Self-reported circumstances and consequences of driving while sleepy

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Abstract

Driver surveys are indispensable sources of information when estimating the role of sleepiness in crash causation. The purpose of the study was to (1) identify the prevalence of driving while sleepy among Finnish drivers, (2) determine the circumstances of such instances, and (3) identify risk factors and risk groups. Survey data were collected from a representative sample of active Finnish drivers (N = 1121). One-fifth of the drivers (19.5%) reported having fallen asleep at the wheel during their driving career, with 15.9% reporting being close to falling asleep or having difficulty staying awake when driving during the previous twelve months. Epworth Sleepiness Scale scores were found to be associated with both types of sleepiness-related driving instances, while sleep quality was associated only with the latter. Compared to women, men more often reported falling asleep at the wheel during the previous twelve months; the differences were somewhat smaller with respect to fighting sleep while driving. The reported discrepancy in sleepiness-related instances (high prevalence of fighting sleep while driving during the previous twelve months and lower proportion of actually falling asleep) identifies young men (≤25 yrs) as one of the main target groups in safety campaigns. Approximately three-quarters of drivers who had fallen asleep while driving reported taking action against falling asleep before it actually happened. Furthermore, almost all drivers who had fallen asleep while driving offered at least one logical reason that could have contributed to their falling asleep. These data indicate some degree of awareness about driving while sleepy and of the potential pre-trip factors that could lead to sleepiness while driving, and supports the notion that falling asleep at the wheel does not come as a (complete) surprise to the driver.

1. Introduction

Given that official statistics regarding sleepiness-related crashes are often not collected (Horne & Reyner, 1999) or tend to underestimate sleepiness as a causal factor (Åkerstedt,

2000), driver surveys are indispensable sources of information when estimating the numbers of such crashes. In contrast to rare official statistics typically showing low numbers (1-3%) of sleepiness-related crashes, drivers' self-reports often indicate a high prevalence of driving while sleepy and a somewhat higher proportion of crashes related to driver sleepiness.

For example, a study examining sleepy driving incidents in Britain reported that 29% of British men have experienced being close to falling asleep while driving in the last 12 months. Moreover, 7% of the drivers who had crashed attributed it to tiredness (Maycock, 1997). In another study on Norwegian drivers, 27% of participants reported having fallen asleep while driving at least once since starting to drive, with 8.3% reporting falling asleep in the last 12 months. Overall, 3.9% of the participants in the Norwegian study reported that falling sleep (or fatigue) had caused their accident (Sagberg, 1999). Regarding Finnish drivers, one of the few existing sleepy driving studies examined incidents of sleepy driving among a stratified random sample of the adult population in the Finnish city of Tampere. Overall, 15% of the drivers reported an incident in which they had fallen asleep while driving and 1.3% reported having been involved in a 'fatigue-related' crash (Martikainen, Hasan, Urponen, Vuori, & Partinen, 1992).

Driver surveys are not only carried out to estimate the number and proportion of sleepiness-related crashes, but also to reveal risk factors and groups, the circumstances of such driving, driver awareness of associated risks, as well as the use of countermeasures. It has often been reported that men (particularly younger), those suffering from acute sleep loss, and drivers with unrecognized and untreated sleep apnea are at higher risk for sleepiness-related crashes (Horne & Reyner, 1999; Phillips & Sagberg, 2013).

Excessive daytime sleepiness, an important sign or criterion for many medical conditions including sleep apnea, narcolepsy, etc., has been found to correlate with the likelihood of falling asleep while driving. The nine-item Epworth Sleepiness Scale (ESS), an inexpensive and easily administered self-report measure of daytime sleepiness, has been frequently used in traffic safety research (Carter, Ulfberg, Nyström, & Edling, 2003; Howard et al., 2004; Maycock, 1997; Powell, Schechtman, Riley, Li, & Guilleminault, 2002). An even shorter one-question measure concerning global dissatisfaction with sleep (GSD) has also been used (Ohayon & Zulley, 2001).

