

Assessing cardiovascular associations to affective states in Australian truck drivers

by Taryn Chalmers¹ and Sara Lal¹

¹Neuroscience Research Unit, School of Medical and Molecular Bioscience, University of Technology Sydney, Taryn.Chalmers@student.uts.edu.au

Abstract

Within this exploratory study, data is presented regarding occupational and lifestyle factors that contribute to cardiovascular disease and depression within the truck driving industry, and subsequently contribute to reduced road safety in Australia. The study assessed associations between mood parameters, heart rate variability (HRV) and blood pressure in the unstudied population of Australian truck drivers. A total of 35 heavy vehicle truck drivers were recruited from the local community. Electrocardiogram recordings were obtained during an active and baseline driving simulator task. HRV low and high frequency parameters were obtained from the ECG. Subjects completed the Profile of Mood States questionnaire and the Lifestyle Appraisal Questionnaire. Blood pressure was recorded before and after the study. Numerous mood states (anger-aggression, total mood disturbance score) were correlated to an increase in sympathetic activity ($p < 0.05$). Diastolic blood pressure was positively correlated to a number of mood states, the most significant correlation being depression-dejection ($p < 0.001$).

Keywords

Blood pressure, Cardiovascular disease, Depression, Heart rate variability, Truck driving

Introduction

The trucking industry plays a fundamental role in the affluence of Australia. A combination of long distances between industries and a low population density results in a heavy dependence upon road freight. Working conditions in the truck driving industry commonly involve both physiological and psychological demands. Intermittent work and rest cycles, loading and unloading of heavy freight [1], intense cabin vibrations, irregular meal schedules, occupational stress [1], monotonous driving conditions and the necessity of intense mental alertness [2], all contribute to impaired truck driver health. As a result of these occupational lifestyle factors, truck drivers potentially elevate their risk of many physiological and psychological health conditions such as diabetes [3], cancer [4], pain [1], sleep apnoea [5], cardiovascular disease (CVD) [2, 6], and affective disorders such as depression [7]. Between June

2010 and June 2011, 211 deaths resulted from 185 crashes involving heavy rigid or articulated trucks in Australia [8]. Despite accounting for only 2.47% of the total vehicles on Australian roads, heavy vehicles have been implicated in 17.96% of the fatal road accidents [9]. The economic implications of these accidents are significant, reportedly costing Australia approximately \$2 billion each year [10]. It has also been shown that approximately one in every five individuals who are injured in the workplace in Australia is a truck driver [11]. This fatality rate is fourteen times that of all other occupational deaths in Australia [11].

Globally, CVD is the leading cause of premature death [12]. Cardiovascular disease [2], myocardial infarction and ischemic heart disease [6] have all been identified as serious health issues within the trucking industry. A study conducted by the National Transportation Safety Board [13] found that 9.2% of fatalities involving truck drivers in America involved some form of cardiac incident. Furthermore, a recent study found that in Australia, a collapse from heart disease accounts for as much as 15% of all crashes where the driver suddenly becomes ill [14]. High rates of obesity, sedentary lifestyles [15], cigarette smoking [15], hypertension [15], saturated fat and alcohol dependent behaviour [15] have all been consistently reported within this occupational field, and as such, contribute to the development of cardiovascular disease within the trucking industry.

Depression is a common affective disorder, which has been previously linked to the truck driving industry. A recent study conducted by Hilton and his team [7] found that 13.3% of Australian heavy vehicle truck drivers exhibited at least a mild form of depression (as measured by the Depression, Anxiety and Stress Scale) in comparison to the reported national rate of 11.6% [16]. Similarly, a study by da Silva-Junior and associates [17] found that 13.6% of the sample cohort of truck drivers ($n=300$) suffered from depression (as diagnosed through the section Major Depressive Episode in the Mini International Neuropsychiatric Interview). Supporting these findings, a study in 2007 found that 14.5% of truck drivers felt more depressed since beginning work within this occupation [18]. Recently, work stress has been heavily implicated as an independent predictor of depression [19]. As previously mentioned, truck drivers are frequently subjected to long

