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Insomnia and accidents: cross-sectional study (EQUINOX) on sleep-related home, work and car accidents in 5293 subjects with insomnia from 10 countries

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SUMMARY

The link between sleepiness and the risk of motor vehicle accidents is well known, but little is understood regarding the risk of home, work and car accidents of subjects with insomnia. An international cross-sectional survey was conducted across 10 countries in a population of subjects with sleep disturbances. Primary care physicians administered a questionnaire that included assessment of sociodemographic characteristics, sleep disturbance and accidents (motor vehicle, work and home) related to sleep problems to each subject. Insomnia was defined using the International Classification of Sleep Disorders (ICSD-10) criteria. A total of 5293 subjects were included in the study, of whom 20.9% reported having had at least one home accident within the past 12 months, 10.1% at least one work accident, 9% reported having fallen asleep while driving at least once and 4.1% reported having had at least one car accident related to their sleepiness. All types of accident were reported more commonly by subjects living in urban compared to other residential areas. Car accidents were reported more commonly by employed subjects, whereas home injuries were reported more frequently by the unemployed. Car accidents were reported more frequently by males than by females, whereas home accidents were reported more commonly by females. Patients with insomnia have high rates of home accidents, car accidents and work accidents related to sleep disturbances independently of any adverse effects of hypnotic treatments. Reduced total sleep time may be one factor explaining the high risk of accidents in individuals who complain of insomnia.

INTRODUCTION

It is well recognized that insomnia impairs daytime functioning, diminishes quality of life and contributes to health-care costs and absenteeism (American Academy of Sleep Medicine, 2005; American Psychiatric Association, 2000; Espie *et al.*, 2012; Leger *et al.*, 2010a,b). One literature review covering more than 50 studies of insomnia showed that estimates of prevalence vary widely, from less than 5% to as high as 40% (Ohayon *et al.*, 2012), because of differences in definitions, study settings and data collection methods. However, when consensus criteria are applied to the definition, it is usually found that insomnia affects approximately 20–25% of adults (American Academy of Sleep Medicine, 2005; American Psychiatric Association, 2000; Ohayon 2002).

Based on these definitions, insomnia is consensually defined as: (a) a difficulty of falling asleep (sleep initiating insomnia), the occurrence of nocturnal awakenings with difficulties getting back to sleep (sleep maintenance insomnia), an early morning awakening (sleep offset insomnia) or no refreshing or non-restorative sleep, and often some of a

combination thereof; (b) occurring at least three times a week for at least 1 month; and (c) producing clinically significant distress or impairment in social, occupational or other important areas of daytime functioning. Despite this high prevalence and consensus about the impact of insomnia on daytime functioning, there are very few epidemiological data describing the daily life events of insomniacs and, more specifically, the incidence and nature of accidents at home and work and while driving.

In terms of car accidents, there may be some confusion concerning driving in insomniacs because driving when sleepy has been widely recognized as a major risk factor for accidents in recent years (Philip *et al*., 2010; Smolenski *et al*., 2011), and some authors combine poor sleep and insomnia in the same category. However, insomniacs have difficulty falling asleep or maintaining sleep, and patients with primary insomnia are not usually tired during the daytime. Some studies have even shown that insomniacs may be more alert than good sleepers (Bonnet and Arand, 1997; Fortier-Brochu *et al*., 2012; Ohayon *et al*., 2012). Nevertheless, 'proneness for errors or accidents at work or while driving' is one of the items in the definition of insomnia (American Academy of Sleep Medicine, 2005), and it is clinically recognized that insomniacs may complain of involuntary somnolence the day after a poor night of sleep because of sleep restriction. It is also possible that insomniacs treated with medium or long half-life hypnotics may have morning somnolence because of the residual effects of their drugs (Roehrs and Roth, 2012; Staner *et al*., 2005).

Whether or not insomnia is associated with an increased risk of accidents is still controversial, because: (1) very few studies have focused on this topic; (2) motor vehicle accidents (MVA) are not always distinguished from domestic or work accidents; and (3) the studies that have been conducted did not generally provide enough detail on the clinical types of insomnia or on its severity.

In a French study comparing 240 subjects with severe insomnia to 391 good sleepers, work accidents were eight times more common over a 12-month period in the severe insomniacs than in the good sleepers (8% versus 1%, $P = 0.0150$), with an average number of 0.07 ± 0.25 accidents per severe insomniac versus 0.01 ± 0.11 per good sleeper ($P = 0.0550$; Leger *et al*., 2002). There was, however, no statistical difference in MVAs over the 12-month period. The authors explained the discrepancy between work accidents and MVAs by suggesting that the severe insomniac subjects may have avoided driving or driven shorter distances: 65.8% of severe insomniacs versus 72.5% of good sleepers drove a car ($P = 0.012$). Daley *et al.* (2009) reported no difference in the MVA rate between insomniacs and good sleepers over a 6-month period in a group of 930 adults in Quebec; however, 23.5% of drivers reporting an accident felt that insomnia had played an important role in the event. In a Japanese study that collected data on occupational injuries in 1298 workers from small-scale manufacturing firms (Nakata *et al*., 2005), insomnia symptoms were associated significantly with occupational injuries in both men and women [odds ratio (OR) = 1.64; 95% confidence interval (CI): 1.23–2.18].

