Sleep Habits and Accident Risk Among Truck Drivers: A Cross-Sectional Study in Argentina

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Abstract: Road accidents are a major cause of death, and sleep deprivation affects driving skills. We conducted a cross-sectional study to evaluate sleep habits and accident risk in long-haul truck drivers in Buenos Aires, Argentina. Questionnaires regarding sleep habits, snoring, and daytime sleepiness were administered, and a limited physical examination was performed. We obtained 738 complete answers (response rate 85%). Mean sleep hours during working days was 5.76 (SD 5.60) per day. Frequent sleepiness while driving was reported by 43.7% of responders. Sleepiness while driving was associated with Epworth Sleepiness Scale values > 10 (odds ratio 1.85, 95% confidence interval = 1.20-2.85). Snoring was reported by 71% of drivers and was frequent in 43.8%. Snoring more than 3 times a week (odds ratio 1.73, 95% confidence interval = 1.23-2.44), sleepiness while driving (OR 1.92, 95% confidence interval = 1.08-1.96), and Epworth Sleepiness Scale score > 10 (odds ratio 2.53, 95% confidence interval = 1.61-3.97) were independently associated with reporting of accidents or near accidents. Sleep deprivation and long driving shifts were prevalent in our study. Accident risk was associated with frequent snoring, daytime sleepiness, and reporting of sleepiness at the wheel. This study highlights the need of improving working conditions in this highly exposed population.

Keywords: Sleepiness, truck drivers, snoring, driving

Citation: Pérez-Chada D; Videla AJ; O’Flaherty ME et al. Sleep habits and accident risk among truck drivers: a cross-sectional study in Argentina. SLEEP 2005;28(9): 1103-1108.

INTRODUCTION

MOTOR VEHICLE ACCIDENTS ARE A MAJOR CAUSE OF DEATH IN WESTERN SOCIETIES. ALTHOUGH EXCESSIVE SPEED AND ALCOHOL CONSUMPTION ARE frequently blamed, alcohol and sleep deprivation have a similar influence on driving performance.\textsuperscript{1} Habitual sleepiness while driving has been reported in 2% to 3% of drivers.\textsuperscript{2,3} Excessive daytime sleepiness as a contributing factor for accidents, particularly among commercial truck drivers, has raised considerable concern.\textsuperscript{4,5} Furthermore, habitually sleepy drivers have a significantly higher risk of car crashes.\textsuperscript{6} Accidents caused by sleepiness often are particularly serious because of lack of reaction to the collision.\textsuperscript{7}

In the United Kingdom, 20% to 25% of motorway accidents can be attributed to drivers falling asleep at the wheel.\textsuperscript{8} The United States National Highway Traffic Safety Administration has estimated the cost of drowsy driving at $12.4 billion per year.\textsuperscript{9} Conservative estimates suggest that 1,500 deaths and 76,000 injuries can be caused by sleep-related accidents.

In the year 2000, there were 1,058 deaths due to car accidents per million vehicles in Argentina.\textsuperscript{10} During 2003, there were 9,556 deaths due to car accidents, and trucks were involved in 13% of accidents.\textsuperscript{11} Sleepiness in long-haul truck drivers is relevant because they might suffer from sleep deprivation due to long working hours, tight delivery schedules, suboptimal sleeping conditions at resting areas, long shifts, and lengthy performance of a frequently monotonous task. Snoring has also been found to increase the likelihood of an accident by 30%.\textsuperscript{12} Several studies have suggested that the prevalence of respiratory disorders during sleep can be higher in professional drivers than in the rest of the population.\textsuperscript{13-17}

The aim of the present study was to evaluate sleep habits, clinical characteristics, and the prevalence of snoring and its relationship with accidents or near accidents in a large unselected population of commercial truck drivers. We also surveyed the strategies adopted to cope with sleepiness while at work.