hours, irregular work/rest cycles, isolation and intense occupational pressure. These common work stressors result in truck drivers being viewed as a depression vulnerable population. Additionally, the implication of long working hours in the development of depression has been further supported by a study conducted by Virtanen and colleagues [20], in which individuals who worked more than 11 hours per day were at a significantly increased odds ratio (OR) of developing depression (2.52 compared to 1.0). Depression has been consistently associated with a decrease in driver performance. A recent study conducted by Hilton and his team [7] found that severe and extremely severe depression in heavy vehicle truck drivers resulted in a significantly higher OR (4.4 and 5.0 respectively) for an accident or near miss. The study also found that self-reported performance at work was reduced by 5.7% in drivers experiencing severe depression when compared to those with no depressive symptoms. Supporting this, Blumash and associates [21] found that individuals with major depressive disorder exhibited marked decreases in steering reaction time and an increased number of crashes when compared to a control sample. These findings provide evidence for the detection and management of depression in heavy vehicle truck drivers in Australia.

Of concern is the scarcity of literature regarding depression in the trucking industry in Australia. Aside from the aforementioned study conducted by Hilton and associates [7], the rate of depression in Australian heavy vehicle drivers has been somewhat overlooked. Of further concern are the statistics regarding the adverse effects of depression on driver performance and the role of CVD in road accidents. Furthermore, the likelihood of seeking medical advice for the treatment of depression in Australia is worrisome, with a recent survey conducted by the Australian Bureau of Statistics [22] ascertaining that only 35% of Australian individuals who had suffered from a mental disorder in the previous 12-month period had accessed appropriate medical services. Despite a higher prevalence of depression amongst females when compared with males in Australia (14.5% and 8.8% respectively [22]), a seemingly entrenched social perception, which dissuades males from seeking medical advice, has resulted in significantly lower diagnostic rates of affective disorders among males [23]. Due to the extreme gender bias of the truck driving industry (97.5% male [24]), an underlying prevalence of undiagnosed affective disorders may be present, supporting the investigation of this health implication within this occupation.

Behavioural cardiology is a developing field of clinical practice based on the understanding that adversative lifestyle behaviours, emotive factors and chronic stress can collectively contribute to atherosclerosis and adverse cardiovascular events. The Australian Heart Foundation has recently identified depression as a modifiable

biomedical risk factor for CVD, and has suggested that the link between depression and cardiovascular impairment warrants further investigation [25]. At present, there have been varying results regarding the impact of this disorder on cardiac activity and the development of cardiovascular disease. The present study aimed to assess the presence and effect of a number of adverse lifestyle and mood states on the cardiovascular system in order to identify possible behavioural and environmental factors within the Australian trucking community that may contribute to the development of CVD. By understanding and evaluating the presence and effect of depression and cardiovascular disease in the Australian truck driving community, we may be able to provide the foundation for the implementation of management procedures to reduce the effects of these disorders on driving ability, and thus, improve road safety within Australia.

Methods

Participants

A total of 35 heavy vehicle truck drivers were recruited from the local Sydney City community, aged between 18 and 69 inclusive. The ratio of males to females reflected the male dominance (97.5%) in the Australian trucking industry, with 33 males and 2 females being recruited to participate. Participants were recruited through local advertisement via a poster, recruitment through contacts established independently to this research, online forums and with the aid and endorsement of Australia Post Transport division and the Transport Workers Union. Participants were required to be employed as a truck driver, regularly driving a truck with a gross vehicle mass of over 4.5 tonne, not be consuming any prescription or non-prescription drugs (excluding tea, coffee and nicotine) and not be suffering from any chronic disease or illness. Participants were required to abstain from food for two hours, nicotine and caffeine for four hours, and alcohol for 12 hours prior to the study.

