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Determinants of the occupational environment and heavy vehicle crashes in Western Australia: A case–control study

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ABSTRACT

Objective: To determine the association between a heavy vehicle driver's work environment, including fatigue-related characteristics, and the risk of a crash in Western Australia.

Methods: This case–control study included 100 long-haul heavy vehicle drivers who were involved in a police-reported crash in WA and 100 long-haul heavy vehicle drivers recruited from WA truck stops, who were not involved in a crash in the previous 12 months. Driver demographics and driving details, work environment, vehicle and sleep-related characteristics were obtained using an interviewer-administered questionnaire. Drivers were tested for obstructive sleep apnoea using an overnight diagnostic device. Conditional multiple logistic regression analysis was undertaken to determine work environment-related factors associated with crash involvement.

Results: After accounting for potential confounders, driving a heavy vehicle with an empty load was associated with almost a three-fold increased crash risk compared to carrying general freight (adjusted OR: 2.93, 95% CI: 1.17–7.34). Driving a rigid heavy vehicle was associated with a four-fold increased risk of crashing compared to articulated heavy vehicles (adjusted OR: 4.08, 95% CI: 1.13–14.68). The risk of crashing was almost five times higher when driving more than 50% of the trip between midnight and 5.59 am (adjusted OR: 4.86, 95% CI: 1.47–16.07). Furthermore, the risk of crashing significantly increased if the time since the last break on the index trip was greater than 2 h (adjusted OR: 2.18, 95% CI: 1.14–4.17). Drivers with more than 10 years driving experience were 52% less likely to be involved in a crash (adjusted OR: 0.48, 95% CI: 0.23–0.99).

Conclusion: The results provide support for an association between a driver's work environment, fatigue-related factors, and the risk of heavy vehicle crash involvement. Greater attention needs to be paid to the creation of a safer work environment for long distance heavy vehicle drivers.

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1. Introduction

Heavy vehicle crashes contribute significantly to the burden of death and injury on Western Australian (WA) and Australian roads. Heavy vehicle crashes result in approximately 250 deaths and 1500 hospitalisations each year in Australia (Bureau of Infrastructure Transport and Regional Economics (BITRE), 2014), with around 26 fatal and 166 serious injury crashes occurring per year in WA (Bramwell et al., 2014). The number of fatalities from crashes involving heavy vehicles declined in Australia by an average of 3.2% per year over the 10-year period between 2004 and 2013, which is

similar to trends in WA (BITRE, 2014). However, 20% of all worker fatalities that have occurred in Australia during the previous decade have been truck and heavy vehicle drivers (Safe Work Australia, 2014).

Previous research indicates that the health and safety of heavy vehicle drivers is influenced by a number of factors in the work environment, including distance travelled, vehicle type, employment type, payment method, driver training, scheduling practices, working hours, and the safety climate within an organisation (Morrow and Crum, 2004; Edwards et al., 2014). However, conflicting results have been reported. For example, a large study of truck-permit holders in Quebec found that longer distances driven and a greater working radius were associated with higher crash risk (Laberge-Nadeau et al., 2000). Another study however, reported that these factors accounted for considerable variation in near miss crash involvement but not crash involvement (Morrow and Crum, 2004).

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Long distance heavy vehicle driving is characterised by inherent factors that can contribute to fatigue, which is a known risk factor for heavy vehicle crashes. Hours worked, difficulty in finding rest stops, difficulty achieving continuous sleep and insufficient recovery from previous work may lead to disturbance in sleep patterns (Morrow and Crum, 2004). Specifically, fatigue has been related to scheduling issues such as night-time driving, inability to choose break times, delivery window size, more arduous schedules and higher work/time-off ratios (Edwards et al., 2014).

Limited information exists however, on heavy vehicle crashes in WA specifically. In 2008, new Heavy Vehicle Driver Fatigue Laws were introduced and all Australian States have adopted this reform except WA and the Australian Capital Territory. The laws set work and rest limits and specify records that must be kept. WA has a unique road environment with vast distances between locations and rest stops, expanses of unpopulated roadway, extreme temperatures and weather conditions and monotonous scenery. While these circumstances may increase the risk of fatigue for heavy vehicle drivers, they also limit the opportunity for frequent rest stops or trips of shorter duration. Due to this, WA has its own fatigue management regulations which are run under occupational health and safety law. These regulations allow longer working hours of up to 17 h per day and 168 h per fortnight.

