

What is already known on this topic

It is government policy in England to reduce substantially the number of people killed or seriously injured on the roads

Non-fatal serious injuries reported through the police fell substantially from 1996 to 2004

What this study adds

The reduction in non-fatal road traffic injuries reported in police statistics probably represents an increase in under-reporting of these injuries, or a reduction in minor injuries, or both

Hospital statistics show that there has been no appreciable reduction in injuries that are serious enough to warrant hospital admission

the police definition includes all hospital admissions, and that the hospital admission figures from HES are higher than the STATS19 figures, means that there must be under-reporting in the STATS19 system (con-

firmed earlier research published for the Department for Transport¹). The findings from hospital admission statistics cast doubt on whether there were reductions in serious road injuries from 1996 to 2004 and on whether the government's targets either overall or for children will be met by 2010. The increase in deaths and serious injuries of motorcyclists requires further investigation in its own right.

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- 1 Department for Transport. *Tomorrow's roads—safer for everyone: the first three year review*. London: Department for Transport, 2004.
- 2 World Health Organization. *European health for all database*. www.euro.who.int/hfad (accessed 16 June 2006).
- 3 Department of Transport/National Statistics. Road accident statistics (STATS19 returns). www.statistics.gov.uk/STATBASE/Source.asp?vlnk=571 (accessed 16 June 2006).
- 4 Simpson HF. *Comparison of hospital and police casualty data: a national study*. Crowthorne: Transport Research Laboratory, 1996 (TRL report 173). (Accepted 1 April 2006)

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Awareness of driving while sleepy and road traffic accidents: prospective study in GAZEL cohort

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Abstract

Objectives To examine the association between self assessed driving while sleepy and the risk of serious road traffic accidents (RTAs).

Design Prospective cohort study.

Setting France.

Participants 13 299 of the 19 894 living members of the GAZEL cohort, workers and recent retirees of a French national utility company followed up since 1989.

Main outcome measures Frequency of driving while sleepy in the previous 12 months, reported in 2001; rate ratios for serious RTAs in 2001-3, estimated by using generalised linear Poisson regression models with time dependent covariates.

Results The risk of serious RTAs increased proportionally with the frequency of self reported driving while sleepy. After adjustment for sociodemographic characteristics, driving behaviour variables, work conditions, retirement, medical conditions and treatments, depressive symptoms, and sleep disorders, the adjusted rate ratios of serious RTAs for participants who reported driving while sleepy in the previous 12 months "a few times" or "once a month or more often" were 1.5 (95% confidence interval 1.2 to 2.0) and 2.9 (1.3 to 6.3) respectively compared with those who reported not driving while sleepy over the same period. These

associations were not explained by any reported sleep disorders.

Conclusions Self assessed driving while sleepy was a powerful predictor of serious RTAs, suggesting that drivers' awareness of their sleepiness while driving is not sufficient to prevent them from having RTAs. Messages on prevention should therefore focus on convincing sleepy drivers to stop driving and sleep before resuming their journey.

Introduction

Published estimates of road traffic accidents (RTAs) attributable to sleepiness range from 3% to 33% according to studies conducted in France,¹ the United States,^{2,3} and Australia.⁴ Little is known about the extent to which drivers are able to assess accurately that they are sleepy while driving.^{2,5} In the 2005 poll of the National Sleep Foundation, 60% of America's adults who drive or have a licence reported that they had driven a motor vehicle when feeling sleepy within the previous year.⁶ A recent survey in France showed that about 6% admitted to having driven while sleepy at least once during the previous three months.⁷ We did a prospective study in a large French cohort to examine the association between self reported frequency of

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driving while sleepy over the previous 12 months and the risk of serious RTAs over the next three years.

Methods

The participants were employees or recent retirees of the French national electricity and gas company. They comprised men aged 40-50 and women aged 35-50 who volunteered to participate in a research cohort (GAZEL).

Materials—We recorded sociodemographic and medical data, including self reported sleep disorders and alcohol consumption,⁸ each year during 2001-3 from the GAZEL cohort questionnaire. We collected data on sleepiness and driving behaviours in 2001 by using a self administered questionnaire. We collected data on accidents in 2001-3 from yearly self administered questionnaires. We followed up reported accidents with a questionnaire about the circumstances, injuries, reasons for the accident, and responsibility of the driver.