The aim of our study was therefore to investigate the risk of car, work and domestic accidents in a large population of subjects with insomnia visiting primary care physicians.

METHODS

Design

This study was an international, non-interventional, cross-sectional, observational survey conducted in a population of subjects with sleep disturbances consulting in primary care offices.

During the survey, information was collected on the current status and characteristics of subjects with sleep disturbances. A total of 647 physicians from 10 different countries participated in the survey: Switzerland, Finland, Sweden, Greece, Portugal, Morocco, Mexico, Jordan, Lebanon and the Philippines. In all countries, the physicians were mainly general practitioners, internal medicine or family medicine specialists. Two previous publications have reported the results related to the prevalence and daytime consequences of insomnia (Leger *et al*., 2010 a,b); the methodology was described in detail in these papers.

Subjects

For each subject who consulted a participating physician on one of two specified consecutive days of the first week following survey initiation, an anonymous 'Patient Log Form' was completed (except in Greece, Portugal, Sweden and Switzerland because of local specificities).

All subjects fulfilling the ICSD criteria for insomnia and satisfying the following inclusion criteria were asked to participate in the survey: age at least 18 years; complaining spontaneously or after physician enquiry of a sleep disorder; and no treatment with a sleep-promoting agent [benzodiazepine (BZD) receptor agonist, tranquillizer, anti-depressant, antihistamine and melatonin agonist] in the previous 4 weeks.

Measurements

After obtaining written informed consent, a questionnaire was submitted to all subjects, including sections on: (a) socio-demographic characteristics [age, gender, body mass index (BMI), family situation, employment, shift work, residence, noisy environment, morning/evening person, possession of a driving licence]; and (b) sleep disturbance complaints: questions were based on ICSD-10 and DSM-IV classifications (American Academy of Sleep Medicine, 2005; American Psychiatric Association, 2000) and included 16 potential independent variables enquiring on the following.

The kind of sleep disorders comprised: (1) difficulty initiating sleep (DIS); (2) difficulty maintaining sleep (DSM); (3) early morning awakening (EMA); (4) non-restorative sleep (NRS); or a combination of these, with questions on the frequency of sleep disturbances (>3 nights per week) and on the duration of the disorder (>1 month; items 5–9).

The subjective consequences of these disorders comprised: (10) waking up rested/non-rested (evaluated on a six-point scale where 0 = completely rested, 5 = completely non-rested; those who scored 4–5 were compared to those who scored 0–3); (11) sleep satisfaction (evaluated on a six-point scale where 0 = completely satisfactory, 5 = completely unsatisfactory; those who scored 4–5 were compared to those who scored 0–3); (12) sleep quality (evaluated on a six-point scale where 0 = excellent, 5 = dreadful; those who scored 4–5 were compared to those who scored 0–3); (13) sufficient sleep duration (evaluated on a four-point scale where 0 = very sufficient, 3 = very insufficient; those who scored 3 were compared to those who scored 0–2); and (14) perceived time in bed (quantitative variable); (15) number of perceived sleeping hours (quantitative variable); and (16) loud snoring.

The consequences of sleep disturbances were assessed by questions on day-after consequences and consequences in the past 6 and 12 months, with the following questions devoted to accidents: (1) how many times have you fallen asleep while driving without having an accident; (2) how many car accidents while driving could have been related to your sleepiness; (3) how many accidents at home could have been related to your sleepiness; and (4) how many accidents at work could have been related to your sleepiness? Having an accident did not necessarily mean that injuries were involved.

Statistical analyses

The data collected in each country were centralized and analysed as one single panel. Statistical analyses were performed using SAS software version 9.1. Parameters are summarized using mean, median, standard deviation and range for continuous data and counts and percentages for categorical data.

Data from all subjects were used for the analysis of domestic accidents, data from subjects in full- or part-time work were used for analysis of work-related accidents and data from subjects with a driving licence were used for analysis of MVAs. Univariate analyses were made on the 16 predefined sleep characteristic variables to identify factors associated with MVAs, work accidents and domestic accidents in the three groups. A complementary analysis was conducted to identify other associated variables, such as sociodemographic characteristics, residence and environment, absenteeism, hospitalizations and medical visits in the past 6 months, which could have explained the occurrence of accidents. Comparisons between groups were made using a Student's *t*-test or Mann–Whitney non-parametric test for continuous data and a chi-square test or Fisher's exact test for categorical data. The characteristics of subjects with more than five car accidents, five home accidents or five work accidents were also described. The cut-off of more than five accidents was not based on specific literature, but decided by our clinical team as severe enough to need careful attention. All statistical analyses were performed at the 5% significance level.

RESULTS

Subjects

A total of 13 124 subjects with sleep disorders were enrolled by the 647 physicians. In this population of subjects who consulted their physician on 1 of 2 consecutive working days, the highest percentages of subjects entered in the Patient Log Forms were from Morocco [n = 4787 (36.5%)], Finland [n = 3302 (25.2%)] and Mexico [n = 3021 (23.0%)]. Of this total group, we retained for the study only those subjects who fulfilled the criteria for insomnia and who did not receive any medical treatment for it in the previous 6 months: 5544 subjects (42%). Another 15.6% of the subjects who had insomnia but who were receiving treatment for their insomnia were not included in the survey.