Regardless of whether those suffering from excessive daytime sleepiness are aware of their condition, it is unlikely that they would fall asleep while driving without experiencing sleepiness before actual falling asleep (e.g., Reyner & Horne, 1998; Williamson, Friswell, Olivier & Grzebieta, 2014). This might not be the case only for those suffering from serious sleep disorders such as narcolepsy: all drivers experience increased sleepiness before falling asleep at the wheel; however, these signs of sleepiness might not be recognized as serious enough. In general, driving while sleepy might not be considered a particularly risky driving behavior. Driver sleepiness is not typically rated as a critical risk factor for crashes (Pennay, 2008; Vanlaar, Simpson, Mayhew, & Robertson, 2008). The behaviour of some drivers seems to mirror this perception, as 73% of drivers in a Norwegian study stated they continue to drive even when aware of their increasing sleepiness (Nordbakke & Sagberg, 2007). Furthermore, drivers quite often act inappropriately by applying ineffective countermeasures such as opening a window or listening to music (e.g., Dawson, 2005; Maycock, 1997; Nordbakke & Sagberg, 2007). Even taking a rest break might not be as effective a countermeasure to reduce sleepiness (e.g., Phipps-Nelson, Redman, & Rajaratnam, 2011; Watling, Smith, & Horswill,

2014) as many drivers believe (Armstrong, Obst, Banks, & Smith, 2010; Nordbakke & Sagberg, 2007).

The purpose of this study was to (1) identify the prevalence of driving while sleepy among a representative Finnish driving population, (2) determine the circumstances of such instances, and (3) identify risk factors and risk groups. The primary motivation for the study was the lack of information, based on a representative Finnish sample, regarding the circumstances and consequences of driving while sleepy.

2. Method

The data for the study were gathered as a part of the annual driver survey of the Central Organization for Traffic Safety in Finland (Liikenneturva). The Finnish market research company TNS Gallup was responsible for the data collection. From the stratified (age, sex and municipality) initial sample (N=1563) of Finnish adults, only persons who drove a motor vehicle at least a few times per year (N=1126) were included in the study. These individuals were interviewed face-to-face. Five subjects were later excluded due to a large number of missing values, leaving for the statistical analysis 1121 drivers who had as least sometimes driven a motor vehicle.

The questionnaire was divided into two parts. The first included general background questions concerning driving exposure, work situation and attitudes toward traffic law enforcement, as well as the Epworth Sleepiness Scale (Johns, 1991) and a question about sleep quality. The latter was based on the GSD question (Ohayon, 1995) and can be found in the appendix. All participants were asked to answer these questions. Participation in the second part of the

questionnaire depended on the responses to the following two questions (1) Have you fallen asleep while driving during the previous 12 months? (2) Have you been close to falling asleep or have you found it difficult to stay awake while driving during the previous 12 months? Those who positively answered either question were asked several additional questions regarding the circumstances of the most recent event (if they had experienced more than one of these events). In most cases, the drivers were first allowed to answer the questions in their own words, and then wrote more structured answers on a paper card (e.g., reasons for falling asleep at the wheel).

The full report (in Finnish with an English abstract) based on this survey was published earlier (Radun & Radun, 2008). From this extensive questionnaire only questions regarding drunk driving have been analyzed and published in English (Radun, Summala, & Radun, 2009; Radun et al., 2014).

A binary logistic regression was the main statistical test used for testing univariate and multivariate associations.

3. Results

3.1. Prevalence and consequences of driving while sleepy

Every fifth (19.5%) driver reported falling asleep while driving at some point during their driving career, with 15.9% reporting having being close to falling asleep or having difficulty staying awake while driving during the previous 12 months. Compared to the instances of being close to falling asleep, the consequences of actually falling asleep were more serious (Table 1) in terms of unintentional departure from the correct driving lane (66.6% vs. 15.2%) as well as crashes (7.8% vs. 1.1%). Altogether 19 people (17 who fell asleep while driving during their driving career and two who were close to falling asleep within the previous 12 months; Table 1) reported sleepiness-related crashes. Therefore, at least 1.7% of our sample of 1121 drivers reported having a sleepiness-related crash.

- please insert Table 1 about here -

3.2. Risk factors and groups

Compared to women, men more often reported falling asleep at the wheel (25.7% vs. 12.5%) and the difference in reporting difficulty staying awake while driving during the previous 12 months pointed in the same direction (17.9% vs. 13.6%) although marginally significant in univariate logistic regression (Figure 1 and Table 2).