Driving behaviour and road safety questionnaire—In 2001, we mailed the driving behaviour and road safety questionnaire to the 19 894 members of the GAZEL cohort.⁸ We assessed driving while sleepy with the question, "In the 12 past months, have you ever driven while sleepy?" (1=never, 2=a few times in the year, 3=about once a month, 4=about once a week, 5=more than once a week). We recorded potential confounders, including drinking and driving, prescribed drugs, and work conditions. We asked them to report their maximum speed in various conditions.

Statistical analysis—We used univariate regression to identify factors associated with reporting driving while sleepy. We then built a multivariate regression model including all factors associated with driving while sleepy (P<20% in the univariate analysis). We built six regression models⁹ with time dependent covariates to estimate the rate ratios of serious RTAs in 2001-3 associated with reported driving while sleepy in 2001 and to test the impact of confounders.

Results

We received responses to the 2001 driving behaviour questionnaire from 14 226 of the 19 894 members of the GAZEL cohort. We excluded 552 participants because of missing data, leaving 13 674 participants (10 480 men; 3194 women). To the question, "In the 12 past months, have you ever driven while sleepy?" 8597 (62.9%) participants responded never, 4917 (36%) a few times in the year, 104 (0.8%) about once a month, 35 (0.3%) about once a week, and 21 (0.2%) more than once a week. See bmj.com for factors associated with the odds of reporting driving while sleepy as determined by logistic regression analysis. Among the 13 299 responding participants, 322 reported one serious RTA, eight reported two serious RTAs, and one reported three serious RTAs in 2001-3.

The table presents results from regression models fitted to estimate the impact of driving while sleepy on the risk of serious RTAs in 2001-3. Compared with participants who reported not driving while sleepy in the previous 12 months, the unadjusted rate ratio in model 1 was 1.6 (95% confidence interval 1.2 to 2.0) for participants who reported having driven while sleepy "a few times in the year" and 3.0 (1.6 to 6.0) for those who reported having done so "once a month or more often." These associations remained largely unchanged when further adjusted for several sets of potential confounders: the corresponding adjusted rate ratios were 1.5 (1.2 to 2.0) and 2.9 (1.3 to 6.3). When we restricted analyses to the subsample of participants who did not report any sleep disorders, the association measures were higher. These strong associations persisted after further adjustment for potential confounders. We estimated the population attributable risk for driving while sleepy as 19.2%.

Examination of the 321 accidents in which the participant was driving showed that the participant was driving a car in 238 cases, a utilitarian vehicle in three cases, a two wheeled motorised vehicle in 19, and a bicycle in 23.

Rate ratios (95% confidence intervals) of serious road traffic accidents in 2001-3 according to frequency of self reported driving while sleepy, determined by generalised linear Poisson regression models*

Participants	Model 1	Model 2	Model 3	Model 4	Model 5	Model 6
All participants						
Self reported frequency of driving while sleepy in 2001:						
Never (n=8597)	1	1	1	1	1	1
A few times in the year (n=4917)	1.6 (1.2 to 2.0)	1.5 (1.2 to 2.0)	1.5 (1.1 to 1.9)	1.5 (1.1 to 1.9)	1.5 (1.1 to 1.9)	1.5 (1.2 to 2.0)
Once a month or more often (n=160)	3.0 (1.5 to 6.0)	3.0 (1.4 to 6.2)	2.9 (1.4 to 6.0)	2.8 (1.3 to 5.8)	2.9 (1.4 to 6.0)	2.9 (1.3 to 6.3)
No of observations used†	37 540	34 854	32 440	32 440	32 426	28 362
Participants without sleep disorders reported or treated in 2001-3						
Self reported frequency of driving while sleepy in 2001:						
Never (n=6679)	1	1	1	–	1	1
A few times in the year (n=3657)	1.6 (1.2 to 2.1)	1.5 (1.2 to 2.0)	1.5 (1.1 to 2.0)	–	1.5 (1.1 to 2.0)	1.6 (1.2 to 2.2)
Once a month or more often (n=96)	4.5 (2.2 to 9.3)	4.7 (2.2 to 9.7)	4.7 (2.2 to 9.8)	–	4.9 (2.3 to 10.3)	4.8 (2.2 to 10.8)
No of observations used†	29 693	28 581	26 620	–	26 612	23 352