Of the 5544 subjects who completed the questionnaire, we finally retained 5292 for analysis (28 subjects had no informed consent and 224 had major study deviations and were excluded). The selected subjects were representative of a general practitioner's usual patients: compared to patients without insomnia, the insomniac patients were older (45 versus 35 years; $P < 0.001$) and were more often female (65% versus 60%; $P < 0.001$).

Occurrence of accidents

The distribution of subjects who reported at least one accident is shown in Fig. 1. The statistical analyses for work accidents were conducted on full- and part-time workers (n = 3302) only; retired and unemployed subjects were not considered. For the analysis of car accidents and cases of falling asleep while driving, 2946 and 2943 subjects with a driving licence were considered for analysis, respectively. Finally, home accidents were evaluated in 5207 subjects.

Accidents attributed to sleepiness

Among insomniacs, 20.9% reported having had at least one accident at home related to their sleepiness within the past 12 months, with a mean number of accidents at home of 4.0 $\pm$ 6.0. Seven per cent of subjects reported having had at least one car accident related to their sleepiness while driving within the past 12 months, with a mean number of car accidents of 1.7 $\pm$ 1.5. A total of 10.1% of the subjects reported having had at least one accident at work related to their sleepiness within the past 12 months, with a mean

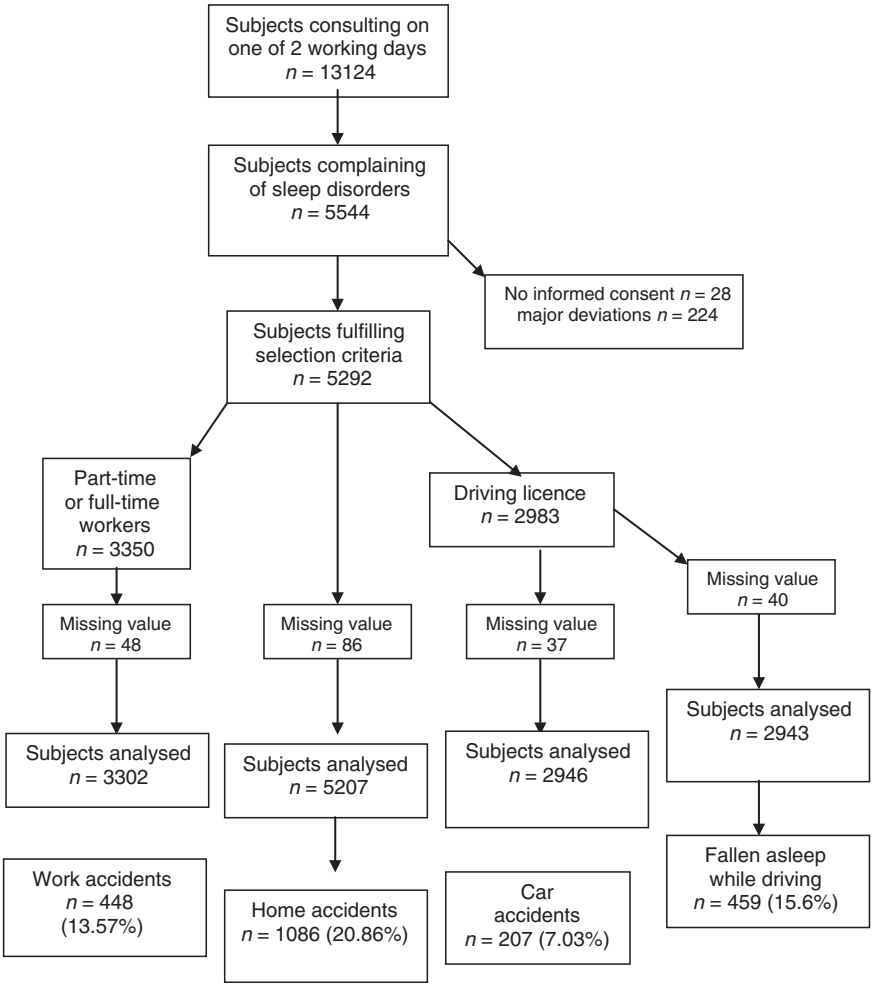

Figure 1. Distribution of subjects included in the study showing the occurrence of accidents.

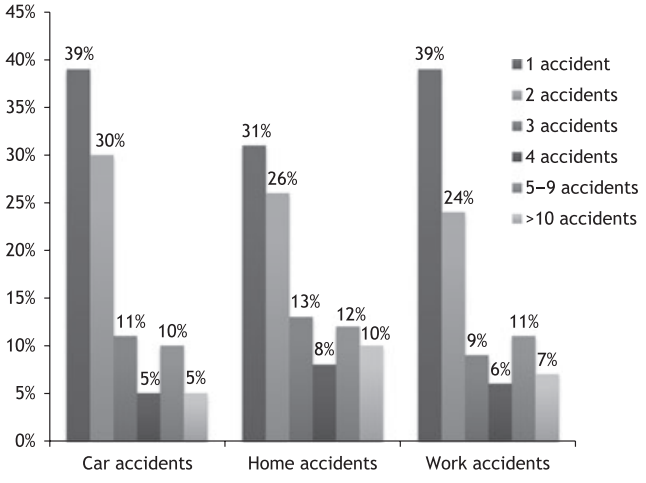

Figure 2. Percentage of subjects reporting at least one accident in the 12 months prior to the study.

number of accidents at work of 3.3 ± 4.0. Fig. 2 shows the number of accidents attributed to sleepiness per subject. A total of 14.5% of the drivers had had three or more accidents due to sleepiness and 30.1% fell asleep at least three times while driving. Among workers, 27.2% reported having had more than three accidents at work, and in the whole group, 30.7% reported having had at least three accidents at home in the last 12 months because of sleepiness.

