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Sleep-related crash characteristics: Implications for applying a fatigue definition to crash reports

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ABSTRACT

Sleep-related (SR) crashes are an endemic problem the world over. However, police officers report difficulties in identifying sleepiness as a crash contributing factor. One approach to improving the sensitivity of SR crash identification is by applying a proxy definition post hoc to crash reports. To identify the prominent characteristics of SR crashes and highlight the influence of proxy definitions, ten years of Queensland (Australia) police reports of crashes occurring in ≥ 100 km/h speed zones were analysed. In Queensland, two approaches are routinely taken to identifying SR crashes. First, attending police officers identify crash causal factors; one possible option is 'fatigue/fell asleep'. Second, a proxy definition is applied to all crash reports. Those meeting the definition are considered SR and added to the police-reported SR crashes. Of the 65,204 vehicle operators involved in crashes 3449 were police-reported as SR. Analyses of these data found that male drivers aged 16–24 years within the first two years of unsupervised driving were most likely to have a SR crash. Collision with a stationary object was more likely in SR than in not-SR crashes. Using the proxy definition 9739 (14.9%) crashes were classified as SR. Using the proxy definition removes the findings that SR crashes are more likely to involve males and be of high severity. Additionally, proxy defined SR crashes are no less likely at intersections than not-SR crashes. When interpreting crash data it is important to understand the implications of SR identification because strategies aimed at reducing the road toll are informed by such data. Without the correct interpretation, funding could be misdirected. Improving sleepiness identification should be a priority in terms of both improvement to police and proxy reporting.

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1. Introduction

Every year driver fatigue or sleepiness is responsible for countless crashes the world over (Akerstedt, 2000). Using a case controlled approach the population attributable risk for driving when sleepy is reported to be 19%, meaning that cessation of all driving when sleepy would result in a 19% decrease in the total number of crashes (Connor et al., 2002). The impact of such crashes for those involved can be devastating, as sleep-related (SR) crashes are highly likely to be fatal or to result in serious injury (Connor et al., 2002). However, there are several barriers faced by road safety authorities, each of which makes reducing the prevalence of driver sleepiness a difficult problem to address. For example, when compared to other causes of driving impairment such as alcohol and drugs, SR impairment can be hard to identify. Enforcement officers report difficulty

in identifying driver fatigue (Radun et al., 2013). This is influenced both by a lack of objective and reliable tests for sleepiness analogous to those available for alcohol or drugs (Pack et al., 1995), but also through deficiencies in officer training in the identification of SR crashes (Radun et al., 2013). The number of reported SR crashes is underestimated within crash data (Akerstedt, 2000). Some road safety authorities address this issue by using proxy definitions of fatigue to supplement police reporting.

Proxy definitions are designed to be applied to all police-reported crashes as part of a post hoc analysis to improve the sensitivity of SR crash identification. The Australian Transport Safety Bureau (ATSB) has developed a recommended proxy definition, and five of the eight Australian jurisdictions have incorporated their own proxy definition into standard practices. Within Queensland, Australia, the attending police officer is responsible for identifying the causes of any crash; as part of this process officers have the option of attributing one of the causes to 'fatigue/fell asleep'. There is currently no standard methodology for identifying 'fatigue/fell asleep' as a crash causal factor. All roadside police officers attend a basic crash investigation course as part of

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their training. In the event of a serious incident (fatal or serious injury) trained crash investigators from the Forensic Crash Investigation unit will attend. These officers specialise in identifying crash causal factors and will take steps beyond roadside investigation (e.g. checking shiftwork rosters, telephone records and bank statements) to identify how long a person has been awake and driving for, if they suspect fatigue. To supplement this, the Queensland proxy definition is applied post hoc by the State Government Department of Transport and Main Roads. This definition states that sleepiness is a contributing factor in all single-vehicle crashes in ≥ 100 km/h speed zones which occur between 2 pm to 4 pm and 10 pm to 6 am, or where a vehicle leaves the roadway with the driver not attempting to avoid the crash. The process of applying a proxy definition is a desk-based exercise outside of the remit of the police. When reporting fatigue crashes road safety authorities either use police-reported SR crashes alone or use proxy identified in addition to the police-reported SR crashes.

The content of proxy definitions have some grounding in scientific research (e.g. single vehicle run off the road crashes are most likely to be SR (Horne and Reyner, 1995b; Packer et al., 2006)). However, there has been some criticism that proxy definitions are too narrow (Crummey et al., 2008) and that they only capture a specific subset of SR crashes (Armstrong et al., 2013).