SUBJECTS AND METHODS

Subjects

Licensed long-haul commercial truck drivers, driving at least 800 km per day, were invited to participate in the study at the Buenos Aires Central Market, the major distribution center for food and goods in the city. They were freelance workers not belonging to transport companies. Subjects were informed about the nature of the study, and participation was voluntary and anonymous. Subjects were approached while waiting to be assigned a new route or to pick up a load at the market’s main parking area. Waiting periods varied widely, lasting in some cases more than 24 hours. During that time truckers stayed by their trucks, resting in the cabin or in precarious facilities.

Methods

An adapted version of the Wisconsin Sleep Cohort Study ques-
tionnaire was translated into Spanish and tested for comprehension. This questionnaire includes a previously validated version in Spanish of the Epworth Sleepiness Scale (ESS). University students administered the questionnaire and performed a limited physical examination. The survey was conducted between June 25 and November 1, 2001.

The questionnaire included questions on sleep habits, snoring, smoking history, sleep quality, and leg movements during sleep, as well as demographic and anthropometric data and strategies adopted by the drivers to cope with sleepiness. EDS was measured using the total score of the ESS. If the difference between the number of hours slept on the weekends and the number of hours slept on weekdays was more than 2 hours, this was considered a marker of insufficient sleep syndrome.

Questions to evaluate sleepiness while driving were included on a 5-point scale, ranging from 1 = “never” to 5 = “always or almost always.” The questions used to evaluate accidents were “Have you ever had an accident due to falling asleep or feeling sleepy while driving?” and “Have you ever been close to having an accident due to falling asleep or sleepiness while driving?” (Yes or no). Snoring was ascertained by the following questions “Have you ever been told that you snore?” (Yes or no). Snoring was ascertained by the following questions “Have you ever been told that you snore?” (Yes or no), and “According to what others have told you, please estimate how often do you snore.” Rarely, sometimes, at least once a week, several (3 to 5) nights per week, every night or almost every night and do not know were the possible answers. Subjects reporting snoring more than 3 nights per week were considered to be frequent snorers.

Weight and height were measured after completing the questionnaire. Neck circumference (in centimeters) was measured with a metric tape at the level of the thyroid cartilage. Arterial blood pressure was measured in the sitting position using an arm cuff while the drivers remained seated by their trucks. Hypertension was defined when blood pressure values were higher than 140/90 mm Hg or therapy for hypertension was prescribed. Body mass index was calculated.

**Statistical Analysis**

Answers such as does not know or does not answer were excluded from the analysis.

<table>
<thead>
<tr>
<th>Table 1—Study Population</th>
</tr>
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<tbody>
<tr>
<td>Parameter</td>
</tr>
<tr>
<td>No.</td>
</tr>
<tr>
<td>Age, y*</td>
</tr>
<tr>
<td>Sex, men</td>
</tr>
<tr>
<td>BMI, kg/m2*</td>
</tr>
<tr>
<td>Overweight (BMI &gt; 25 kg/m²)</td>
</tr>
<tr>
<td>Smoking</td>
</tr>
<tr>
<td>Hypertension</td>
</tr>
<tr>
<td>Snoring</td>
</tr>
<tr>
<td>ESS &gt;10</td>
</tr>
<tr>
<td>ISS</td>
</tr>
<tr>
<td>Sleepiness while driving</td>
</tr>
</tbody>
</table>

Data are presented as number (%) unless otherwise indicated. 
*Mean (standard deviation) 
BMI refers to body mass index; ESS, Epworth Sleepiness Scale; ISS, insufficient sleep syndrome, meaning that the difference between the number of hours of sleep on weekdays and the number of hours of sleep on weekends is 2 hours or more.