Factors associated with reporting an accident

Sociodemographic variables associated with reporting any kind of accident are shown in Table 1. Males reported more sleep-related car accidents and 'sleeping at the wheel' than females, who reported more domestic accidents than males. An urban residence (versus rural or suburban), complaint of a noisy environment and having been hospitalized or off sick in the 6 months prior to the study were systematically associated with an increased risk of all types of accident.

Tables 2–4 show the comparisons of sleep characteristics of subjects who reported at least one car accident (Table 2), work accident (Table 3) or home-related accident (Table 4) compared to those who reported no such accidents. DIS, EMA and NRS, but not DMS, were systematically more frequent in subjects with accidents. Estimates of sleep quality, sleep satisfaction, waking up non-rested and sleep duration also differed significantly between subjects who

Table 1 Sociodemographic characteristics associated with any report of an accident

	Falling asleep at the wheel		*Car accidents*		*Work accidents*		*Home accidents*	
	Total population analysed (n = 2942)	*At least one accident (n = 459)*	*Total population analysed (n = 2945)*	*At least one accident (n = 207)*	*Total population analysed (n = 3298)*	*At least one accident (n = 447)*	*Total population analysed (n = 5202)*	*At least one accident (n = 1085)*
Sex								
Male (%)	1496 (50.85)	312 (67.97)*	1498 (50.87)	137 (66.18)*	1453 (44.06)	206 (46.09)	1871 (35.97)	309 (28.48)
Female (%)	1446 (49.15)	147 (32.03)	1447 (49.13)	70 (33.82)	1845 (55.94)	241 (53.91)	3331 (64.03)	776 (71.52)*
Age								
Mean (SD)	46.62 (13.52)	45.46 (12.52)	46.62 (352)	45.49 (13.13)	43.50 (12.12)	41.74 (12.59)	45.79 (15.30)	46.61 (15.08)
BMI								
Mean (SD)	25.94 (4.32)	26.64 (4.57)	25.94 (4.32)	26.40 (4.26)	25.74 (4.45)	26.22 (4.41)	25.93 (4.51)	26.22 (4.48)
Living with other people								
Yes (%)	2656 (90.25)	434 (94.55)	2659 (90.26)	194 (93.72)	3020 (91.46)	426 (95.09)	4716 (90.57)	1011 (93.09)
No (%)	287 (9.75)	25 (5.45)*	287 (9.74)	13 (6.28)	282 (8.54)	22 (4.91)	491 (9.43)	75 (6.91)
Number of people at home								
Mean (%)	3.2 (1.9)	3.4 (1.9)	3.2 (1.9)	3.8 (2.2)*	3.6 (2.3)	4.0 (2.2)	3.7 (2.4)	4.0 (2.4)
Number of children < 6 years old								
Mean (SD)	0.4 (0.8)	0.6 (0.9)	0.4 (0.8)	0.7 (1.0)*	0.5 (0.8)	0.8 (1.0)*	0.5 (0.9)	0.7 (1.0)
Employment								
Full time (%)	1948 (66.78)	349 (76.54)*	1950 (66.78)	147 (71.71)	2583 (78.23)	348 (77.68)	2584 (50.19)	438 (40.78)
Part time (%)	387 (13.27)	46 (10.09)	388 (13.29)	26 (12.68)	719 (21.77)	100 (22.32)	718 (13.95)	185 (17.23)
Unemployed (%)	582 (19.95)	61 (13.38)	582 (19.93)	32 (15.61)	0 (0.00)	0 (0.00)	1846 (35.86)	451 (41.99)*
Shift worker								
Yes (%)	479 (20.99)	101 (25.90)	480 (21.01)	48 (28.07)*	654 (20.20)	108 (24.77)*	654 (20.20)	133 (21.84)
No (%)	1803 (79.01)	289 (74.10)	1805 (78.99)	123 (71.93)	2584 (79.80)	328 (75.23)	2584 (79.80)	476 (78.16)
Residence								
Rural (%)	432 (14.72)	51 (11.14)	433 (14.74)	21 (10.19)	451 (13.70)	50 (11.24)	723 (13.95)	124 (11.48)
Suburban (%)	607 (20.68)	71(15.50)	607 (20.66)	30 (14.56)	653 (19.84)	72 (16.18)	1014 (19.56)	206 (19.07)
Urban (%)	1896 (64.60)	336 (73.36)*	1898 (64.60)	155 (75.24)*	2188 (66.46)	323 (72.58)*	3447 (66.49)	750 (69.44)*
Noisy environment								
Yes (%)	1141 (38.96)	242 (52.95)*	1141 (38.92)	122 (59.51)*	1441 (43.84)	271 (61.17)*	2297 (44.34)	621 (57.50)*
No (%)	1788 (61.04)	215 (47.05)	1791 (61.08)	83 (40.49)	1846 (56.16)	172 (38.83)	2883 (55.66)	459 (42.50)
Hospitalization								
No (%)	2831 (96.56)	409 (89.50)	2833 (96.56)	172 (83.50)	3185 (96.75)	398 (89.44)	4995 (96.22)	991 (91.67)
Yes (%)	101 (3.44)	48 (10.50)*	101 (3.44)	34 (16.50)*	107 (3.25)	47 (10.56)*	196 (3.78)	90 (8.33)*
Sick days								
No (%)	2216 (75.86)	245 (53.61)	2218 (75.85)	82 (39.81)	2350 (71.45)	132 (29.46)	3854 (74.92)	545 (51.13)
Yes (%)	705 (24.14)	212 (46.39)*	706 (24.15)	124 (60.19)*	939 (28.55)	316 (70.54)*	1290 (25.08)	521 (48.87)*