In the multivariate analysis, gender differences persisted regarding falling asleep at the wheel. On the other hand, age was a significant predictor for both of the dependent variables in the univariate and multivariate analyses (Table 2). Figure 1 shows that more than 30% of middle-aged men reported falling asleep at the wheel. The youngest group of men reported far fewer instances of falling asleep while driving during the previous twelve months, even though they

reported a high prevalence of fighting sleep. The ESS was also a strong predictor for both dependent variables in the univariate and multivariate analyses, whereas the sleep quality question lacked predictive power in the multivariate model with falling asleep at the wheel as the dependent variable. Yearly mileage was positively associated with difficulty staying awake while driving during the previous 12 months.

- please insert Figure 1 about here -

- please insert Table 2 about here -

3.3. Countermeasures taken and reasons behind sleepiness-related incidents

Among the 219 drivers who had fallen asleep while driving during their driving career, 162 (74%) reported taking action against falling asleep. Just over half of these drivers (53.1%) stopped to take a break; among these, more than half went for a walk, one-third drank coffee, and one-fifth took a nap. The remaining drivers (46.9%) who continued to drive despite fighting sleepiness chose to implement an in-vehicle countermeasure. The most frequent of such actions were opening a window for fresh air (59.2%), increasing the volume of the radio/music (35.5%), talking to a passenger (11.8%), singing (11.8%), and smoking (10.5%).

Almost all drivers offered at least one reason that, according to them, contributed to their sleepiness-related incident (Table 3). The reasons are grouped into four different types. It can be seen that sleepiness-related factors were the most commonly cited for both types of

sleepiness-related incidents. The duration of sleep as well as the situational factor of being on a long drive were reported as the most frequent individual contributing factors.

- please insert Table 3 about here -

3.4. Drivers' perceptions of general crash causal factors

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Fatigue was rated as the third most important causal crash factor, behind alcohol and speeding, when considering only the *very important* category of factors, and behind alcohol and driver inattention when taking into account all answers (Table 4). A binary logistic regression was run to examine the associations between age and sex for rating fatigue as a causal crash factor (very important category vs. others). A statistically significant effect of age (Wald's χ^2=12.47, df=5, $p<0.05$) was found, while sex was significant only through its interaction with age (Wald's χ^2=17.67, df=5, $p<0.01$). The model fit was not improved by the inclusion of the following variables: ever falling asleep while driving and/or having been close to falling asleep while driving during the previous 12 months. This interaction can be seen in Figure 2, with the two oldest groups of men less frequently citing fatigue as a very important crash causal factor than any other group of drivers.

- please insert Figure 2 about here -

4. Discussion

As in many earlier studies, driver self-reports once again indicated a high prevalence of falling asleep at the wheel at least once during one's driving career (19.5% of all participants;

25.7% of men and 12.5% of women). The self-reported instances of recent problems in maintaining wakefulness while driving were similarly high (15.9% of all participants; 17.9% of men and 13.6% of women).

Two years after the current data had been collected, the same organization (Liikenneturva) conducted another driving survey study on a comparable representative sample of Finnish drivers. The subsequent study used the exact same question regarding recent problems in maintaining wakefulness while driving. Interestingly, this time 24% of respondents (27% of men and 21% of women) reported such problems (Rajalin & Pöysti, 2011), an increase of a little above of 50%.

In 2010, a new survey was again conducted by the same organization, however this time with a slightly different question (Have you fallen asleep or been close to falling asleep while driving during the previous 12 months?) and with different pre-defined answers. (While in the two previous surveys respondents were asked to answer simply yes or no, in this survey the answers were give on a five-point scale ranging from never to often.) Even more respondents (28%; 34% of men and 21% of women) answered this new question positively (Nordic Road Safety Council, 2010).

We are unaware of any (significant) change in sleeping and driving habits among Finnish drivers between the surveys (i.e., 2007- 2010) that could explain this increase. Certainly, the data are not fully comparable, as the question in 2010 was different from those in the two previous surveys. Nevertheless, the 50% increase between 2007 and 2009 is quite large. It is possible that increased attention in the media on driving while sleepy had made some respondents *better* at recognizing and recalling instances of being sleepy while driving.

