Driver sleepiness and the risk of car crash injuries : The Auckland Car Crash Injury Study

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The Auckland Car Crash Study (ACCIS) has been undertaken as a response to the shortage of reliable information about causal factors for car crash injuries, other than alcohol, speed and seatbelt usage. It aims to identify potentially modifiable risk factors for car crashes that produce serious injuries and assess the contribution of different factors to the burden of injury. The study has measured a range of driver, vehicle and environmental factors, and driver sleepiness is the first major factor to be analysed.

Although driver sleepiness is considered a significant risk factor for car crash injuries, international estimates of the proportion of crashes and burden of injury attributable to driver sleepiness vary from 1-25%. This variation reflects uncertainty about both the prevalence of sleepiness in car drivers and the risk that this confers. Previous research has generally involved unrepresentative samples of drivers, and most studies have investigated the effects of sleep disorders on crash risk rather than the effect of sleepiness in general.

This study aimed to 1. measure the risk of a crash resulting in hospitalisation or death of a car occupant that is associated with driver sleepiness, and 2. determine the proportion of crashes attributable to driver sleepiness in the Auckland region.

This study is unique in a number of ways. The whole driving population of the Auckland region has been studied. We compared all drivers involved in crashes resulting in the hospitalisation or death of a car occupant, with drivers from a representative sample of driving time on Auckland region roads. The study has used a range of indicators of acute and chronic sleepiness, and measured behaviours known to be associated with decreased alertness. It has simultaneously measured the factors which affect the relationship of sleepiness with crash risk (confounders) such as age, gender, alcohol and other drugs, mileage, speed of traffic and socioeconomic status, so that they can be taken into account.

This is the first time that a study like this has been undertaken in NZ and as far as we are aware, it is the first of its kind in the world.

Study design:
In this *population-based case-control study*, we found the cases by identifying all car crash injury hospitalisations and deaths in the region over the study period, as they happened. We interviewed the driver in hospital if injured, by phone if discharged home or uninjured, or interviewed a proxy if the driver died. We also reviewed medical records, including blood alcohol information and carried out an environmental survey at the crash site, which included traffic volume and speed.
The control drivers were sampled to represent the total amount of driving on the roads in the region during the same time period. Sites on the region's road network were randomly selected and drivers were recruited at roadside surveys at random

times of the day and night where they were also breathalysed. They were interviewed by telephone over the next day or two. Environmental surveys were also conducted at these recruitment sites.

Measures of sleepiness:
The participant's interview included the Stanford Sleepiness Scale, which measures level of alertness at the time of crash or survey, and the Epworth Sleepiness Scale, which determines the driver's usual level of daytime alertness or chronic sleepiness. Information was gathered on hours of sleep and sleep patterns immediately before the crash/survey and usual patterns of sleep. Work patterns including shift work, symptoms of sleep disorders and the time of day of the crash/survey were also included.

Results:
There were 615 cars identified during the study period in which at least one occupant was hospitalised or killed, with 683 non-fatal admissions and 63 deaths. 93% of these drivers or their proxies took part in the study. 588 drivers of the randomly sampled control vehicles participated (79%).

The vast majority (>90%) of car driving was unimpaired by sleepiness as measured by the Stanford Sleepiness Scale or the Epworth Sleepiness Scale.

There was a strong and consistent relationship between measures of acute sleepiness and the risk of serious injury crashes.

- Driving with 5 hours sleep or less in the last 24 hours almost tripled the risk of an injury crash (RR = 2.85)
- Driving while feeling sleepy ("feeling a little foggy headed" or worse) was associated with nine times the risk of driving at your most alert, or nearly 7 times the risk of driving when you feel relaxed (RR= 6.75).
- Driving between 2am and 5 am increased risk more than five-fold (RR= 5.61).

In contrast to these findings none of the measures associated with chronic sleepiness were found to be associated with a significant increase in risk of a serious injury crash.

The driver characteristics associated with increased risk of injury crashes were driving with 5 or less hours sleep in the last 24 hours, and driving with a Stanford Sleepiness Score of 4 or more, where 4 is the statement "feeling a little foggy-headed". These drivers represent only a small proportion of the total driving in the region, but the effect of the increase in risk in this small proportion means that about 9% of crashes involving hospitalisation or death of a car occupant can be attributed to driver sleepiness, and specifically these two behaviours.

For the first time this gives us a reliable quantitative estimate of the burden of car crash injury due to sleepiness and the specific behaviours that need to be targeted in order to reduce this burden. We can be confident that these estimates are relevant to our population because they have been derived locally in a representative way.

This information can be used to inform the development and prioritisation of interventions to reduce injuries. Although the effect of driver sleepiness is not of the same magnitude as alcohol, speed and seatbelt usage it is nevertheless a very significant and potentially modifiable contributor to car crash injury in our population. Driver education, and employer education, will be necessary to effect changes in behaviour and the challenge will be to get these simple messages across effectively.