SD, standard deviation; BMI, body mass index.
*Significantly associated with an increased rate of accidents or reporting being sleepy, $P < 0.001$.

reported an accident and those who did not. Interestingly, the estimated number of hours of sleep differed significantly in those who reported a car accident [4.90 (1.51) versus 5.47 (4.45) h, $P < 0.0001$], a work accident [5.04 (1.46) versus 5.48 (1.49) h, $P < 0.0001$] or a home accident [6.51 (1.77) versus 6.68 (1.70) h, $P = 0.0005$] and those who did not. Snoring loudly was significantly more frequent in those who reported a car accident (55.88% versus 46.36%; $P = 0.009$), but this difference was not significant for work (47.99% versus 43.83%; $P = 0.1$) or for home (42.08% versus 44.56%; $P = 0.14$) accidents.

Significantly more subjects fulfilled the criteria for DSM-IV insomnia in the group reporting car accidents and home accidents than in the group with no accidents (respectively, 85.00% versus 79.95%; $P = 0.001$; 79.43 versus 76.37; $P = 0.01$), but significantly fewer in the group with work accidents (70.37 versus 77.69; $P = 0.001$). The ICSD-10 criteria did not vary in the two groups because this was a study inclusion criterion.

DISCUSSION

First, our study showed that insomnia was associated with a higher risk of accidents due to sleepiness. This higher risk was assessed not only for MVA, but also for domestic home and work accidents. Despite increasing public health interest surrounding the risks of 'driving while drowsy', the involvement of insomnia in this risk remains unclear (Connors *et al.*, 2002; Philip *et al.*, 2010). By definition, insomnia has daytime consequences, including 'proneness to accidents' (American

Table 2 Characteristics of sleep in subjects with insomnia reporting no car accidents related to sleepiness in the 12 months prior to the study (n = 2739) and those who reported at least one car accident (n = 207)

Car accidents	*None in the last 12 months (*n *= 2739)*	*At least one accident (*n *= 207)*	*Total (*n *= 2946)*	P-*value*
DIS				
Yes (%)	1987 (72.54)	175 (84.54)	2162 (73.39)	0.0002 (χ^2)
No (%)	752 (27.46)	32 (15.46)	784 (26.61)	
DMS				
Yes (%)	2169 (79.19)	174 (84.06)	2343 (79.53)	0.09 (χ^2)
No (%)	570 (20.81)	33 (15.94)	603 (20.47)	
EMA				
Yes (%)	1716 (62.65)	157 (75.85)	1873 (63.58)	0.0001 (χ^2)
No (%)	1023 (37.35)	50 (24.15)	1073 (36.42)	
NRS				
Yes (%)	2099 (76.63)	176 (85.02)	2275 (77.22)	0.006 (χ^2)
No (%)	640 (23.37)	31 (14.98)	671 (22.78)	
Wake up rested/non-rested				
Rather/completely non-rested (%)	969 (35.43)	97 (47.08)	1066 (36.24)	0.003 (χ^2)
Rested (%)	1766 (64.57)	109 (52.91)	1875 (63.75)	
Sleep satisfaction				
Rather/completely unsatisfied (%)	1003 (36.63)	104 (50.48)	1107 (37.61)	0.0001 (χ^2)
Satisfied (%)	1735 (63.37)	102 (49.51)	1837 (62.40)	
Sleep quality				
Poor/dreadful (%)	1020 (37.35)	110(53.39)	1130 (38.48)	<0.0001 (χ^2)
Good (%)	1711 (62.65)	96 (46.60)	1807 (61.53)	
Sleep duration				
Insufficient/very insufficient (%)	754 (27.61)	81 (39.51)	835 (28.44)	0.0003 (χ^2)
Sufficient (%)	1977 (72.39)	124 (60.49)	1101 (71.56)	
Number of hours you think you slept				
Mean (SD)	5.47 (1.45)	4.90 (1.51)	5.43 (1.47)	<0.0001 (*t*-test)
Time in bed (h)				
Mean (SD)	6.73 (1.55)	6.20 (1.60)	6.69 (1.56)	<0.0001 (*t*-test)
Sleep efficacy (%)				
Mean (SD)	81.40 (17.02)	78.92 (18.73)	81.23 (17.15)	0.1 (*t*-test)
Snoring loudly				
Yes (%)	1260 (46.36)	114 (55.88)	1374 (47.02)	0.009 (χ^2)
No (%)	1458 (53.64)	90 (44.12)	1548 (52.98)	
Reported diagnosis of sleep disorders breathing SDB				
Yes (%)	234 (8.51)	29 (14.6)	263 (8.92)	0.006 (χ^2)
No (%)	2506 (91.49)	178 (85.4)	2683 (89.18)	
Insomnia (DSM-IV definition)				
Yes (%)	2189 (79.95)	176 (85.00)	2365 (80.17)	0.001 (χ^2)
No (%)	550 (20.05)	31 (15.00)	581 (19.83)	
Insomnia (ICSD)				
Yes (%)	2672 (97.59)	207 (100.0)	2879 (97.69)	0.2 (χ^2)
No (%)	66 (2.41)	0 (0.0)	66 (2.31)	