Continuous measurements were presented as mean ± SD, or medians. Categorical variables were presented as percentages and 95% confidence intervals (CI). Univariate comparisons were performed by Student t test or its nonparametric equivalent, Mann-Whitney test, for comparison of independent groups. For comparisons of proportions and categorical data, χ² was used. A logistic regression model was employed to assess the association between accidents or near accidents and the following risk factors: snoring, insufficient sleep syndrome, sleepiness while driving, and ESS scores. Adjustment for several confounders such as number of hours at the wheel, nighttime driving, and age was included in the analysis. Confounding effects and interactions were explored by comparing models with and without the interaction term or confounding factors using the likelihood ratio test. The proportion of reported accidents or near accidents was plotted against the cumulative number of independent risk factors identified in the logistic regression models. Two-tailed P values < .05 were considered as indicators of statistical significance. Data analysis was performed with Intercooled Stata software (College Station, Tex, v.8.0).

**RESULTS**

Of the 905 consecutive drivers who were approached, 770 answered the questionnaire (response rate: 85%). Among nonresponders, the main reason for refusing to participate was the need to depart promptly from the market. We excluded 32 subjects due to incomplete data on key variables. Subject characteristics are summarized in Table 1. Mean driving time was 15.9 (SD 5.60) hours. Work shifts were longer than 12 hours in 84.7% (CI = 82.1-87.3). Nighttime driving was reported by 58.5% (CI = 54.9-62.1). Accidents were reported by 61 (8.27%; CI = 6.40-10.5) and near accidents by 271 subjects (36.7% CI = 33.2-40.3).

**Data on Sleep Habits**

ESS scores and insufficient sleep syndrome are shown in Table 2. Drivers slept less than 4 hours on weekdays in 45% of cases (CI = 41.5-48.7). An insufficient sleep syndrome was found in 86.9% of respondents (CI = 84.5-89.4). Snoring was present in 71.9% of the sample (CI = 68.7-75.2). It was rated as occasional in 298 (56.1%; CI = 51.8-60.4) and frequent in 233 respondents (43.8%; CI = 39.6-48.7). Witnessed apneas were reported by 35 subjects (4.7%; CI = 3.3-6.5), all of them snorers. Subjects who reported apneas had a higher ESS score (ESS 8.14 ± 6.8 vs 4.6 ± 4.8, P < .01), showed a higher prevalence of hypertension (57.1% vs 38.4%, P < .01), and were older (43.5 ± 10.3 years vs 37.8 ± 10.3, P < .01).

<table>
<thead>
<tr>
<th>Table 2—Sleep Patterns and Sleepiness</th>
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<tbody>
<tr>
<td><strong>Sleep data</strong></td>
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<tr>
<td>Usual sleep period, h</td>
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<tr>
<td>Sleep during weekend, h</td>
</tr>
<tr>
<td>Difference in total sleep time (weekends - weekdays), h</td>
</tr>
<tr>
<td>Reported sleep latency, min</td>
</tr>
<tr>
<td>Naps, min</td>
</tr>
<tr>
<td>Epworth Sleepiness Scale score</td>
</tr>
</tbody>
</table>

Data are presented as mean ± SD.
Frequent and very frequent sleepiness while driving were associated with habitual snoring (odds ratio 1.42; CI = 1.04-1.95) and an ESS score > 10 (OR 2.06; CI = 1.35-3.15), and long driving intervals (OR 1.55; CI = 1.01-2.3). Nighttime driving and insufficient sleep syndrome were not associated with sleepiness while driving (OR 1.26, CI = 0.93-1.68, and OR 1.28, CI = 0.81-1.92, respectively). Performing a logistic regression analysis an ESS score > 10 was the only variable independently associated with sleepiness while driving (OR 1.85; CI = 1.20-2.65). The highest ESS scores were found in drivers working long number of hours at the wheel and with short sleep periods on the face. EDS was not longer a statistically significant factor. The probability of crashes or near misses increased according to the number of risk factors present (sleepiness while driving, snoring, and ESS > 10, Hosmer-Lemeshow goodness of fit $\chi^2 = 6.7$, $P = .25$) (Figure 1). If the association was causal and unconfounded, the population attributable fraction for driving risk would be 24% for snoring, 18% for ESS > 10, and 16% for sleepiness while driving. When considering the effect of these factors on risk for accidents, each factor did not modify the effect of the others. No interactions were found.