Despite their limitations, proxy definitions are being actively used by road safety authorities so it is vital to understand the implications this has on crash statistics. This is particularly important when it is considered that road safety authorities will use crash statistics from their own jurisdictions to inform future investment in road safety. In deciding whether to invest in measures to reduce driver fatigue, road safety authorities are likely to first consider if SR crashes are prevalent in their jurisdiction and second to identify which drivers are most at risk. With such crucial decisions being made based on region-specific data, the implications of how the data is processed and interpreted should be fully understood.

The aim of this paper is twofold: First, to characterise SR crashes in high speed zones (≥ 100 km/h) and the vehicle operators involved in them. Second, to demonstrate the implications of using proxy definitions for estimates of the prevalence and characteristics of SR crashes.

2. Method

2.1. Crash data

Queensland police-reported crashes of motorised vehicles occurring in 'high' (≥ 100 km/h) speed zones between 1st January 2000 and 31st December 2009 were examined. Ten years of crash data provides sufficient scope for identifying general trends, and permits meaningful comparisons between SR and not sleep-related crashes (not-SR). Police crash reports detail all police attended crashes which occur on a public road, and where any of: a person was killed or injured, a vehicle towed, or greater than \$2500 of damage to property other than vehicles was incurred. Crashes resulting from medical conditions and deliberate acts are excluded. Police crash reports detail vehicle operator characteristics and crash characteristics, as well as crash causal factors identified by the reporting Queensland Police Services (QPS) officer.

2.2. Sleep-related classification

Three analysis approaches were taken to the classification of SR crashes.

First, all crash reports where the contributory factor "fatigue/fell asleep" was noted by the police officer were classified as SR. The remainder of the crash reports were classified as not-SR.

Second, all crash reports regardless of police officer classification were subject to the Queensland proxy definition of fatigue. Following the Queensland proxy definition, all crashes in ≥ 100 km/h zones which occur between 2 pm to 4 pm and 10 pm to 6 am, in which a single vehicle was involved, or where the vehicle leaves the roadway with the driver not attempting to avoid the crash, were classified as SR. The remainder of the crash reports were considered as not-SR.

Finally, all crash reports with either a police or proxy classification of SR were considered to be SR. The remainder of the crash reports were considered as not-SR. This approach is commonly taken by road authorities who use proxy definitions.

2.3. Statistical analysis

Examination of vehicle operator and crash characteristics was undertaken to identify any significant differences between SR and not-SR crashes. A range of characteristics were considered, those most interesting in terms of differences between SR and not-SR are reported in the current paper. Characteristics not presented include: vehicle type, number of occupants, lighting conditions, atmospheric conditions and road surface conditions. Categorical data were analysed using Chi-square (χ^2) tests with Cramer's V (ϕ_c) as an estimate of effect size. As suggested by Aron (2012), a Cramer's V of less than .10 was considered to be a small effect size, between .10 and .30 moderate, and more than 0.30 a large effect size. Analysis was undertaken three times following three different methods of identify SR crashes: (1) police-reported; (2) proxy definition; and, (3) combination of police-reported and proxy definition.

A significance level (α) of .001 was used due to the use of multiple tests and a large sample size. Accordingly, adjusted standardised residuals outside ± 3.29 were considered significant. In order to include vehicle operator characteristics as variables of interest, the main unit of analysis was the drivers/riders involved in crashes during the period, rather than crashes per se. All statistical analyses were conducted using IBM SPSS 19.0 statistical software.

3. Results

Overall, there were 65,204 vehicle operators (drivers and riders) involved in crashes on high speed (≥ 100 km/h) Queensland roads during the 10 year period of interest. Using police report alone, 3,449 (5.3%) crashes were classified as SR. Using the proxy definition alone 9,739 (14.9%) crashes were classified SR. When police-reported and proxy definition were combined, a total of 11,477 (17.6%) crashes were classified as SR. Half ($n = 1738$) of the police-reported crashes did not meet the proxy definition.

3.1. Police-reported sleep-related crash characteristics

The proportion of police-reported SR crashes including each vehicle operator and crash characteristic of interest is displayed in Table 1. Vehicle operators involved in police-reported SR crashes were significantly more likely to be male, aged 16–24, provisional licence holders and have illegal blood alcohol concentration (BAC), compared with those in not-SR crashes. Police-reported SR crashes were more likely to be serious, single-vehicle crashes involving hitting a stationary object and where the vehicle overturned. Intersections and traffic control were significantly less likely to be a factor in SR than not-SR crashes. SR crashes were significantly more likely to occur at weekends and between the hours of 10 pm and 6 am.

3.2. Proxy identified sleep-related crash characteristics

The proportion of proxy definition identified SR crashes including each vehicle operator and crash characteristic is displayed in

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