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Original Article

Sleep disorders and accidental risk in a large group of regular registered highway drivers

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ABSTRACT

Objective: Despite convincing evidence regarding the risk of highway accidents due to sleepiness at the wheel, highway drivers still drive while sleepy. Sleep disorders can affect driving skills, but the relative impact of sleep complaints among a large population of highway drivers is still unknown.
Methods: Out of 37,648 questionnaires completed by frequent highway users (registered in an electronic payment system), we ran our analyses on 35,004 drivers who responded to all items. The questionnaire previously used in a telephone survey included socio-demographics, driving and sleep disorders items (Basic Nordic Sleep Questionnaire) and the Epworth Sleepiness Scale.
Results: Of all drivers, 16.9% complained of at least one sleep disorder, 5.2% reported obstructive sleep apnea syndrome, 9.3% insomnia, and 0.1% narcolepsy and hypersomnia; 8.9% of drivers reported experiencing at least once each month an episode of sleepiness at the wheel so severe they had to stop driving. One-third of the drivers (31.1%) reported near-miss accidents (50% being sleep-related), 2520 drivers (7.2%) reported a driving accident in the past year, and 146 (5.8%) of these driving accidents were sleep-related. The highest risk of accidents concerned patients suffering from narcolepsy and hypersomnia (odds ratio 3.16, $p < .01$) or multiple sleep disorders (odds ratio 1.46, $p < .001$). Other major risk factors were age [18–30 years (OR 1.42, $p < .001$)] and being unmarried (OR 1.21-fold, $p < .01$).
Conclusions: In regular highway drivers, sleepiness at the wheel or sleep disorders such as hypersomnia and narcolepsy are responsible for traffic accidents independent of age, sex, marital status or socio-professional categories.

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1. Introduction

Epidemiological studies from the 1990s showed that fatigue and sleep-related accidents represent up to 20% of all traffic accidents in industrial societies [1–5]. Drowsiness has been identified as the reason behind fatal road crashes and many industrial accidents [6–10].

Healthy subjects driving in the middle of the night have already demonstrated major driving impairment related to circadian and homeostatic pressure [11], but many drivers are also patients affected by sleep disorders who must face altered driving habits [12].

Sleep disorders are very common in the adult general population [13–17]. Insomnia concerns one adult out of five [16,18] and sleep apnea 5–10% [19,20]. Excessive daytime somnolence is present in about 10% of adults [13], and restless legs syndrome (RLS) in 5–10% of adults [14,17]. Narcolepsy is a rare disease with less than 0.1% of adults affected [21].

The risk of accidents due to sleep disorders has been extensively studied in patients with sleep apnea [22] with many of the studies showing a 2- to 3-fold increased risk. Rare and limited studies have also compared insomniacs' risk of accidents to the risk of good sleepers [23,24]. However, there is less epidemiologic research available on the risk of accidents in hypersomniac and narcoleptic drivers [25–27] possibly because of the low prevalence of these diseases [25,26,28,29].

Finally, some sleep disorders have been studied as accident risk factors, but these studies were conducted among small patient

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cohorts, and additive risk factors like profession or driving habits were rarely considered [25,26].

Recently, Powell et al. [29] used a novel methodology based on Internet interviews to investigate the risk of driving when sleepy. The study clearly showed the predictable risk of near misses related to sleepiness in the occurrence of future sleep-related accidents. They also showed that patients suffering from sleep disorders had more sleep-related accidents but no information was available on the medical status of these patients (treated versus untreated). They also had no information on the origin of the responders because the database was generated by anonymous volunteers asked to fill in a questionnaire after watching an American TV show on sleepiness at the wheel.

Europe differs from the United States in many respects, and the prevalence of sleep disorders, drug intake or poor sleep hygiene may be an area of difference between the two continents. We first conducted a telephone survey based on a representative sample of French drivers [30]. The questionnaires included sociodemographics, driving and sleep disorders items and the Epworth Sleepiness scale. Of 4774 drivers (response rate: 86%), 28% experienced at least one episode of severe sleepiness at the wheel (i.e., requiring them to stop driving) in the previous year; 11% of drivers reported at least one near-miss accident in the previous year (46% sleep-related); 5.8% of drivers reported at least one accident, 5.2% of these being sleep-related (an estimate of 90,000 sleep-related accidents per year in France). Experiencing at least one episode of severe sleepiness at the wheel was strongly associated with near misses (OR 6.50, 95% CI, 5.20–8.12, $p < 0.001$) and traffic accidents (OR 2.03, 95% CI, 1.57–2.64, $p < 0.001$) in the past year. Statistical power was not sufficient in this study to assess the impact of rare sleep disorders (i.e., narcolepsy–hypersomnia) on accident risk. We therefore planned a larger epidemiological survey on a sample of frequent highway drivers using the same questionnaire.