### DISCUSSION

As far as we are aware, this study, with a high response rate, shows the sleep habits and driver characteristics in the largest sample ever described in South America. The main findings were a marked reduction of usual sleep time, long driving shifts, and high frequency of sleepiness while driving (44% of cases). EDS and sleepiness while driving were associated with driving risk, and sleepiness while driving was associated with long work intervals.

We surveyed a middle-aged predominantly male and overweight population (compared with population-based data showing a prevalence of a body mass index > 25 mg/kg² of about 60%[25]) of long-haul professional drivers. Smoking, hypertension, and snoring were also prevalent. Reporting of job conditions disclosed a long number of hours at the wheel with short sleep periods on

### Table 3—Measures to Fight Sleepiness Associated With Driving Risk

<table>
<thead>
<tr>
<th>Protective behavior</th>
<th>Crude OR (95%CI)</th>
<th>Percentage of answers (no.)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Speed up</td>
<td>3.68 (1.70-7.95)</td>
<td>4.30 (32)</td>
</tr>
<tr>
<td>Sing without stopping</td>
<td>2.15 (1.47-3.13)</td>
<td>19.1 (141)</td>
</tr>
<tr>
<td>Listening to music without stopping</td>
<td>2.13 (1.56-2.90)</td>
<td>41.2 (304)</td>
</tr>
<tr>
<td>Open the window of the cabin</td>
<td>1.96 (1.44-2.66)</td>
<td>46.8 (345)</td>
</tr>
<tr>
<td>Stop and splash cold water in the face</td>
<td>1.93 (1.42-2.61)</td>
<td>49.5 (365)</td>
</tr>
<tr>
<td>Listen to the radio without stopping</td>
<td>1.85 (1.34-2.57)</td>
<td>29.4 (217)</td>
</tr>
<tr>
<td>Talk to someone else without stopping</td>
<td>1.46 (1.01-2.09)</td>
<td>20.6 (152)</td>
</tr>
<tr>
<td>Light a cigarette while driving</td>
<td>1.41 (1.01-1.95)</td>
<td>28.2 (208)</td>
</tr>
<tr>
<td>Leave the road and take a 30- to 40-minute nap or rest</td>
<td>0.67 (0.49-0.91)</td>
<td>62.1 (458)</td>
</tr>
</tbody>
</table>

OR refers to odds ratio; CI, confidence interval.

Frequent and very frequent sleepiness while driving were reported by 43.8% (CI = 40.2-47.4) and an ESS score > 10 by 13.9% (CI = 11.4-16.5) of the sample. Subjects with an ESS score > 10 reported sleepiness while driving more frequently (59.2% vs 13.9% (CI = 11.4-16.5) of the sample. Subjects with an ESS score > 10 by 35.0% of the sample ever described in South America. The main findings were a marked reduction of usual sleep time, long driving shifts, and high frequency of sleepiness while driving (44% of cases). EDS and sleepiness while driving were associated with driving risk, and sleepiness while driving was associated with long work intervals. The probability of crashes or near misses increased according to the number of risk factors present (sleepiness while driving, snoring, and ESS > 10, Hosmer-Lemeshow goodness of fit $\chi^2 = 10.10$, $P = .25$) (Figure 1). If the association was causal and unconfounded, the population attributable fraction for driving risk would be 24% for snoring, 18% for ESS > 10, and 16% for sleepiness while driving. When considering the effect of these factors on risk for accidents, each factor did not modify the effect of the others. No interactions were found.