Procedure

Participants were tested between 9.30 am and 3 pm in order to negate the variations in heart rate between 8 - 9am and 4 - 8pm recently identified by Chen [26]. Furthermore, by ensuring participants abstained from consuming food for two hours prior to testing, the effect of the post-prandial blood pressure dip was negated. The study was conducted in a controlled laboratory environment, with auditory and visual interference being reduced as much as viably possible. Light sources were controlled, with laboratory blinds being drawn to reduce the impact of external light sources influencing physiological measurements. The study was comprehensively detailed to the subject upon arrival, with the opportunity for questions being presented. Upon confirmation of written consent, the study was commenced.

Blood pressure

Upon commencement of the study, three pre-study blood pressure (BP) readings were obtained. The volunteer was required to remain seated for five minutes prior to the BP readings being recorded, with a two minute seated interval between each of the measurements. In accordance with the National Heart Foundation of Australia BP guidelines [27] and the UTS HREC approved emergency protocol, a BP reading of greater than 160/100 mmHg resulted in the participant being excluded from the study. Furthermore, the participant was advised to seek urgent medical advice and the offer was made to escort the individual to the nearest medical facility. A participant with a pre-study BP reading greater than 140/90 mmHg but lower than 160/100 mmHg, whilst included in the study, was advised to consult their general practitioner regarding their elevated BP reading. Three post-study BP readings were also obtained, again in accordance with the National Heart Foundation of Australia BP guidelines [27] and the UTS HREC approved emergency protocol.

Lifestyle Appraisal Questionnaire

The Lifestyle Appraisal Questionnaire (LAQ) [28], a validated and clinically reliable questionnaire, was used to record demographic, lifestyle and psychological stress information from participants. The LAQ consists of two parts, with Part I consisting of 22 questions, with the highest obtainable score being 73. This information included family history of disease, smoking status, alcohol intake, exercise and diet regime, etc. The higher the score obtained from Part I of the LAQ, the greater the risk of developing a chronic illness later in life [28]. Part II of the LAQ consists of 27 items, and assessed an individual's "cognitive appraisal of pressure and demands" [28]. Following this, body mass index was objectively measured in the laboratory.

SmartData questionnaire

The SmartData questionnaire [29] provides demographical information regarding licensing, trucking history, employment status, nutrition, accident history and working conditions. This questionnaire was utilised as a basis for possible stratification of data, and to ascertain common conditions of truck driving in Australia. Following the administration of the SmartData questionnaire, the Likert Fatigue scale was completed.

Likert Fatigue Scale

The Likert scale is used to measure fatigue levels both prior and post the electrocardiogram (ECG) study [30]. The measure employs a rating scale of four points: not at all, slightly, moderately or markedly fatigued, and the participant circles the appropriate response. Fatigue has

been shown to impact upon heart rate variability (HRV) and as such, this confounder is measured pre and post study to provide adequate information to allow for thorough identification of any areas of possible inter-individual variability.

Profile of Mood States Questionnaire

The Profile of Mood States questionnaire (POMS) [31] is composed of 65 items describing six mood subscales: tension-anxiety, depression-dejection, anger-hostility, vigor-activity, fatigue-inertia, and confusion-bewilderment. An overall measure of total mood disturbance is calculated for all six subscales by combining the scores obtained on the tension-anxiety, depression-dejection, anger-hostility, fatigue-inertia and confusion-bewilderment scales minus the score on the vigor-activity scale. The POMS questionnaire is a subjective measurement of well-being, and is an assessment of an individual's mood state during the previous week, including the day of participation. This measurement is not used in this study to clinically diagnose depression in individuals, but rather, to elucidate mood states that may impact physiological parameters. This questionnaire is a well-validated, reliable, low cost, ergonomic psychometric tool.