Alternatively, the greater media attention could have contributed to the likelihood of "a good subject effect" (Orne, 1962). However, given that the main theme in our 2007 survey was driver sleepiness while only some sleepiness-related questions were included in the 2007 and 2010 surveys, there is no reason to expect that a good subject effect occurred and was responsible for the observed increase. Finally, we cannot fully exclude the possibility that different sampling methods and the resulting different samples are behind these reported numbers.

Quite different changes over time in the proportions of drivers reporting falling asleep at the wheel were made evident in a series of surveys conducted on random samples of crash-involved drivers in Norway (Phillips & Sagberg, 2013). While the proportion of not-at-fault crash-involved drivers reporting falling asleep at some point during their driving careers was quite similar over an 11-year period (29, 23 and 27 per cent in 1997, 2003 and 2008, respectively), this was not the case for such instances occurring during the preceding twelve months (8.3, 5.8 and 2.9 per cent in 1997, 2003 and 2008, respectively). The authors were themselves surprised and puzzled by this dramatic change, and were unable to offer a conclusive explanation for it. There had been a significant change in response rates (28, 29.7 and 18.5 per cent in 1997, 2003 and 2008, respectively), but that was not seen as a likely reason .

The results of the present study also suggest that at least 1.7% of Finnish drivers had experienced a sleepiness-related crash. It should be stressed here that this is a proportion of the whole Finnish active driving population, not crash-involved drivers only. More precisely, 1.5% reported crashing because of falling asleep at some point during their entire driving career and an additional 0.2% reported a crash while fighting sleep at the wheel during the last

12 months. The figure (1.3%) reported in an earlier Finnish study is not fully comparable as the study included only one Finnish town and focused on fatigue-related crashes rather than those caused by falling asleep (Martikainen et al., 1992). International comparisons are even more difficult mainly because there are no many data sets collected from samples representative of the general driving populations. Unfortunately, even a recent large European survey (19 countries) about sleepiness at the wheel also failed to obtain representative samples (Goncalves et al., in press). Nevertheless, some data exist; for example, 2.8% of drivers in New York State, U.S.A, had ever crashed because of falling asleep (McCartt, Ribner, Pack, & Hammer, 1996); 0.6% of Ontario drivers, Canada, reported having a crash during the previous year because they fell asleep or nodded off (Vanlaar et al., 2008), and in France 0.3% drivers reported sleep-related driving accidents during the previous year (Sagaspe et al., 2010). Other problems for direct comparisons arise from the usage of different terms (fatigue, sleepiness, drowsiness, falling asleep) and time frames (one, two or three years, or ever). In conclusion, obvious issues emerge when estimating the prevalence of driving while sleepy and sleepiness-related crashes based on driver self-reports, and this should be kept in mind when making time and cross-cultural comparisons.

Similar to previous studies (e.g., Hanning & Welsh, 1996; Beirness, Simpson & Desmond, 2004), women less often reported falling asleep at the wheel compared to men (Figure 1 and Table 2). Women are known to cause only a small proportion of sleepiness-related crashes (Horne & Reyner, 1995). Two reasons for this are often mentioned in the literature. The first is exposure to risk, which might be higher among men because they generally drive more frequently, for longer durations and more often at night. The second relates to the possibility that women are more aware of sleepiness-related driving impairment and the associated risks (Barret, Horne & Reyner, 2004; Obst, Armstrong, Smith, & Banks, 2011) as they are more

risk-perceptive of dangerous driving behavior in general (Rhodes & Pivik, 2011). However, our data show that when asked to estimate the importance of driver fatigue as a cause of crashes, the difference between men and women is obvious in only the two oldest groups of drivers (Figure 2). This could be due to older male drivers' having greater perceived control of their driving (Windsor, Anstey, & Walker, 2008). Perceptions of one's own driving ability can influence perceptions of risk (Matthews & Moran, 1986). We also found that these differences between men and women were not moderated by self-reported recent problems with sleepiness while driving. Thus, the importance of driver fatigue as a cause of crashes could be dependent on several factors (e.g., overall risk perceptions, driving history, etc.) not just recent problems with sleepiness while driving.