DIS, difficulty initiating sleep; DMS, difficulty maintaining sleep; DSM-IV, *Diagnostic and Statistical Manual of Mental Disorders*, 4th edn; EMA, waking too early; ICSD, International Classification of Sleep Disorders; NRS, non-restorative sleep; SD, standard deviation; (%) = percentage of the respective group who answered yes or no.

Academy of Sleep Medicine, 2005; American Psychiatric Association, 2000). It has been demonstrated clearly that acute or chronic sleep reduction, which may or may not accompany insomnia, increases the lateral standard deviation of driving simulators or 'sleepy' driving at the wheel (Philip *et al*., 2012).

However, the association between insomnia symptoms or syndromes and accidents is still controversial (Kucharczyk *et al*., 2012; Leger *et al*., 2010a,b), and is often limited to the debate concerning the potential side effects of hypnotics on driving ability.

Indeed, it is usually recognized that hypnotics with long half-lives (medium- and long-term BZDs and antihistaminic) may induce a risk of accidents when subjects drive in the morning, and a risk of falls during the night in the elderly (Roehrs and Roth, 2012). In Europe, the vast majority of hypnotics are labelled with a sign indicating the possible risk of accidents as a result of the treatment. There is, however,

Table 3 Characteristics of sleep in subjects with insomnia reporting no work accident related to sleepiness in the 12 months prior to the study (n = 2584) and those who reported at least one work accident (n = 448)

Work accidents	*None in the last 12 months (n = 2854)*	*At least one accident (n = 448)*	*Total (*n *= 3302)*	P-*value*
DIS				
Yes (%)	2091 (73.27)	394 (87.95)	2485 (75.26)	<0.0001 (χ^2)
No (%)	763 (26.73)	54 (12.05)	817 (24.74)	
DMS				
Yes (%)	2228 (78.07)	363 (81.03)	2591 (78.47)	0.15 (χ^2)
No (%)	626 (21.93)	85 (18.97)	711 (21.53)	
EMA				
Yes (%)	1793 (62.82)	326 (72.77)	2119 (64.17)	<0.0001 (χ^2)
No (%)	1061 (37.18)	122 (27.23)	1183 (35.83)	
NRS				
Yes (%)	2191 (76.77)	378 (84.38)	2569 (77.80)	0.0003 (χ^2)
No (%)	663 (23.23)	70 (15.63)	733 (22.20)	
Wake up rested/non-rested				
Rather/completely non-rested (%)	989 (34.69)	214 (47.88)	1203 (36.48)	<0.0001 (χ^2)
Rested (%)	1862 (65.31)	233 (52.13)	2095 (63.52)	
Sleep satisfaction				
Rather/completely unsatisfied (%)	1026 (35.98)	214 (47.88)	1240 (37.59)	<0.0001 (χ^2)
Satisfied (%)	1826 (64.03)	233 (52.13)	2059 (62.41)	
Sleep quality				
Poor/dreadful (%)	1058 (37.14)	218 (48.77)	1276 (38.73)	<0.0001 (χ^2)
Good (%)	1790 (62.85)	229 (51.23)	2019 (61.27)	
Sleep duration				
Insufficient/very insufficient (%)	2287 (80.38)	403 (90.36)	2690 (81.74)	<0.0001 (χ^2)
Sufficient (%)	558 (19.61)	43 (9.64)	601 (18.26)	
Number of hours you think you slept				
Mean (SD)	5.48 (1.49)	5.04 (1.46)	5.42 (1.49)	<0.0001 (*t*-test)
Time in bed (h)				
Mean (SD)	6.74 (1.55)	6.36 (1.47)	6.68 (1.56)	<0.0001 (*t*-test)
Sleep efficacy (%)				
Mean (SD)	81.55 (17.26)	79.23 (17.89)	81.22 (17.36)	0.006 (*t*-test)
Snoring loudly				
Yes (%)	1239 (43.83)	215 (47.99)	1454 (44.40)	0.1 (χ^2)
No (%)	1588 (56.17)	233 (52.01)	1821 (55.60)	
Insomnia (DSM-IV definition)				
Yes (%)	2214 (77.69)	315 (70.37)	2529 (80.17)	0.001 (χ^2)
No (%)	640 (22.31)	133 (29.63)	773 (19.83)	
Insomnia (ICSD)				
Yes (%)	2812 (98.53)	113 (99.12)	2925 (98.59)	0.12 (χ^2)
No (%)	42 (1.47)	1 (0.88)	49 (1.41)	

DIS, difficulty initiating sleep; DMS, difficulty maintaining sleep; EMA, waking too early, NRS, non-restorative sleep; SD, standard deviation; (%) = percentage of the respective group who answered yes or no; DSM-IV, *Diagnostic and Statistical Manual of Mental Disorders*, 4th edn; ICSD, International Classification of Sleep Disorders.