The goal of this new study was to investigate the accidental risk of subjects reporting sleep disorders in a French highway drivers population.

2. Methods

2.1. Participants

With the assistance of the French highway association, Association Française des Sociétés d'Autoroute (AFSA), a non-profit foundation whose mission is to dispense information which will prevent accidents on the highway, we gained access to a database of more than 350,000 registered drivers who used a computerized pay system to avoid long queues at highway toll booths. After obtaining driver authorization, the AFSA conducted regular surveys via the Internet to improve their knowledge and understanding of driver needs and behaviour. All subscriber cars were equipped with an infrared system, which allowed the AFSA to calculate drivers' average mileage on the highway. In addition, drivers provided socioeconomic data for the study.

Out of 313,715 emails sent from 7 December 2007 to 16 January 2008, we received 9488 hits to our server with no response, 4119 questionnaires partially completed (and not included in the analysis), and 37,648 questionnaires were completed throughout. An additional 2644 questionnaires were eliminated due to incoherent responses. The analyses were conducted on a sample of 35,004 drivers.

The French Ministry of Transport called for an evaluation of the national risk of sleep-related accidents. Our team was asked to conduct studies on sleepiness at the wheel using, first, a representative sample of drivers interviewed by telephone [30], then an internet sample in order to inform and educate drivers in future public campaigns. We chose to use for our internet survey a similar methodology to the one published by Powell et al. [29], i.e., we investigated (1) the risk of sleepy driving among French highway drivers, and (2) the relative accidental risk of subjects complaining of sleep disorders. An email was sent to every driver in the database inviting them to complete a questionnaire on the ASFA website. Volunteers responded to the following:

(1) Thirty-one questions including information on sex, age, body mass index, marital status, profession and driving habits.
(2) A set of 4 questions exploring the occurrence of near misses and actual driving accidents. A near-miss driving accident was defined as a detected event that did not cause harm and therefore had limited immediate impact (e.g., inappropriate line-crossing). A driving accident was measured by actual material damage or physical injury.
(3) A previously validated set of 10 questions explored frequency and conditions in which sleepiness at the wheel affected drivers [30–32]. Six of the questions inquired about alcohol, coffee and caffeinated beverage consumption. The effects of coffee and napping on the level of alertness were also investigated as a way to evaluate countermeasures to sleepiness.
(4) Specific questions from the Basic Nordic Sleep Questionnaire (BNSQ) [33] explored snoring frequency.
(5) The Epworth Sleepiness Scale (ESS) [34] to explore excessive daytime sleepiness.
(6) Patients were asked if they had ever been diagnosed and treated for sleep disorders (obstructive sleep apnea syndrome [OSAS], RLS, insomnia, narcolepsy/hypersomnia) or psychiatric disorders (anxiety or depression).

All these questions have been used in a past study [30], to which readers can refer for further methodological questions.

The database was anonymous according to the recommendations of the "Commission Nationale Informatique et Libertés" which insures the ethical usage of data collected for scientific purpose.

2.2. Statistical analyses

Multivariate logistic regression analyses were performed. License (number of years), sex, age, body mass index (BMI), marital status, professional driver status, socio-professional categories, kilometers driven per year, ESS scores, pathologies, self-reported treatment, stimulant effect of coffee, tea or cola, stimulant effect of napping, and severe sleepiness at the wheel resulting in needing to stop were submitted as dependent variables. The driving license question was categorized by period of 10 years of driving; age was classified into 18–30, 31–50, 51–65 and >65 years categories; BMI was continuously analyzed (unit per unit); marital status was categorized as single, married, separated and divorced or widowed; professional driver status was dichotomized into yes or no; socio-professional categories were categorized as executive position and others; kilometers driven per year were categorized as 0–25,000 and 25,000–>40,000; ESS scores were classified into 0–10, 11–15 or >15; pathologies were classified into OSAS, RLS, Insomnia, Anxiety–Depression, Narcolepsy/Hypersomnia, Multi-Pathologies and without pathology (controls); self-reported treatment was dichotomized into yes or no; stimulant effect of coffee, tea or cola was dichotomized into yes or no; stimulant effect of nap was dichotomized into yes or no; and severe sleepiness at the wheel resulting in the need to stop was dichotomized into yes or no.