### Table 4—Risk Factors Associated With Reporting of Accidents or Near Accidents

<table>
<thead>
<tr>
<th>Risk Factor</th>
<th>Crude OR (95%CI)</th>
<th>Adjusted OR* (95%CI)</th>
</tr>
</thead>
<tbody>
<tr>
<td>ESS score &gt;10</td>
<td>3.05 (1.98-4.69)</td>
<td>2.53 (1.61-3.97)</td>
</tr>
<tr>
<td>ISS</td>
<td>1.72 (1.07-2.77)</td>
<td>1.27 (0.75-2.14)</td>
</tr>
<tr>
<td>Sleepiness at the wheel</td>
<td>1.62 (1.20-2.17)</td>
<td>1.92 (1.08-1.96)</td>
</tr>
<tr>
<td>Snoring &gt;3 times per week</td>
<td>1.59 (1.16-2.17)</td>
<td>1.73 (1.23-2.44)</td>
</tr>
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</table>

*Adjusted odds ratio (OR) by age, nighttime driving, and number of hours at the wheel.

We surveyed a middle-aged predominantly male and overweight population (compared with population-based data showing a prevalence of a body mass index > 25 mg/kg² of about 60%[25]) of long-haul professional drivers. Smoking, hypertension, and snoring were also prevalent. Reporting of job conditions disclosed a long number of hours at the wheel with short sleep periods on

### Figure 1—Relationship between reported accident risk and cumulative number of independent risk factors from none to all 3 (snoring, Epworth Sleepiness Scale > 10, and sleepiness while driving).
weekdays and frequent nighttime driving. This situation places a strain on attention and driving performance and can be common in underdeveloped countries, even though violation of regulations has also been reported in Finland and the United States.24,25

Sleepiness while driving was frequent in our sample. Our results are consistent with those of McCartt, who found sleepiness while driving in 47% of a random sample of 538 professional drivers in the United States.25 This picture can possibly be found in other Latin American countries: in a World Health Organization survey, Brazil had 24 crash fatalities per 100,000 inhabitants, whereas Argentina had a rate of 6.8. deaths per 100,000, and Chile and Colombia suffered higher accident rates.26 Supporting this assumption, in a smaller survey conducted in Peru among bus drivers, 45% reported accidents or near misses while driving. Fifty-five percent of the drivers slept less than 6 hours per day, and tiredness as a proxy of sleepiness while driving was reported in 56%.27 Sleepiness while driving was associated with an ESS score > 10 in multivariate analysis. Even though 80% of our group had an insufficient sleep syndrome, it is interesting to note that only 14% reported an ESS score > 10, those being predominantly nighttime drivers with long shifts. Mean ESS scores were 4.75 in the entire sample, so most of the group exposed to the same sleep debt did not perceive such a high impact of sleepiness in their daily activities. Drivers without excessive daytime sleepiness were also less prone to accidents. Although no data on ESS distribution in Argentina are available, we did find, in our sample, a subgroup of subjects with higher ESS values when compared with the rest of the sample. This subgroup also had a higher risk for accidents.

Drivers reported the use of several measures to cope with sleepiness, and some were more dangerous than protective. In 40% of answers, drivers did not stop to take a nap when drowsy. The small number of drivers who slowed down or passed the wheel to someone else may be explained by most of them traveling alone or with a nonprofessional driver as company. Speeding up was associated with significant risk but, fortunately, was reported in a low percentage of cases. Nevertheless, some of the most risky measures were frequently reported.

As expected, this sleep-deprived population of professional drivers was prone to accidents or near misses. Several factors were associated with driving risk in univariate analysis: insufficient sleep syndrome, reporting of sleepiness while driving, ESS score > 10, and frequent snoring. When these factors and their potential confounders were evaluated in the multivariate analysis, insufficient sleep syndrome was no longer an accident predictor. Even with sleep deprivation, driving probably remains a highly stimulating activity, and some professional drivers can develop a training effect that allows them to develop a semiautomatic task with a relatively low risk. Age, as a proxy of driver experience, had a protective effect, as has been suggested by other authors.21 In this particular scenario, the loss of circadian rhythm by nighttime driving, the poor performance after long work shifts, the contribution of snoring, and, perhaps, the presence of sleep apnea are important risk factors. Wylie et al28 showed that the time of day had more impact on driver fatigue than did time on task or cumulative number of trips. In a study conducted in Finland, Hakkanen reported that 40% of long-haul truck drivers had problems in staying alert on at least 20% of their rides and that more than 20% of the truckers reported having dozed off at least twice while driving. Drivers adopted several measures to fight drowsiness.24

In the Finnish study, the mean number of hours of sleep was 7.2, and sleepiness was only associated with night shifts. On the other hand, in our sample, the reported mean number of hours of sleep was 3.6 per day. Daytime sleepiness, arduous work schedules, poor sleep on the road, symptoms of sleep disorders, and predominantly nighttime driving have been previously described as risk factors for sleepiness while driving.25

Snoring in our study was a contributing factor, accounting for 25% of accident risk.