little published information on this risk. Partinen *et al.* (2003) performed a double-blind, randomized, placebo-controlled, three-treatment and three-period cross-over study investigating the effects of zolpidem (10 mg) and temazepam (20 mg) versus placebo on driving performance in real-life conditions in 18 insomniacs. The authors found no differences between treatments for the primary outcome measure. There were also no differences in speed deviation or reaction time to tasks; however, lane position deviation was greater after administration of zolpidem compared to both placebo and temazepam (P = 0.025 and 0.05, respectively). Menzin *et al.* (2001) calculated the potential effects of sleep medication on MVAs in France. Using the model of standard deviation of a vehicle's lateral position (SDLP) they suggested that, compared with zaleplon, use of zopiclone for 14 days would be expected to result in 503 more accidents per 100 000 drivers.

Moreover, work and domestic accidents are usually not taken into account in studies on insomnia and accidents, although they may have considerable associated costs (Shahly *et al.*, 2012; Leger and Bayon, 2010).

We believe that our study brings new data to this ongoing debate. First, our study shows that car accidents are not the most frequent accidents in subjects with

Table 4 Characteristics of sleep in subjects with insomnia reporting no home accident related to sleepiness in the 12 months prior to the study (n = 4121) and those who reported at least one home accident (n = 1086)

Home accidents	*None in the last 12 months (*n *= 4121)*	*At least one accident (*n *= 1086)*	*Total (*n *= 5207)*	P-*value*
DIS				
Yes (%)	3119 (75.69)	940 (86.56)	4059 (77.95)	<0.0001 (χ^2)
No (%)	1002 (24.31)	146 (13.44)	1148 (22.05)	
DMS				
Yes (%)	3267 (79.28)	903 (83.15)	4170 (80.08)	0.0045 (χ^2)
No (%)	854 (20.72)	183 (16.85)	1037 (19.92)	
EMA				
Yes (%)	2704 (65.62)	770 (70.90)	3474 (66.72)	0.001 (χ^2)
No (%)	1417 (34.38)	316 (29.10)	1733 (33.28)	
NRS				
Yes (%)	3166 (76.83)	917 (84.44)	4083 (78.41)	<0.0001 (χ^2)
No (%)	955 (23.17)	169 (15.56)	1124 (21.59)	
Wake up rested/non-rested				
Rather/completely non-rested (%)	1516 (36.83)	539 (49.72)	2055 (39.52)	<0.0001 (χ^2)
Rested (%)	2600 (63.17)	545 (50.28)	3145 (60.48)	
Sleep satisfaction				
Rather/completely unsatisfied (%)	1579 (38.32)	558 (51.52)	2137 (41.07)	<0.0001 (χ^2)
Satisfied (%)	2541 (61.67)	525 (48.48)	3066 (58.93)	
Sleep quality				
Poor/dreadful (%)	1621 (39.41)	1568 (52.39)	2189 (42.13)	<0.0001 (χ^2)
Good (%)	2492 (60.59)	516 (47.60)	3008 (57.88)	
Sleep duration				
Insufficient/very insufficient (%)	3333 (81.13)	988 (91.40)	4321 (83.27)	<0.0001 (χ^2)
Sufficient (%)	775 (18.87)	93 (8.60)	868 (16.73)	
Number of hours you think you slept				
Mean (SD)	5.36 (1.58)	5.00 (1.58)	5.28 (1.59)	<0.0001 (χ^2)
Time in bed (h)				
Mean (SD)	6.68 (1.70)	6.51 (1.77)	6.64 (1.72)	0.0005 (*t*-test)
Sleep efficacy (%)				
Mean (SD)	80.57 (18.63)	77.38 (19.47)	79.90 (18.86)	<0.0001 (*t*-test)
Snoring loudly				
Yes (%)	1819 (44.56)	454 (42.08)	2273 (44.04)	0.14 (χ^2)
No (%)	2263 (55.44)	625 (57.92)	2888 (55.96)	
Insomnia (DSM-IV definition)				
Yes (%)	3147 (76.37)	862 (79.43)	4009 (76.88)	0.01 (χ^2)
No (%)	973 (23.63)	224 (20.57)	1207 (23.12)	
Insomnia (ICSD)				
Yes (%)	4112 (99.79)	1086 (100.0)	5198 (98.29)	0.15 (χ^2)
No (%)	9 (0.21)	0 (0.00)	9 (1.71)	

DIS, difficulty initiating sleep; DMS, difficulty maintaining sleep; EMA, waking too early; NRS, non-restorative sleep; SD, standard deviation; (%) = percentage of the respective group who answered yes or no; DSM-IV, *Diagnostic and Statistical Manual of Mental Disorders*, 4th edn; ICSD, International Classification of Sleep Disorders.

insomnia. Of subjects with insomnia, 20.9% reported a home domestic accident in the past 12 months, 10.1% reported at least one accident at work and approximately 7% a car accident. Home- and work-related accidents as a consequence of insomnia are largely ignored in the literature. There are many more data related to falls and hip fractures in elderly patients treated for insomnia. BZD and non-BZD hypnotics are known to increase the rate of falls during the night (Berry *et al.*, 2013). However, it is not easy to differentiate the contribution of poor sleep to these accidents from that of its treatment (Widera, 2013). In our group, the average age was 45 years and subjects being treated with hypnotics were excluded. We can, therefore, attribute the accidents to poor sleep more directly. Our sociodemographic analysis shows that home accidents were significantly more common in urban areas (69.44% versus 19.07% in suburban and 11.43% in rural areas; $P < 0.001$), unemployed (41.99% versus 17.23% part-time and 70.78% full-time; $P < 0.0001$) and females (71.52% versus 28.48% of males; $P < 0.0001$) who were exposed to a noisy environment (57.50 versus 42.5% non-exposed; $P < 0.001$).