Heart rate variability

Standardised attachment of a three-lead electrocardiogram was performed, with the active electrodes being positioned at the intercostal space between the fourth and fifth ribs, two centimetres laterally from each side of the sternum and the reference electrode being secured underneath the shoulder. Following this, the participant was asked to rest for five minutes, after which, the participant was seated in the driving simulator and after participating in the race format for ten minutes to familiarise themselves with program, were asked to complete the 'active' driving situation, in which they were engaged in a race meeting (Fuji Speedway) with other automatically generated cars whilst a concurrent twenty-minute ECG recording was obtained. The driver was then asked to rest for ten minutes. Following this, a baseline (control) recording was obtained, which involved the participant engaging in a twenty minute driving session, again on the Fuji Speedway, with the absence of other automobiles on the road whilst a concurrent twenty-minute ECG recording was taken. The driving simulator was employed in order to elicit a physiological stress response, and it should be noted that subjects were familiarised with the program prior to ECG recordings being obtained. Heart rate variability (HRV) data was then obtained from the R-R intervals of the ECG recordings using a non-parametric algorithm (Fast Fourier Transform) and used as a quantitative measurement of the sympathetic (Low Frequency HRV) and parasympathetic nervous systems (High Frequency HRV). HRV reactivity was obtained by calculating the increase from baseline to active states in the various HRV parameters.

Heart rate variability analysis

Initially, using the QRS detector, the pre-processing step of HRV analysis included band pass filtering to decrease power line noise, baseline wander, muscle noise and any other interference components. The pass band at approximately 5 – 30 Hz is sufficient to cover most of the frequency content of QRS complex [32]. After this pre-processing had occurred, a set of decision rules were applied to define if a QRS complex had occurred. The decision rules included the average heart beat period as well as the amplitude threshold, which were amended adaptively as the detection process continued. The fiducial point was selected to be the R-Wave, and the time at which the R-Wave occurs was logged. Post R-Waves identification, and time of R-Wave occurrence was determined, the HRV time series was derived. The R-R intervals were determined as the variances between successive R-Wave occurrence time periods. A power spectrum density (PSD) estimate was then used to calculate the R-R interval series. The PSD estimation is performed using the Fast Fourier Transform based Welch's periodogram method (Hann window was used). In the Welch's periodogram method, the HRV sample is separated into overlapping segments (50% overlap). The spectrum was then acquired by calculating the average spectra of these segments. This method reduces the amount of variance of the FFT spectrum. The frequency bands derived for short-term HRV recordings were low frequency (LF, 0.04 – 0.15 Hz) and high frequency (HF, 0.15 – 0.4 Hz). The absolute power values for each frequency band were derived through integration of the spectrum over the band limits.

Results

Significance testing was conducted using a standard confidence interval of 95%. Correlation analysis identified a number of statistically significant associations between BP and LAQ scores (Table 1). Pre-study systolic BP was positively correlated with both P1 ($r = 0.34$, $p = 0.049$) and P2 ($r = 0.39$, $p = 0.02$) of the LAQ. This positive correlation was also identified for pre-study diastolic BP with respect to P1 ($r = 0.47$, $p = 0.004$) and P2 ($r = 0.38$, $p = 0.024$) of the LAQ. Additionally, an increase in post-study systolic BP was associated with increased P1 ($r = 0.43$, $p = 0.009$) and P2 scores ($r = 0.46$, $p = 0.006$).

A number of statistically significant correlations between pre-study diastolic BP and the scores from the POMS questionnaire were identified. Those who presented with high pre-study diastolic BP readings, also reported higher tension-anxiety ($r = 0.34$, $p = 0.043$), fatigue-inertia ($r = 0.35$, $p = 0.038$), total mood disturbance ($r = 0.38$, $p = 0.023$) and the most significant association; depression-dejection ($r = 0.43$, $p = 0.009$) scores.