Young men are one of the groups of drivers most at risk for sleepiness-related crashes (Horne & Reyner, 1995). The results of the present study show that among men, the youngest group (less than 25 years old) actually reported the fewest incidents of falling asleep at the wheel (Figure 1 and Table 2). However, given that this group reported more occurrences of being close to falling asleep in the previous 12 months, it is likely that some of these individuals might actually fall asleep while driving in the near future. This designates such drivers as a target for safety campaigns aimed at reducing sleep-related crashes. Recent work suggests that risk perception and motivation to drive while sleepy could be important factors associated with continuing to drive while sleepy among younger drivers (Watling, Armstrong, Obst, & Smith, 2014).

One of the study's main findings was the utility of the ESS and its association with both of the dependent variables in the logistic regressions. Specifically, the increasing ESS values were

associated with an increasing odds ratio of ever having fallen asleep while driving and being close to falling asleep in the previous 12 months. The study's ESS results are consistent with earlier research (Carter, Ulfberg, Nyström, & Edling, 2003; Howard et al., 2004; Maycock, 1997; Powell, Schechtman, Riley, Li, & Guilleminault, 2002). Sleep quality was also associated with the dependent variable of being close to falling asleep in the previous 12 months but was not associated with ever having fallen asleep. The differences between the two measures and their relationship to the dependent variables could be due to the sleep quality question assessing shorter-term, more immediate problems with sleep, whereas the ESS was assessing daytime sleepiness over a longer period of time (Johns, 1991). Nonetheless, the utility of both measures and their association with sleepiness-related incidents is supported by the current data.

The finding that three-quarters of the drivers who had fallen asleep took action against it, and that almost all drivers offered at least one valid reason contributing to their sleepiness-related incident, indicate some degree of awareness about experiencing increased sleepiness before actually falling asleep at the wheel (Horne & Baulk, 2004). However, it is well known that many drivers may fail to recognize the seriousness of the situation (Horne & Reyner, 2001) because the symptoms of sleepiness are considered trivial (Dinges, 1995). Some drivers also tend to neglect these symptoms due to being generally less aware about sleepiness and its associated risks as well as highly motivated to reach their destinations (Kaplan, Itor, & Dement, 2008). General awareness about fatigue as a risk factor was reasonably high in our sample: 57.2% of the drivers rated fatigue as a very important factor contributing to road crashes. However, 88.8% rated alcohol as a very important factor, considerably more than for fatigue. Furthermore, in North Carolina, U.S.A., 74.1% of non-crash drivers and 84.5% of those involved in sleepiness-related crashes rated fatigue as very important factor in motor

vehicle crashes (Stutts, Wilkins, & Vaughn, 1999), which is again much higher than in our Finnish sample.

Drivers also quite often apply only brief or otherwise ineffective countermeasures (e.g., Dawson, 2005; Maycock, 1997; Nordbakke & Sagberg, 2007). "Taking a break" is one of the recommendations of safety campaigns and is incorporated in professional drivers' regulations. More than half of our drivers reported doing so before falling asleep while driving. However, it is not sufficient, as recent driver simulator studies show that breaks have only a transient effect on sleepiness (Phipps-Nelson, Redman & Rajaratnam, 2011; Watling, Smith, & Horswill, 2014). Taking a break has actually be seen as an extenuating circumstance for a driver who falls asleep and causes a crash (Finnish Supreme Court decision no. 1998:124; discussed in Radun et al., 2009). Clearly, even those who apply the most effective countermeasures, such as taking a nap (19 of the 219 drivers in our study who reported falling asleep), are not completely safe. It must be noted that countermeasures are aimed at reducing the risk of a sleep-related crash; they cannot eliminate it. Stopping and going to sleep is sometimes the only option.

The present study has certain limitations. As with any survey study, the results have possibly been influenced by recollection problems and social desirability bias. Another limitation relates to the small number of available predictors in the logistic regression models. For example, the survey data contained no information about lifetime mileage. Finally, as the data were collected in face-to-face interviews, the participants verbally responded to the ESS, which is different from the validated administration of this scale. Furthermore, it should not be forgotten that when using an ESS score to predict the likelihood of falling asleep while driving a certain degree of "contamination" exists (Maycock, 1997). In other words, the

ESS's situation eight (Chance of dozing "in a car, while stopped for a few minutes in traffic") might measure the same thing as "Have you ever fallen asleep while driving?"

