indicated when using sleep restriction therapy as it may also produce residual daytime sleepiness.

The association between self-reported short sleep duration (<6 h/night) to the higher risk for traffic collisions in men might be related to different types of insomnia between men and women in this age group. Because we did not get objective measurements of sleep (e.g. actimetry or polysomnography) during our study, we cannot comment on the role of specific sleep disturbances such as nocturnal awakenings and fragmented sleep,

or on the potential presence of other sleep disorders (sleep apnea). Further studies should investigate the prospective relationship between objective sleep duration and sleep fragmentation and the risk of traffic collisions.

Our study presents several limitations, the first one being the absence of objective data from the motor vehicle department to confirm the presence or absence of accidents. The second limitation refers to the fact that we do not know if the driver was responsible for the traffic accident. We also ignore the driving experience and driving exposure (number of kilometers driven/year) that account for part of the variance in accidental risk. In addition, we did not have an objective measure (i.e. actimetry) of sleep duration. Finally, we did not have enough information on specific drugs used for insomnia to examine whether short-acting and long-acting drugs had different impacts on accidental risks. Previous research has indicated that indeed long-acting drugs benzodiazepines might heighten the risk of road collisions relative to short-acting drugs, particularly in the elderly [6]. Even so, these limitations do not fundamentally compromise the value of our results obtained in a large prospective cohort. The fact that our results are consistent with previous publications is reassuring and our study brings innovative results on the importance of age and sex in analyzing the driving risk in people with insomnia. Further research is needed to confirm our results with accidental data from the department of motor vehicles and objective measures of sleep. It would be worth looking at objective sleep duration and sleep medications intake and cognitive performance to confirm the risk/benefits of hypnotics.

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References

1. Bioulac S, *et al*. Risk of motor vehicle accidents related to sleepiness at the wheel: a systematic review and meta-analysis. *Sleep.* 2017;**40**(10). doi:10.1093/sleep/zsx134
2. Powell NB, *et al*. Sleepy driver near-misses may predict accident risks. *Sleep.* 2007;**30**(3):331–342.
3. Philip P, *et al*. Sleep disorders and accidental risk in a large group of regular registered highway drivers. *Sleep Med.* 2010;**11**(10):973–979.
4. Connor J, *et al*. Driver sleepiness and risk of serious injury to car occupants: population based case control study. *BMJ.* 2002;**324**(7346):1125.
5. Morin CM, *et al*. Chronic insomnia. *Lancet.* 2012;**379**(9821):1129–1141.
6. Hemmelgarn B, *et al*. Benzodiazepine use and the risk of motor vehicle crash in the elderly. *JAMA.* 1997;**278**(1):27–31.
7. Orriols L, *et al*.; CESIR Research Group. Benzodiazepine-like hypnotics and the associated risk of road traffic accidents. *Clin Pharmacol Ther.* 2011;**89**(4):595–601.
8. Léger D, *et al*. Insomnia and accidents: cross-sectional study (EQUINOX) on sleep-related home, work and car accidents in 5293 subjects with insomnia from 10 countries. *J Sleep Res.* 2014;**23**(2):143–152.
9. Morin CM, *et al*. Epidemiology of insomnia: prevalence, self-help treatments, consultations, and determinants of help-seeking behaviors. *Sleep Med.* 2006;**7**(2):123–130.
10. Morin CM, *et al*. The natural history of insomnia: a population-based 3-year longitudinal study. *Arch Intern Med.* 2009;**169**(5):447–453.
11. Kish L. *Survey Sampling.* New York: Wiley & Sons; 1965.
12. Morin CM, *et al*. The insomnia severity index: psychometric indicators to detect insomnia cases and evaluate treatment response. *Sleep.* 2011;**34**(5):601–608.
13. Buysse DJ, *et al*. The Pittsburgh sleep quality index: a new instrument for psychiatric practice and research. *Psychiatry Res.* 1989;**28**(2):193–213.
14. Smets EM, *et al*. The multidimensional fatigue inventory (MFI) psychometric qualities of an instrument to assess fatigue. *J Psychosom Res.* 1995;**39**(3):315–325.
15. Schwarz R, *et al*. Fatigue in the general population. *Onkologie.* 2003;**26**(2):140–144.
16. Singer S, *et al*. Age- and sex-standardised prevalence rates of fatigue in a large hospital-based sample of cancer patients. *Br J Cancer.* 2011;**105**(3):445–451.
17. Johns MW. A new method for measuring daytime sleepiness: the Epworth sleepiness scale. *Sleep.* 1991;**14**(6):540–545.
18. Allison PD. *Survival Analysis Using SAS: A Practical Guide.* 2nd ed. Cary, NC: SAS Institute Press; 2010.
19. Singer JD, Willett JB. *Applied Longitudinal Data Analysis: Modeling Change and Event Occurrence.* New York: Oxford University Press; 2003.
20. SAS Institute. *SAS/STAT 13.2 User's Guide.* Cary, NC: SAS Institute; 2014.
21. Stepanski E, *et al*. Daytime alertness in patients with chronic insomnia compared with asymptomatic control subjects. *Sleep.* 1988;**11**(1):54–60.