Table 1. Blood pressure associations with Lifestyle Appraisal Questionnaire

		r	p
Pre-study systolic BP	LAQ P1	0.34	0.049
	LAQ P2	0.39	0.020
Pre-study diastolic BP	LAQ P1	0.47	0.004
	LAQ P2	0.38	0.024
Post-study systolic BP	LAQ P1	0.43	0.009
	LAQ P2	0.46	0.00

The regression analysis for pre-study diastolic BP had an overall significance ($F = 2.42$, $df = 9, 25$, $p < 0.039$, $R = 0.68$, $R^2 = 0.47$, Adjusted $R^2 = 0.27$) for nine variables (age, BMI, LAQ P1, LAQ P2, tension-anxiety, anger-aggression, fatigue-inertia, depression-dejection, TMD) together accounting for 46% of the variance in pre-study diastolic BP. The regression analysis for post-study systolic BP was significant ($F = 3.9$, $df = 4,30$, $p < 0.011$, $R = 0.59$, $R^2 = 0.34$, Adjusted $R^2 = 0.26$) for four variables (age, BMI, LAQ P1 and LAQ P2) together accounting for 34% of the variance in post-study systolic BP. The individual variable that was most predictive of post-study systolic BP variability was LAQ P2 ($p = 0.03$).

A statistically significant positive correlation was identified between LF HRV measured during the active phase and anger-aggression ($r = 0.38$, $p = 0.03$) (Table 2). A significant positive correlation between HF and anger-aggression ($r = 0.42$, $p = 0.001$) and a negative correlation with the vigor-activity score ($r = -0.36$, $p = 0.004$) was also identified. HF reactivity showed a positive correlation with the anger-aggression subscale ($r = 0.38$, $p = 0.023$) and was negatively correlated with vigor-activity ($r = -0.34$, $p = 0.048$). No significant correlations were identified between POMS mood subscale scores and HRV data during the passive phase of testing.

Table 2. Mood disturbance associations with HRV during an active task

HRV parameter	POMS mood subscale	r	p
LF (ms²) (Active)	Anger-aggression	0.38	0.03
	Vigor-activity	-0.31	0.07
	TMD	0.32	0.07
HF (ms²) (Active)	Anger-aggression	0.42	0.01
	Confusion-bewilderment	0.32	0.06
	Vigor-activity	-0.36	0.04
	TMD	0.33	0.06

Discussion

Although no previous literature has addressed the links between part 1 of the LAQ and BP measurements, the present study identified a positive correlation between adverse lifestyle factors and pre/post-study SBP and pre-study DBP. Collectively, it can be assumed that an individual engaging in a number of undesirable lifestyle habits, such as those assessed in part 1 of the LAQ, is likely to have high BP. High SBP and DBP have been strongly associated with an increased CVD risk [33], and as such, addressing these adverse lifestyle factors that contribute would be beneficial in reducing BP in truck drivers.

Part 2 of the LAQ assesses an individual's cognitive appraisal of pressures and life demands over the previous eight weeks [28]. It is used to assess an individual's own assessment of the psychological pressures they are experiencing, and produces a raw score from which their levels of perceived stress can be determined. It is widely accepted that there is a significant positive correlation between psychological stress and BP [34]. The present study supports these findings, with pre and post-study SBP, and pre-study DBP found to be positively associated with perception of stress in the truck drivers. A number of mechanisms for this increase in BP, as a result of psychological stress, have been suggested. Individuals who experience prolonged periods of psychological stress have been shown to present higher circulating levels of cortisol, an essential glucocorticoid that controls catecholamines and a number of vasoactive agents that regulate vasculature tone [35]. Cortisol acts to enhance SNS activity by increasing the sensitivity of adrenergic receptors to catecholamine activation [36]. Furthermore, it has been suggested that due to the ability of cortisol to shift fluid from intracellular to extracellular compartments of the kidney, circulating blood volume may increase as a result, thereby increasing BP [37]. The hippocampus is the negative feedback mechanism for the control of circulating cortisol. Consistently elevated cortisol levels, such as those seen in times of prolonged and cumulative stress, reduce the hippocampal neuronal integrity, causing dysregulation of the HPA-axis [38]. This altered function of the HPA-axis has been directly linked to elevations in BP [38].