Statistical tests of the regression estimates odds ratio (ORs) were based on Wald statistics. Odds ratios and their 95% confidence intervals (CIs) were presented to show the association. All

analyses were performed using the SPSS statistical software package (SPSS, v.12.0, Inc., Chicago, Illinois).

Chi-square tests were used to make comparisons between treated and non-treated sleep disorders subjects on driving accidents, sleepy driving accidents, near-miss driving accidents and sleepy near-miss driving accidents.

3. Results

3.1. Participants

Table 1 summarizes the demographic characteristics of the sample. As seen, most of the drivers were male, aged 45.2 years on average.

Table 1
Demographic characteristics of the 35,004 respondents.

Characteristic	Mean ± SD or percent
Age (yrs)	45.2 ± 13.0
Female	26.2%
Body mass index (kg/m^2)	25.4 ± 4.2
Marital status	
Married	77.8%
Single	12.6%
Separated or divorced	8.6%
Missing	1%
Number of children	1.6 ± 1.3
Socio-professional categories	
Farmers	0.3%
Artisans	2.6%
Senior executive	49.7%
Middle management	16.3%
Employees	10.7%
Working class	2.3%
Retired	14.3%
Non-worker	3.1%
Missing	0.7%
With a job	76.9%
Work	
Diurnal work	92.1%
Nocturnal work	1.6%
Shift-work	4.9%
Missing	1.3%
Time at work per week (hrs)	42.7 ± 10.8
Main reasons of driving on road	
Home-work	61.9%
Professional reason	14.5%
Hobbies	14.6%
Shopping	5.3%
Week-end	1.1%
Holidays	0.2%
None	0.8%
Missing	1.5%
License (yrs)	25.5 ± 12.4
Frequency of driving a car	
One or more per day	79.7%
One or more per week	17.3%
One or more per month	1.8%
One or more per year	0.1%
Missing	1.4%
Kilometers driven per year	
0–5000	1.0%
5000–10,000	6.9%
10,000–15,000	14.8%
15,000–25,000	34.0%
25,000–40,000	28.1%
>40,000	15.2%
% of driving between midnight and 6 AM	7.2 ± 10.1
Self-considered as professional drivers	17.3%

Compared to the AFSA representative sample of 1526 volunteers, the participants of this study were slightly younger (45.2 y.o. vs. 48.3 y.o.), more likely to be male (73.8% vs. 65%) and more likely to work in executive or management positions (66% vs. 56%). Proportion of individuals driving more than 40,000 km/yr was lower in this study (15.2% vs. 33%).

3.2. Prevalence of sleep complaints

Table 2 provides data on reported psychiatric and sleep disorders and percentages of self-reported treatments and behaviours. Of all responders, 16.9% reported a single sleep disorder and 4.4% of the participants were affected by several disorders.

Table 3 summarizes data concerning subject characteristics in the five groups of pathology and in the healthy control group. These self-reported sleep disorders were also compared with the clinical profiles of respondents (see Table 3).

3.3. Sleepiness at the wheel

Table 4 contains data about sleepiness at the wheel, near misses and accidents. More than half of the respondents (57.3% vs. 28% in the telephone survey) declared they experienced at least one episode of severe sleepiness at the wheel in the previous year.

3.4. Near-miss accidents

One-third of the drivers (31.1% vs. 11% in the telephone survey) reported at least one near-miss accident during the previous year and 50% of these near misses were sleep-related (15.9% of drivers affected by near-miss sleepy driving accidents). Near-miss sleepy accidents were principally located on highways (77.6%), concerned long trips (63.8%) and occurred more often during the night (40.9%) than in the day (29.4%).

3.5. Driving accidents

Two thousand five-hundred and twenty drivers (7.2%) reported a driving accident in the previous year and 146 (5.8% versus 5.2% in the telephone survey) of these accidents were sleep-related. Sleepy driving accidents occurred more often on highways (57.7%). They were reflected in both short (53.3% vs. 84.6% in the telephone sur-

Table 2
Sleep disorders and behaviour.