In conclusion, this study shows a high prevalence of driving while sleepy among Finnish drivers. It also identifies the ESS as a strong predictor of sleepy driving episodes, and provides further evidence of driver awareness of increased sleepiness before actually falling asleep at the wheel. This awareness is relevant for legal implications regarding drivers who fall asleep while driving. As we have earlier noted, "from a legal standpoint it is crucial whether or not a driver falls asleep without any warning, and if there is one, whether or not he or she consciously decides to ignore the warning signs and continues to drive, knowing that such an action is endangering traffic safety" (Radun et al., 2013). Improving drivers' attitudes regarding the dangerousness of driving while sleepy, as well as their actual behaviors, are important objectives and can lead to a safer road environment for all drivers.

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Appendix

Sleep quality question: "How do you rate your sleep in general?"

1. I sleep well

2. Occasionally I do not sleep well, but I am generally happy about my sleep

3. My sleep has already caused me problems, I think I have a problem with my sleep

4. I sleep badly

5. I sleep very badly

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Table 1. Consequences of sleepiness-related driving instances

		Crossing the centerline	***Crossing the edge line***	***Other***	***Cannot recall***	***Total***
Fell asleep	Crash	6 (10.7%)	11 (12.2%)	0 (0%)	0 (0%)	17 (7.8%)
while driving	No crash	50 (89.3%)	79 (87.8%)	71 (100%)	2 (100%)	202 (92.2%)
(ever)	**Total**	**56 (25.6%)**	**90 (41.1%)**	**71 (32.4%)**	**2 (0.9%)**	**219 (100%)**
Being close to	Crash	0 (0%)	1 (5.9%)	1 (0.7%)	0 (0%)	2 (1.1%)
falling asleep	No crash	10 (100%)	16 (94.1%)	146 (99.3%)	4 (100%)	176 (98.9%)
(12 months)	**Total**	**10 (5.6%)**	**17 (9.6%)**	**147 (82.6%)**	**4 (2.2%)**	**178 (100%)**

Table 2. Logistic regression models for predicting sleepiness-related instances

		EVER falling asleep while driving: 19.5%		***Being close to falling asleep while driving in previous 12 MONTHS; 15.9%***	
		Univariate	Model	Univariate	Model
	%	Odds ratio (95% CI)	Odds ratio (95% CI)	Odds ratio (95% CI)	Odds ratio (95% CI)
SEX		**p<0.001**	**p<0.001**	**P=0.052**	p>0.05
Woman (ref.)	46.6				
Man	53.4	2.43 (1.77-3.34)	2.60 (1.86-3.65)	1.38 (0.99-1.91)	
AGE		**P=0.061**	**p<0.01**	**p<0.01**	**p<0.01**
≤25 (ref.)	17.8				
26-35	18.5	1.98 (1.18-3.31)**	2.47 (1.43-4.28)**	0.74 (0.46-1.21)	0.68 (0.39-1.17)
36-45	16.1	1.88 (1.10-3.21)*	2.43 (1.38-4.30)**	0.87 (0.53-1.44)	0.69 (0.39-1.22)
46-55	16.3	1.90 (1.11-3.23)*	2.33 (1.32-4.12)**	0.92 (0.56-1.51)	0.78 (0.45-1.36)
56-65	17.8	1.31 (0.76-2.27)	1.35 (0.74-2.45)	0.54 (0.31-0.92)*	0.46 (0.25-0.84)*
≥66	13.6	1.30 (0.73-2.34)	1.47 (0.78-2.79)	0.18 (0.08-0.41)***	0.21 (0.09-0.51)**
Sleep quality (higher score, worse quality)		P=0.059	p>0.05	**p<0.01**	**p<0.01**
1 (ref.)	47.9				
2	37.0	1.28 (0.92-1.77)		1.45 (1.01-2.07)*	1.44 (0.98-2.13)
3-5	15.1	1.62 (1.07-2.46)*		2.00 (1.29-3.11)**	2.33 (1.42-3.82)**
ESS		**p<0.001**	**p<0.001**	**p<0.001**	**p<0.01**
0-3 (ref.)	33.0				
4-6	30.6	1.54 (0.99-2.37)	1.58 (1.02-2.47)*	1.83 (1.16-2.88)**	2.00 (1.23-3.25)**
7-9	22.4	2.69 (1.75-4.15)***	2.77 (1.77-4.33)***	1.98 (1.22-3.19)**	2.02 (1.22-3.36)**
10-13	12.2	3.72 (2.28-6.05)***	4.16 (2.51-6.90)***	3.19 (1.89.5.38)***	3.36 (1.91-5.92)***
≥14	1.8	7.78 (3.06-19.82)***	7.83 (2.99-20.53)***	5.00 (1.87-13.36)**	5.81 (1.92-17.62)**
Missing-29cases					
YEARLY MILEAGE (km)		**p<0.001**	p>0.05	**p<0.001**	**p<0.001**
≤1000 (ref.)	7.1				
1001-5000	15.5	1.59 (0.65-3.87)		0.84 (0.32-2.20)	0.98 (0.37-2.64)