*Model 1=unadjusted rate ratios; model 2=rate ratios adjusted for sex (male/female), age (covariate of three categories), occupational category (time dependent covariate of three categories: unskilled workers, skilled workers, managers), and driving mileage per year (time dependent covariate logarithmically transformed); model 3=model 2 + alcohol consumption (five category, time dependent covariate describing quantity and frequency), maximum speed greater than ±10% of legal limits in built-up areas (yes/no), on rural roads (yes/no), and on highways (yes/no), risky use of mobile phone (yes/no), vehicle categories (four categories), and traffic ticket fixing (yes/no); model 4=model 3 + sleep disorder (three category, time dependent covariate: no sleep disorder, sleep disorder, sleep disorder treated); model 5=model 4 + working overtime (never, occasionally, often/always), time constraints at work (never, occasionally, often/always), and working night shifts (never, on occasion, regularly); model 6=model 5 + depressive symptoms in 2002 and use of drugs in 2001 (never, for anxiety, for depression, for other nervous disease, for sleep), medical conditions treated in 2001-3 (none, dental or gum problems, cataract, renal colic or kidney stones, glaucoma, hiatus hernia, gastric ulcers, diabetes); for analysis of participants without sleep disorders reported or treated in 2001-3, no adjustment was made for the sleep disorder variable in models 5 and 6.

†Cumulative person years of observation during three year follow-up.

Discussion

We found a robust association between self assessed driving while sleepy and the risk of serious road traffic accidents in the following three years; the risk increased with reported frequency of driving while sleepy. The association was not modified by a wide range of potential confounders. When we restricted the analysis to the subsample of participants who did not report any sleep disorders in 2001-3, the association was even stronger.

Strengths and limitations

Our results are consistent with previous findings from New Zealand, France, and the United States,^{1 2 10} and they support laboratory simulation studies suggesting that drivers are able to perceive that they are sleepy while driving.⁵ Our study is the only prospective study we are aware of, because participants were from a large cohort followed regularly, we were able to control for a range of potential confounders. Additional analysis did not find any interaction effect with the nature of travel (commuting, professional, or private).

Although self reported measures of risky driving behaviours have been found to have considerable validity in predicting risk of traffic accidents,¹¹ they cannot account for all sleepy driving situations. This lack of accuracy is unlikely to have biased our results. A recent study found that self reported sleepiness when driving was consistent with sleepiness as an independent model based on circadian and sleep factors.¹²

We recorded driving while sleepy and serious RTAs in different time periods, assuming that driving while sleepy is a consistent behaviour over several years. In 2004, we sent a second driving behaviour and road safety questionnaire to the participants to assess changes in drivers' behaviour from the 2001 reports. Comparison of answers between 2001 and 2004 showed a fair stability in terms of driving while sleepy ($\kappa = 0.47, P = 0.008$).

We estimated the population attributable risk for sleepy driving as 19%, a figure consistent with data from a study in New Zealand (19%).¹⁰ Published estimates of the proportion of car crashes attributable to the driver's sleepiness range widely, from 3% to 33%.^{1 2 4 10} Our study sample was not representative of French drivers as a whole. Although people with sleep disorders were more likely to report driving while sleepy, the association between self reported sleep disorders and the risk of serious RTAs seemed to be lower. This suggests that drivers with previous sleep disorders may adopt self regulatory behaviours.

Implications

Our prospective data clearly identified driving while sleepy unrelated to any medical condition as a significant independent factor contributing to serious RTAs, with important consequences for public safety because of the high proportion of drivers concerned.¹⁵ Our results suggest that drivers are aware that they are sleepy when driving but do not act accordingly.¹⁴ Drivers may either underestimate the impact of sleepiness on their driving performance or overestimate their capacity to fight sleepiness.²

The role of policing should consist in developing and implementing national campaigns to promote "sleep hygiene" or how to deal with sleepiness.¹⁵

What is already known on this topic

Retrospective studies suggest that sleepiness in drivers is an important factor contributing to the burden of traffic related morbidity and mortality

What this study adds

Self assessed driving while sleepy is a powerful predictor of serious road traffic accidents

This suggests that drivers are able to accurately assess sleepiness while driving but do not act accordingly

Prevention programmes should also include building or improving rest areas and installing shoulder rumble strips. In addition, legislative or regulatory initiatives should be discussed,¹⁶ even if appropriate tools to measure drivers' sleepiness are still to be developed. Finally, development and evaluation of in-vehicle systems that can detect a sleepy driver should also be promoted.

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