Characteristics	Mean ± SD or percent
Suffer from	
None	72.2%
Obstructive sleep apnea syndrome	5.2%
Restless leg syndrome	2.3%
Insomnia	9.3%
Anxiety–depression	6.5%
Narcolepsy–hypersomnia	0.1%
Multi-pathologies	4.4%
At least one sleep disorder	16.9%
% treated patients	
Obstructive sleep apnea syndrome	22.8%
Restless leg syndrome	13.1%
Insomnia	9.9%
Narcolepsy–hypersomnia	20.8%
Alcoholic drinks per week	7.5 ± 8.0
Cups of coffee or tea per week	17.8 ± 11.1
Can of cola per week	3.3 ± 4.8
Cans of energy drink per week	1.8 ± 3.2
Stimulant effect of these drinks (yes)	47.9%
Stimulant effect of a nap (yes)	53.9%

Table 3
Subject characteristics (mean ± SD) in the 5 groups of pathology and in the healthy control group.

Groups	Number of subjects	% treated subjects	% Females	Age, y (range)	Body mass index (BMI), kg/m^2	% Epworth Sleepiness Scale score ⩾16	% Snorers (every night)
Controls	25,502	0.2	25.2	44.1 ± 12.9 (18–96)	25.2 ± 4.0	2.5	13.5
Obstructive sleep apnea syndrome	1843	22.8	5.3	51.8 ± 11.9 (18–82)	28.0 ± 4.8	4.5	58.5
Restless leg syndrome	816	13.1	30.3	48.3 ± 13.2 (20–79)	25.8 ± 4.4	4.3	17.0
Insomnia	3297	9.9	31.0	50.0 ± 12.3 (19–89)	25.6 ± 4.1	2.6	15.9
Anxiety–depression	2289	–	39.2	42.6 ± 11.8 (18–94)	25.4 ± 4.7	4.7	18.2
Narcolepsy/hypersomnia	48	20.8	27.1	45.2 ± 14.6 (21–76)	25.7 ± 3.7	23.0	33.3

y: year.

vey) and long (44.5%) trips, and most of them occurred during the day (58.4% versus 84.6% in the telephone survey).

3.6. Predictive factors of traffic accidents

Table 5 contains information about the association between demographic variables, presence of sleep disorders, and prediction of driving accidents. Being unmarried was associated with a 1.21-fold increase (95% CI, 1.07–1.37, $p < .01$) in the accident rate. Age between 18 and 30 years was associated with an increase in the accident rate to 1.42 (95% CI, 1.22–1.64, $p < .001$) of the rate found in individuals who were 10 years older. The odds ratio of females was 1.16 (95% CI, 1.05–1.28, $p < .01$) times as high as males.

Professional drivers (Odds ratio 1.15 [95% CI, 1.02–1.30, $p < .05$]) as well as drivers who drove more than 25,000 km/year (Odds ratio 1.21 [95% CI, 1.09–1.33, $p < .001$]) were at higher risk of driving accidents; there was a particularly high risk of accidents associated with narcolepsy and hypersomnia (Odds ratio 3.16 [95% CI, 1.36–7.33, $p < .01$]).

No other association between sleep disorders, insomnia, OSAS, RLS and driving accidents was found. No association between socio-professional categories and driving accident was found.

Table 6 provides data on the prediction of sleepy driving accidents. There was a substantial ordered relationship between the ESS score and the risk of sleepy driving accidents. Drivers who reported needing to stop driving because of severe sleepiness at the wheel had a 9.48-fold increase (95% CI, 4.14–21.72, $p < .001$) in the rate of sleepy driving accidents. Of particular note was the high risk of sleepy accidents associated with narcolepsy and hypersomnia (Odds ratio 8.78 [95% CI, 1.97–39.06, $p < .01$]), OSAS (Odds ratio 2.09 [95% CI, 1.06–4.13, $p < .05$]) and insomnia (Odds ratio 1.78 [95% CI, 1.01–3.14, $p < .05$]).

3.7. Impact of treatment

No difference was found between treated and untreated drivers suffering from sleep or psychiatric disorders regarding driving accidents. Only treated apneics presented fewer near-miss accidents (Chi-square test = 6.435, $p = .011$) and fewer sleepy near-miss accidents (Chi-square test = 4.553, $p = .035$) compared to untreated apneics.