5001-10000	24.1	2.25 (0.98-5.21)		1.20 (0.50-2.87)	1.43 (0.58-3.52)
10001-20000	29.7	2.73 (1.20-6.21)*		2.16 (0.94-4.93)	2.63 (1.12-6.19)*
20001-30000	11.8	4.24 (1.79-10.05)**		2.44 (1.00-5.94)*	2.95 (1.17-7.45)*
30001-50000	7.5	2.65 (1.03-6.81)*		4.71 (1.91-11.64)**	6.04 (2.36-15.47)***
≥50001	4.2	4.91 (1.82-13.23)**		5.95 (2.23-15.85)***	5.88 (2.10-16.47)**
Missing-27cases					
JOB		**p<0.05**	p>0.05	**p<0.001**	p>0.05
Outside working life (ref.)	35.0				
Full time	48.8	1.61 (1.15-2.26)**		2.42 (1.63-3.60)***	
Part time	10.5	1.13 (0.65-1.97)		2.08 (1.16-3.71)*	
Unemployed	5.6	1.88 (1.00-3.54)*		1.81 (0.85-3.86)	
Unpaid vacation 2 cases					
Valid cases			1092 (97.4%)		1065 (95.0%)
Positive cases			212 (19.4%)		169 (15.9%)
Model Specificity			98.3%		99.0%
Model Sensitivity			7.5%		5.9%
Model overall prediction			80.7%		84.2%

Table 3. Drivers' perceptions of contributing factors to their sleepiness-related incidents

	EVER falling asleep while driving (N=219)	***Being close to falling asleep in previous 12 months (N=178)***
Sleepiness-related factors	**161 (73.5 %)**	**118 (66.3%)**
Little sleep the previous night	72 (32.9%)	62 (34.8%)
Little sleep during the previous several nights	37 (16.9%)	35 (19.7%)
Being awake for a long period of time	62 (28.3%)	43 (24.2%)
Time-of-day effects (is this a situational factor?)	40 (18.3%)	34 (19.1%)
Tendency to easily fall asleep	11 (5.0%)	4 (2.2%)
Situational factors	**123 (56.2%)**	**99 (55.6%)**
Long drive	72 (32.9%)	63 (35.4%)
Boring, monotonous driving	88 (40.2%)	63 (35.4%)
Alone in the car	65 (29.7%)	43 (24.2%)
Pre-drive activity	**57 (26.0%)**	**35 (19.7%)**
Tiring/stressful day at work	45 (20.5%)	35 (19.7%)
Too much physical activity / physical strain	14 (6.4%)	6 (3.4%)
Ingestion	**19 (8.7%)**	**14 (7.9%)**
Heavy meal before or during the drive	6 (2.7%)	8 (4.5%)
Alcohol ingestion during the previous 24 hours	9 (4.1%)	3 (1.7%)
Use of medication	4 (1.8%)	2 (1.7%)
Number of drivers who gave at least one reason	**213 (97.3%)**	**167 (93.8%)**

Table 4. Perceived importance of different factors in causing motor vehicle crashes