Domestic home accidents are, however, probably more difficult to assess than driving accidents. When subjects

answer the question: 'how many accidents at home could have been related to your sleepiness?' they probably interpret accidents very differently: some may simply think of having had any burn when cooking, others may have had serious falls in their home. The epidemiology on domestic accidents is quite new; in France, however, recent analysis showed that domestic accidents have increased during the last 5 years (Richard *et al*., 2013). They occurred mainly during recreational activities, predominently in the older population, and were associated with physical or mental health problems (chronic disease, disability, sleep disorders). We also observed that those who reported home accidents had significantly more hospitalizations and sick days than subjects who reported no accidents, which may contribute to subsequent costs.

As widely appreciated, car accidents and 'sleeping at the wheel' were more common in urban males exposed to noisy environments (Leger *et al*., 2010a,b). In a study by Philip *et al.* (2010), sleepy drivers and those who had had a car accident in the last year also reported more sick leave and hospitalizations, with associated costs. In our study, work accidents were significantly more common in urban shift workers exposed to noisy environments and with higher rates of hospitalization and sick leave, findings that confirm previous results on work accidents due to insomnia (Akerstedt *et al*., 2002; Daley *et al*., 2009).

Secondly, to our knowledge, previous studies have not detailed so carefully (16 items) the sleep disturbances that can be reported subjectively by patients and which may be associated with insomnia-related accidents. We believe that this study makes an important contribution to the understanding of poor sleep-related accidents. Sleep duration (usual total sleep time) appears to be a significant factor associated with the three kinds of accident. Compared to those without accidents, subjects who reported car accidents slept an average of 4.9 ± 1.60 versus 5.47 ± 1.55 h ($P < 0.0001$), those with work accidents 5.04 ± 1.46 versus 5.48 ± 1.49 h ($P < 0.0001$) and those with home accidents 5.00 ± 1.58 versus 5.36 ± 1.58 h ($P < 0.0001$). We recognize that, in our study, total sleep time was assessed by only one item: 'how many hours do you think you sleep at night on average?' and that this is insufficient to assess this variable adequately. However, total sleep time *per se* is rarely investigated in epidemiological studies on insomnia, and we show that sleep deficit may explain some of the accidents in insomniacs.

Except for DMS, all the other sleep items differed significantly between subjects who reported car, work or home accidents and those who did not. This observation is interesting, because we showed in the same sample that patients suffering from all insomnia symptoms reported the most severely impaired daytime functioning compared with patients suffering from initiation or maintenance insomnia only (Leger *et al*., 2010a,b). Non-restorative sleep, poor sleep quality or feeling not rested in the morning seems to predict an increased risk of accident.

Thirdly, we believe that this is one of the first studies to assess the risk of accidents in patients with insomnia independent of the influence of hypnotics. Because of the aims of the study (Leger *et al*., 2010a,b), we focused upon untreated insomniacs visiting primary care physicians. We demonstrated that when they had insomnia, these patients had a higher risk of accidents even though they were not taking any medication for their insomnia. This is a somewhat new concept, because it is clear that some treatments may have adverse effects on alertness the day after taking the medication and, therefore, on the risk of accidents (Partinen *et al*., 2003; Roehrs and Roth, 2012; Staner *et al*., 2005).

We acknowledge several imitations to this survey. The insomnia symptoms were self-reported measures assessed in a sleep questionnaire completed by a physician. It is possible that individuals who have a poor perception of sleep may also report a poor perception of other domains of their life. However, it has also been demonstrated that insomniacs have poorer daytime functioning than good sleepers independent of possible physical or psychological (anxiety or depression) comorbidities (Daley *et al*., 2009; Fortier-Brochu *et al*., 2012). Comorbidities were not strictly assessed in this study. In many countries, in a large study it is necessary to limit the number of questions in order to ensure good-quality answers, and it was decided that assessing comorbidities completely with well-validated questions should not be included. Moreover, having interviewed only subjects who were not on any treatment, we may have underestimated the full impact of insomnia on accidents. The cross-sectional design of this study allows us to obtain a picture of a given population at a given time, which should encourage further longitudinal exploration to estimate the real impact of insomnia symptoms in primary care practice.

To conclude, our study demonstrates that insomnia is highly prevalent around the world and is associated with a higher risk of accidents at home, at work and while driving.

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AUTHOR CONTRIBUTIONS

DL designed the study, analysed the results and wrote the manuscript. VB analysed the results and wrote the manuscript. MO analysed the results and reviewed the manuscript. PP analysed the results and reviewed the manuscript. PE

designed the study, analysed results and wrote the manuscript. AM analysed the results and reviewed the manuscript. BF analysed the results and reviewed the manuscript.

CONFLICT OF INTEREST

No conflicts of interest declared.

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