4. Discussion

To our knowledge this is the first study to focus on sleep disorders in a sample of highway drivers, most of whom were working. Many studies have been done on patients with sleep disorders or in samples of the general population. However, the novel concept in our study was to concentrate on reporting sleep disorders and the risk of traffic accidents in regular highway drivers.

Such drivers report a higher prevalence of accidents (7 accidents/100 drivers) compared to the number recorded by the French police force (3 accidents/1000 drivers) [35]. These high figures are probably related to the fact that unlike in the national database where the police forces are systematically called, the severity of accidents was not a limiting criterion, so many of the accidents that occurred in the previous year did not result in traffic disruption or physical injury but simply in vehicle damage.

Near-misses are very frequent among our population and predict both sleepy and non-sleepy accidents [29,30]. Hence, they should be considered by drivers as strong warning signals for future accidents. In a recent study using a different group of drivers representative of the French population [30] we also found a high rate of sleepiness at the wheel (28%) and a high number of near-miss accidents (11%), 46% of them being sleep-related. Interestingly, if sleepiness at the wheel and near misses are more frequently reported in the internet population than in the telephone survey, the accident rates almost do not differ between the two studies (respectively, 7.2% vs. 5.8% and 5.8% vs. 5.2%). These differences could be explained by different roads being used by the two groups, i.e., the internet subjects are driving more frequently on freeways which are known to be safer roads.

Another interesting finding was the high prevalence of sleep disorders and severe sleepiness at the wheel in a population of highway drivers. Multiple regression analyses confirmed well-known factors responsible for traffic accidents like age, professional and marital status, and average mileage driven per year, but also pointed to the role of sleep disorders, such as narcolepsy/hypersomnia or a combination of several sleep complaints. Among the sleep disorders, OSAS is not the only disease responsible for excessive daytime sleepiness; narcolepsy has also been studied as a risk factor for traffic accidents. Aldrich [25] showed that narcoleptic patients presented a higher risk of sleep-related accidents than apneic subjects. In that study, the proportion of individuals with sleep-related accidents was 1.5- to 4-fold greater in the hyper-somnolent patients than in the control group. However, the number of patients was quite limited and other risk factors like age, marital status or driving patterns received insufficient attention. Interestingly, in our study, the most frequent sleep disorders, e.g., OSAS or insomnia, did not come out in the first level of analysis. OSAS is probably the most widely studied pathology with respect to traffic accidents. Sleepiness at the wheel is obviously a main symptom to investigate in conjunction with the severity of the disease (AHI > 30). Our findings confirm the data of Lloberes et al. and Masa et al. [15,36] showing not all apneic drivers have accidents, but mainly those complaining of sleepiness at the wheel. Elevated risks for motor vehicle crashes due to sleepiness and cataplexy were reported in a small sample of untreated narcolepsy patients [37]. More recently in a large epidemiological study, Powell et al. [29] showed that narcolepsy increased 4-fold the risk of sleep-related accidents. In our study, 48 subjects with narcolepsy/hypersomnia were highway drivers and had a higher

Table 4
Sleepiness, near-miss accidents and accidents.

Characteristic	Mean ± SD or percent
Severe sleepiness at the wheel needing to stop	
Never	41.8%
Less than once per month	46.1%
At least once per month	8.9%
At least once per week	2.2%
Missing	0.9%
Sleepy during driving	57.3%
Sleepy during	
Nocturnal driving	34.2%
Diurnal driving	36.7%
Both	28.9%
Missing	0.3%
Near-miss driving accidents during previous year	31.1%
Near-miss sleepy driving accidents during previous year	15.9%
Number of near-miss sleepy driving accidents during previous year	4.1 ± 7.9
Location of near-miss sleepy driving accidents	
City	1.0%
Road	15.2%
Highway	77.6%
All types of roads	5.9%
Missing	0.3%
Type of trip for near-miss sleepy driving accidents	
Short trip	25.0%
Long trip	63.8%
All types of trips	10.7%
Missing	0.4%
Time of day for near-miss sleepy driving accidents	
Day	29.4%
Night	40.9%
Day and night	29.1%
Missing	0.6%
Driving accidents during previous year	7.2%
Sleepy driving accidents during previous year	0.4%
Number of sleepy driving accidents during previous year	1.1 ± 0.4
Location of sleepy driving accidents	
City	19.0%
Road	21.9%
Highway	57.7%
All types of roads	1.5%
Missing	0.0%
Type of trip for sleepy driving accidents	
Short trip	53.3%
Long trip	44.5%
All type of trips	2.2%
Missing	0.0%
Time of the day for sleepy driving accidents	
Day	58.4%
Night	35.0%
Day and night	5.8%
Missing	0.7%
Anticipatory measures before departure	56.5%
Type of preparation	
Normal sleep duration	86.2%
Earlier departure in order to plan breaks	7.7%
Plan to sleep during breaks	1.0%
Take stimulant drinks	1.5%
Second rested driver	2.7%
Nothing	0.7%
Missing	0.2%