A recent study on the epidemiology of police-reported articulated heavy vehicle crashes between 2001 and 2013 in WA, reported that 65% were multi-vehicle crashes, 82% occurred during daylight hours (6 am–6 pm), nearly 80% of drivers were aged 30–59 years and speed was recorded as a factor in 11% of crashes (Zhang et al., 2014). An earlier survey of WA heavy vehicle drivers on hours of work and perceptions of fatigue reported that 38% of heavy vehicle drivers exceeded 14 h of driving in a 24 h period, 20% had less than 6 h of sleep before their current journey, 14% reported nodding off at least occasionally whilst driving and 16% reported having near misses at least occasionally (Arnold et al., 1997). Of the 5% of drivers who reported crashing in the previous 9 months, 12% thought it was related to fatigue (Arnold et al., 1997). While these findings suggest fatigue may be a significant safety issue for heavy vehicle drivers, no current information exists on work environment-related risk factors for heavy vehicle crashes in WA.

Recently, a large case–control study of long distance heavy vehicle drivers was conducted in two States of Australia, New South Wales and Western Australia (Stevenson et al., 2010). The combined results of this study found that driving at night, with empty loads, less experienced drivers, lack of regular breaks and lack of vehicle safety devices increased the risk of heavy vehicle crashes in NSW and WA (Stevenson et al., 2014). However, due to WA's unique circumstances, it is important that work environment-related risk factors are examined specifically for WA portion of this study. Therefore, the aim of this study was to examine the association between work environment-related factors and the likelihood of heavy vehicle crash involvement in WA.

2. Materials and methods

2.1. Study design and participants

This paper reports the results from the WA component of a case–control study of heavy vehicle crashes undertaken in two States of Australia (Stevenson et al., 2014). All participants were driving a heavy vehicle of ≥ 12 tonnes in tare weight and were undertaking a trip ≥ 200 km from their WA truck-base at the time of a crash (cases) or being approached for an interview (controls).

Cases consisted of 100 long distance heavy vehicle drivers who were involved in a police-reported crash in WA between January 2009 and November 2011. Potential cases were excluded if the

crash resulted in a fatality, the driver was transported unconscious from the scene or the driver was admitted to hospital for 2 or more weeks. This is due to ability to recall the crash being affected by losing consciousness and it was felt it would be too distressing for the participant if they were very seriously injured. Bus/coach drivers were also excluded. Controls consisted of 100 long distance heavy vehicle drivers who had not been involved in a police-reported crash in the previous 12 months. Controls were also excluded if they were driving a bus or coach. The study was approved by the Curtin University Human Research Ethics Committee, approval number 161/2007.

2.2. Case recruitment

The WA Police sent contact details of commercial drivers involved in a police-attended crash in WA to the study team weekly between January 2009 and November 2011. Drivers were then sent a letter of invitation to participate in the study, and trained interviewers made telephone contact with the potential participants. Telephone interviews were then undertaken within 2–4 weeks of the crash. Of the 1155 heavy vehicle drivers identified from police records, 977 were not eligible to participate in the study due to weight/type of vehicle, length of trip, or missing contact details. While 178 drivers met the eligibility criteria for the study, 100 agreed to participate (56%).

2.3. Control recruitment

Control drivers were recruited from 4 truck stops across WA between July 2009 and November 2011. The truck stops were chosen to cover all major trucking routes in WA and included Kewdale (approximately 10 km from Perth central business district (CBD)), Upper Swan (approximately 35 km from Perth CBD), Meekatharra (approximately 775 km from Perth CBD) and Overlander (approximately 700 km from Perth CBD). Recruitment took place across different days and months to ensure varied travel patterns. Those drivers who agreed to participate were interviewed at the truck stop or by phone at a convenient date within 1–2 weeks of the initial contact. A total of 256 heavy vehicle drivers were approached to participate in the study with 136 drivers being eligible to participate. A total of 100 controls were recruited from 4 truck stops, yielding a response rate of 73.5%.

2.4. Data collection

Data collection consisted of two parts: a 40-min interviewer-administered questionnaire and sleep monitoring. All participants received study information sheets and provided informed consent. Both case and control interviews were conducted by the same interviewers, all trained using a standardised protocol. The questionnaire was developed by consensus of a panel comprising experts in transportation, the heavy vehicle industry, fatigue and sleep disorders, legislation, injury prevention, and road safety. All participants received a \$50 voucher as remuneration for their time.

The interview collected information including; demographics, anthropometry, driving and crash history, schedule and payment information, truck loads and configuration, health and medical information, substance use, the Epworth Sleepiness Scale (ESS) and the Multivariable Apnea Prediction (MAP) Index. The MAP Index incorporates self-reported responses to questions about breathing disorders, and other risk factors such as BMI, age and gender (Maislin et al., 1995) and is specifically designed to be predictive of obstructive sleep apnoea (OSA). Sleep (quantity and quality) was measured for the day of the crash/interview and the preceding two days. Consumption patterns of caffeinated substances consumed for the purpose of staying awake during the past month were asked

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