A number of studies found strong positive correlations between anxiety and BP [39]. The present study supports these findings to some degree, with pre-study DBP found to be positively correlated to Tension-anxiety scores attained from the POMS questionnaire. Unlike previous studies, however, no correlation was found between SBP and Tension-anxiety in the sample studied. This could be attributed to the predominantly male sample of the present study, as it has been reported that men will often underreport symptoms and severity of anxiety in surveys in which they are asked to assess their own psychological

health [40]. The Tension-anxiety scores attained from the present sample (12.8 ± 5.4) were comparable to the normative values (12.9 ± 6.8) [31]. Despite, this, due to the disinclination of men to report anxiety symptoms accurately on surveys, the true incidence of anxiety disorders within this cohort may actually be significantly higher.

The link between fatigue and BP has been comprehensively investigated numerous times. A recent study found that individuals who scored high on the Epworth Sleepiness Scale (ESS) displayed an increased casual SBP and DBP, when compared with those who attained low ESS scores [41]. Furthermore, short sleep durations, an occupational condition that is often reported by truck drivers, has been consistently associated with an increased risk of hypertension [42]. The present study supports these findings, with a positive correlation identified between pre-study DBP and Fatigue-inertia. The mechanisms by which fatigue influences BP can be attributed to the natural diurnal pattern of BP changes. With the onset of sleep and actual sleep, BP progressively decreases until an individual awakens [43]. This awakening is accompanied by a rapid increase in BP [42]. Sleeping fewer hours per night, as is reported by a large percentage of truck drivers would therefore act to increase average 24-hour BP, an issue in truck drivers. Overall, it should be noted that the Fatigue-Inertia mean score reported from participants in the present study was 2.6 points higher than the reported normative scores, which may suggest that fatigue is an issue within the Australian truck driving industry.

There have been a number of studies that have examined the links between depression and BP. While some found a positive association between depressive symptoms and BP [44], others identified a negative correlation [45]. It should be noted, however, that the inverse relationships found to be associated with depression were generally identified in geriatric populations [45]. The present study found that of all the POMS subscales, Depression-dejection scores had the strongest positive correlation with higher pre-study DBP. Furthermore, there was a trend towards significance with post-study SBP and higher Depression-dejection. As the present truck driver study sample had a highest individual age of 57, results parallel prevalent literature that suggest BP is positively correlated with depression in samples aged >65 years. This finding supports the initial hypothesis of the study, which stated that depression would be linked to increases in blood pressure. A number of mechanisms have been proposed to justify the increase in BP associated with depression and depressive symptoms. An increase in SNS activity, resulting in an exaggerated cardiovascular reactivity response, is one prominent theory [46]. Also, HPA axis dysregulation resulting in variable hypersecretion of cortisol has been hypothesised to result from depression [47]. It should also be noted that individuals within the present study presented an average

Depression-Dejection score of 3.2 points higher than the reported normative, indicating that this condition may be of concern within this industry.

The present study identified a positive correlation between low frequency (LF) (sympathetic activity) HRV during the active driving phase, and the Anger-aggression subscale of the POMS questionnaire. In previous studies, anger has been shown to have a positive relationship with LF activity, indicating an increased sympathetic outflow and sympathetic dominance, which has been identified as a predictive factor for the development of CVD [48]. It has been suggested that the increase in LF HRV in individuals exhibiting anger and aggression can be attributed to the sympatho-adrenal system, which, when experiencing high levels of anger or aggressive behaviour, is over-stimulated, resulting in sympathetic dominance [49]. Furthermore, it has been observed that the application of norepinephrine to the paraventricular hypothalamic nucleus resulted in increases in circulating corticosteroids and glucose [50]. It has been hypothesised that the close physical proximity of the hypothalamic regions involved in defence and those that stimulate the sympatho-adrenal system, may provide evidence for a functional interaction between the neural mechanisms for anger and aggression, and the sympatho-adrenal control of the body at the hypothalamic level [51].