risk of accidents compared to controls. The risk did not differ significantly between treated and untreated patients. However, the number of patients in each group (38 vs. 10) was too small to provide firm conclusions.

The risk of accidents in insomniacs is controversial: (1) very few studies have investigated the issue; (2) motor vehicle accidents are not always differentiated from domestic or occupational accidents; and (3) there are no detailed data on type of insomnia and severity. One study showed that insomnia was associated with an increased risk of work accidents (8-fold compared to good sleepers) in the previous 12 months [23] but not automobile accidents. Furthermore, Daley et al. [38] recently found that nonmotor vehicle accidents occurred at higher rates in insomniacs than in good sleepers (GS) (12.5% vs. 6.4% for GS; OR: 2.4) but no difference was found for motor vehicle accidents.

In another professional sample of insomniacs, Leger et al. found a higher risk of car accidents [24]. Our sample was largely composed of non-professional drivers, which could explain these different results. Here again insomniacs are a very heterogeneous group of patients, some of them complaining of excessive daytime sleepiness and others reporting normal levels of alertness. These differences could explain why insomniacs do not come out on the first level of accident analysis (non sleep-related accidents).

When we consider specifically sleep-related accidents, OSAS, insomnia and narcolepsy/hypersomnia come out as risk factors. These findings confirm, as mentioned before, that it is not only the sleep disorder, but the occurrence of sleepiness at the wheel which is probably the most dangerous factor to explain accidents in patients. This assumption is reinforced because accidental risk is proportional to the level of Epworth sleepiness scale, as shown by Powell et al., but also with the severity of the disease, narcoleptics/hypersomniacs being significantly sleepier and more involved in sleep-related accidents than apneics or insomniacs.

Finally, the very high prevalence of sleepiness at the wheel (8.9% of the drivers reported at least one episode of sleepiness at the wheel per month, so severe they had to stop the car) in this active population should encourage road safety agencies to promote campaigns against sleepiness at the wheel.

Our study has some limitations. First, our group overrepresents male drivers compared to national statistics (74% vs. 59% of male drivers). However, the AFSA representative sample was also composed mostly of men (65%). Therefore, most drivers taking the highway regularly are men. Also, since the study was conducted online, it is possible that some segments of the population were more likely to answer our survey (mainly younger individuals familiar with the use of a computer and internet and professional workers). According to Nielsen Net, 58.1% of the French population was using the internet in 2008 (http://www.internetworldstats.com/eu/fr.htm).

Second, sleep disorders were assessed on the basis of driver testimonials, but there was no clinical interview to confirm the disease or treatment. However, our sample reflects the prevalence of psychiatric and sleep disorders in epidemiological studies performed in western populations [13,14,16–18,39]. Some sleep disorders like insomnia or RLS are slightly underrepresented, but this could be because our population was mainly composed of men under 65 years of age, a sample of individuals less affected by these sleep disorders. Narcolepsy and hypersomnia are reported by 0.1% of the population, which is also an appropriate figure. In Table 3, showing the characteristics of patients complaining of sleep disorders, the reported symptoms match the classical definition of these disorders. For instance, subjects reporting OSAS were mainly middle-aged males who often exhibit a higher incidence of snoring and who are heavier and sleepier than insomniac patients. Non-sleepy women were highly prevalent in the insomniac groups. Narcoleptics and hypersomniacs were non-obese subjects with the highest level of sleepiness in the entire disorders sample. Even though we did not conduct a clinical interview to precisely assess sleep complaints, the use of commonly used questionnaires like the BNSQ and the ESS and the coherence between symptoms and self-reports of the diseases suggest that our data are reliable. The final limitation was that we were not able to collect data on usual sleep duration, although ESS scores do provide an indirect measure of poor sleep hygiene.