	Alcohol	*Speeding*	*Fatigue*	*Driver inattention*	*Poor weather conditions*	*Aggressive driving*	*Driver inexperience*
Very important	996 (88.8%)	713 (63.6%)	641 (57.2%)	620 (55.3%)	577 (51.5%)	522 (46.6%)	480 (42.8%)
Somewhat important	111 (9.9%)	339 (30.2%)	435 (38.8%)	460 (41.0%)	470 (41.9%)	507 (45.2%)	553 (49.3%)
Somewhat unimportant	12 (1.1%)	59 (5.3%)	43 (3.8%)	38 (3.4%)	69 (6.2%)	79 (7.0%)	85 (7.6%)
Very unimportant	2 (0.2%)	9 (0.8%)	1 (0.1%)	1 (0.1%)	4 (0.4%)	7 (0.6%)	2 (0.2%)
Cannot say		1 (0.1%)	1 (0.1%)	2 (0.2%)	1 (0.1%)	6 (0.5%)	1 (0.1%)

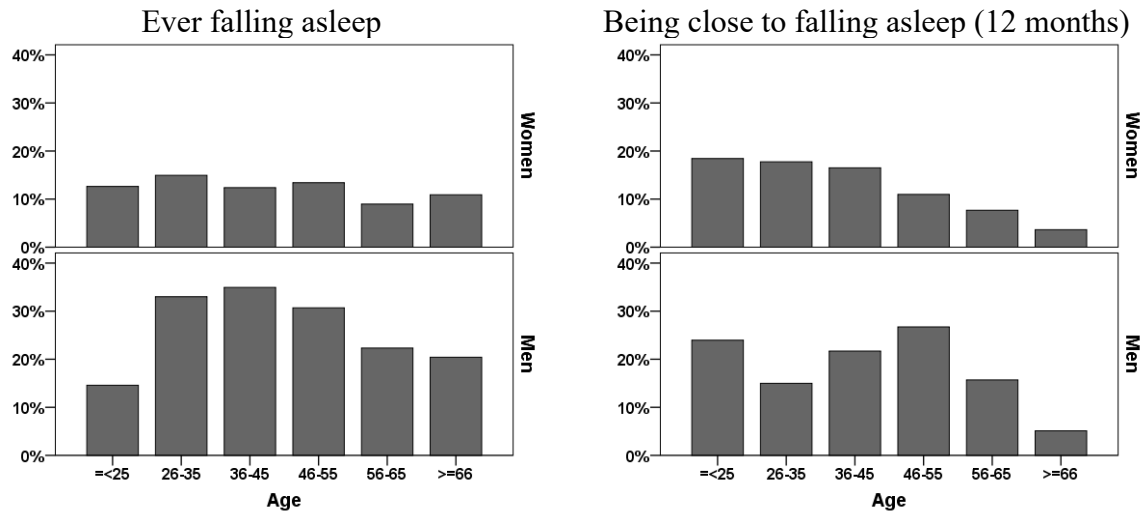

Figure 1. Sleepiness-related instances by age and sex

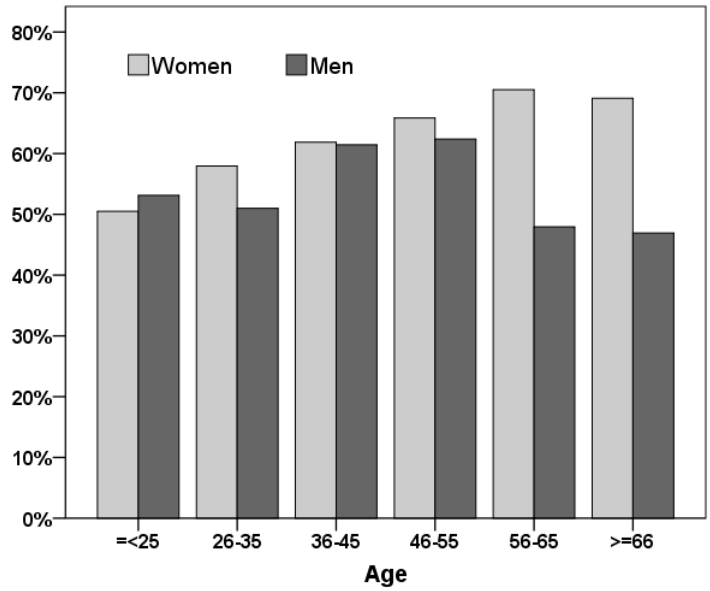

Figure 2. Age, sex and fatigue as a 'very important' factor in causing motor vehicle crashes