Conclusion

A number of psychological states were assessed in relation to blood pressure. Psychological stress was associated with an increase in BP. This finding parallels the literature, which suggests that psychological stress increases the levels of circulating cortisol, thereby increasing vasoconstriction and blood volume, resulting in elevated BP [35]. Within the present study, fatigue was also positively correlated to BP. This finding is well supported by the current literature [42]. Depression was also found to be associated with an increase in DBP. Although current literature has debated the impacts of depression on BP, the present study suggests that this negative mood state may be associated with an increase in BP, and may subsequently result in an increased cardiovascular risk. The psychological health of Australian truck drivers has been somewhat overlooked, with only one study having assessed the psychological wellbeing of this cohort [7]. The Hilton study [7] assessed the prevalence of depression, anxiety and stress-related mood impairment within Australian truck drivers, although no comparisons were made to cardiovascular health. The present study assessed a more comprehensive range of mood states within this industry, including depression, anger, psychological stress, anxiety, confusion and fatigue. Findings from the present study suggest that a number of these negative mood states (psychological stress, tension-anxiety, depression-dejection and fatigue-inertia) are correlated to alterations in BP. As such, the identification and managements of these

mood states would improve both the psychological and cardiovascular health of individuals within this industry.

There is also varying evidence regarding the effects of a number of mood states on autonomic activity (as assessed by HRV analysis). The current study identified positive associations between LF HRV (sympathetic activity) and anger. In previous studies, anger has been shown to have a positive relationship with LF activity, indicating an increased sympathetic dominance, which has been identified as an indicator for the development of cardiovascular impairment [48].

Collectively, the findings from the present study provide a novel perspective on the physiological and psychological health of Australian truck drivers. The present study is the first assess to the effects of certain lifestyle and mood states on cardiac parameters (such as BP and HRV) in the cohort of Australian truck drivers. The present study addressed the gaps in research by assessing a number of mood states and their relationships with cardiac parameters. The study found that multiple lifestyle and mood parameters (BMI, psychological stress, anger and depression) were associated with altered cardiovascular function. Elucidating from previous literature, reducing the incidence of these factors would work to reduce both CVD and depression, in turn, increasing driver performance, thereby improving road safety in Australia. These findings also suggest that the improved awareness and management of these factors in the male dominated truck driving industry would improve both the short term psychological and long term cardiovascular health of these individuals, in turn, reducing the socioeconomic burden associated with these affective disorders and cardiovascular disease in Australia. Considering that heavy vehicle accidents reportedly cost Australia approximately \$2 billion each year [10], improving the psychological profile of these individuals would, in turn, reduce the effects of disorders such as depression on driving ability. Furthermore, identifying depression as a contributing factor to impaired cardiovascular function would provide the foundation for the management of this disease within the Australian truck driving industry. Road safety in Australia is a vital aspect of this industry that requires a holistic approach. By incorporating both physiological and psychological management schemes, the safety gains in terms of improved driver ability, and reduction in both absenteeism and cardiovascular related road crashes, would be beneficial.

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Seriously injured occupants of passenger vehicle rollover crashes in NSW

by Mike R Bambach¹, Rebecca J Mitchell¹, Garrett Mattos¹, Raphael H Grzebieta¹ and Andrew S McIntosh¹

¹*Transport and Road Safety (TARS) Research, University of New South Wales, Australia*

Abstract

This study uses linked police-reported road crash and hospitalisation datasets to establish the patterns of serious injury sustained by occupants of passenger vehicle rollover crashes in New South Wales, 2001 to 2011. A total of 10,876 casualties were identified that were injured in crashes where rollover was the primary event. The injury patterns are compared with in-depth rollover crash investigations using United States data, where injury mechanisms were identified in an effort to establish rollover crash test protocols and identify appropriate areas for vehicle improvements to ameliorate serious injuries. The aim of the present study is to establish similarities

between patterns of serious injury to the head, spine and thorax between Australia and the United States, such that the lessons learned with regards to injury mechanisms, test protocols and vehicle performance requirements may be shared and used to improve vehicle rollover crashworthiness in both countries. General descriptors of rollover crash incidence, characteristics and determinates of serious injury in NSW are also reported.

Keywords

Rollover, Serious injury, Injury mechanisms, Rollover crashworthiness