Table 5
Multivariate logistic regression results for prediction of driving accidents.

	Total *n*	Driving accident[a]		Odds ratio (95% CI)	*p* Value
		Yes *n*	%		
License (yrs)[b]				**0.98** (0.97–0.99)	.001
Sex					
Male	25,879	1710	6.6	Referent	
Female	9272	792	8.5	**1.16** (1.05–1.28)	.01
Age (yrs)					
18–30	5413	683	12.6	**1.42** (1.22–1.64)	.001
31–50	16,938	1220	7.2	Referent	
51–65	10,941	510	4.7		ns
>65	1822	88	4.8		ns
Marital status					
Married	27,494	1782	6.5	Referent	
Single	4458	485	10.9	**1.21** (1.07–1.37)	.01
Single separated or divorced or widowed	3049	229	7.5	**1.31** (1.11–1.54)	.001
Professional driver					
No	28,543	1971	6.9	Referent	
Yes	6111	495	8.1	**1.15** (1.02–1.30)	.05
Kilometers driven per year					
0–25,000	20,043	1299	6.5	Referent	
25,000–>40,000	15,296	1218	8.0	**1.21** (1.09–1.33)	.001
Pathologies					
Controls	25,502	1794	7.0	Referent	
OSAS[c]	1843	106	5.8		ns
RLS[d]	816	45	5.5		ns
Insomnia	3297	206	6.2		ns
Anxiety–depression	2289	192	8.4		ns
Narcolepsy/hypersomnia	48	10	20.8	**3.16** (1.36–7.33)	.01
Multi-pathologies	1544	164	10.6	**1.46** (1.20–1.78)	.001

CI denotes confidence intervals. Bold characters concern significant odd ratios.
[a] A driving accident was defined if material damage or physical injury occurred.
[b] Odds ratio for License assesses the effect of each 10-year increase in driving license.
[c] Obstructive sleep apnea syndrome.
[d] Restless legs syndrome.

Table 6
Multivariate logistic regression results for prediction of sleepy driving accidents.

	Total *n*	Sleepy driving accident[a]		Odds Ratio (95%CI)	*p* Value
		Yes *n*	%		
Marital status					
Married	27,494	90	0.3	Referent	
Single	4458	36	0.8	**1.94** (1.22–3.07)	.01
Separated or divorced or widowed	3049	12	0.4		ns
Epworth Sleepiness Scale					
0–10	24,767	56	0.2	Referent	
11–15	7965	57	0.7	**2.22** (1.48–3.31)	.001
>15	1116	21	1.9	**5.00** (2.79–8.56)	.001
Pathologies					
Controls	25,502	79	0.3	referent	
OSAS[b]	1843	12	0.6	**2.09** (1.06–4.13)	.05
RLS[c]	816	3	0.4		ns
Insomnia	3297	17	0.5	**1.78** (1.01–3.14)	.05
Anxiety–depression	2289	11	0.5		ns
Narcolepsy/hypersomnia	48	2	4.2	**8.78** (1.97–39.06)	.01
Multi-pathologies	1544	14	0.9		ns
Severe sleepiness at the wheel needing to stop					
No	14,783	7	0.0	Referent	
Yes	20,236	131	0.6	**9.48** (4.14–21.72)	.001

CI denotes confidence intervals. Bold characters concern significant odd ratios.
[a] A sleepy driving accident was defined if material damage or physical injury occurred due to sleepiness.
[b] Obstructive sleep apnea syndrome.
[c] Restless legs syndrome.

5. Conclusion

Severe episodes of sleepiness at the wheel frequently occur, even for supposedly healthy drivers. Sleepiness at the wheel, especially in patients suffering from narcolepsy and hypersomnia, should be systematically explored and caution regarding the danger of "driving sleepy" should be given before initiating treatment.

Disclosure

No financial conflict of interest.

Competing interests

None.

Contributors

P.P., J.T., J.B. and B.B. made the initial hypothesis. P.S., J.T. and E.L. analyzed the data. P.P., J.T., P.S., E.L., D.L. and M.O. wrote the initial draft and the others authors worked on the final edition of the paper. P.P. is the guarantors of the paper.

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Appendix A. Supplementary data

Supplementary data associated with this article can be found, in the online version, at doi:10.1016/j.sleep.2010.07.010.

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