Snoring is an independent risk factor for sleep apnea29 but can also induce sleepiness by itself, independent of the apnea-hypopnea index.30 Accident risk in sleepy drivers is associated with the number of respiratory effort related arousals.31 As has been noted previously, the contribution of respiratory events was important even after adjustment for the impact of the loss of sleep hygene. Accident risk was related to ESS scores in our study. Some previous studies have found no relationship between ESS and accident risk in professional and nonprofessional drivers,32,33 whereas others have found associations with accident liability or crashes.14,34 A recent study with a large sample found that ESS scores were related to accident risk.17 Moreover, objective measurements of performance using Multiple Sleep Latency Test in sleepy drivers showed correlation between accident risk and ESS scores.35 In our study, drivers with the highest load of driving hours and nighttime driving reported excessive daytime sleepiness. Carter et al36 also reported that ESS scores are associated with any kind of accidents only when self-estimated sleep debt is present. However, sleepiness is frequently denied as a causal factor by drivers involved in crashes.34,35 Quality of sleep, job conditions, and snoring have an impact when sleep deprivation is common and is at least as important as the sleep debt itself. These factors act in an additive fashion.

This survey has several limitations, as the outcome and exposition measures can be affected by several biases. We had no access to log devices to objectively assess the distance and travel schedule nor to objectively documented accident reports. So, we had to rely on drivers’ assessments of these issues. However, because the questionnaire was anonymous and the employers were not involved in the inquiry, there was no possibility of differential reporting looking for a secondary gain. Moreover, self-reported sleep time of long-haul truckers may be significantly overestimated when assessed by objective measurements.4 Stutts et al,34 using police-reported crashes in an unselected population, reported stronger associations between sleepiness and accidents. Even though survivor bias and underreporting may weaken the strength of associations in our study, they remain significant, according to previous studies.38

We included no questions on alcohol consumption or use of stimulating or soporific medications, since we were concerned about refusal to participate by asking sensitive questions. However, many drivers spontaneously reported that they chewed coca leaves in an attempt to be alert during their long travels. Use of narcotic analgesics and antihistaminics has been recently associated with accident risk.17 Alcohol intake has been found to be present in between 33% and 69% of fatal crashes in low-income countries.39 In Argentina, alcohol ingestion of more than 72 g per day has been reported in 13.2% of the adult population.40 Therefore, some residual effect of this unmeasured confounder may exist in our analysis.

To conclude, this study shows that a combination of preva-

_SLEEP, Vol. 28, No. 9, 2005_
lent snoring, frequently perceived sleepiness, and adoption of risky measures to cope with sleepiness signal a population with significant accident risk. On the other hand, working conditions for long-haul drivers and the association of working conditions with accident risk in Argentina, and probably in other developing countries, represent an unacceptable hazard for road safety and its consequences of severe injuries, enormous healthcare and economic costs and, more importantly, premature death. We must remain committed to identifying simple and reliable instruments to survey large populations of drivers. The challenge is to develop questionnaires adapted to specific groups in order to identify risk factors amenable to intervention. However, our responsibility is also to call the attention of employers and regulatory authorities to improve the working conditions of these highly exposed groups in an attempt to preserve their lives and health, as well as the lives and health of other potential victims involved in a crash.

ACKNOWLEDGEMENTS

We are grateful to our librarian Carla Ragghianti and to Hugo Vidal Fernández from Instituto Superior de Educación Vial.

REFERENCES


