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SJ Raftery, LN Wundersitz

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AUTHORS

SJ Raftery, LN Wundersitz

PERFORMING ORGANISATION

Centre for Automotive Safety Research
The University of Adelaide
South Australia 5005
AUSTRALIA

SUPPORTED BY

Motor Accident Commission
GPO Box 1045
Adelaide SA 5001
AUSTRALIA

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ABSTRACT

Observational surveys of restraint use in South Australia have reported vehicle occupant wearing rates somewhere in the order of 97%, however these rates drop below 70% for crashes where vehicle occupants are killed or seriously injured. In order to seek some understanding of why the prevalence of seat belt use varies between observational surveys and crash statistics a review of published international research and an analysis of a sample of fatal crashes in South Australia were undertaken. The literature review indicated that individuals less likely to wear seat belts were also most likely to be involved in crashes resulting in death or serious injury. A review South Australian Coroner's data for fatal crashes in 2008 revealed that 37% of vehicle occupants killed in a crash were unrestrained. Further analysis indicated that those least likely to be restrained were younger, more likely to have tested positive to drugs and were more likely to have engaged in extreme behaviour than those who were restrained. Restraint use was also less common amongst fatalities in rollover crashes and amongst those ejected from the vehicle. Restraint use was also identified as an important issue for Indigenous Australians and people in regional and remote areas. Examination of the characteristics of fatal crashes revealed that observational survey methodologies have a limited capacity to detect those least likely to wear seat belts. Evidence of a selective recruitment effect was also observed. The findings are discussed in relation to potential countermeasures to increase restraint use.

KEYWORDS

Restraint usage, Fatality, Literature review

Summary

Recent observational surveys of restraint use in South Australia have reported vehicle occupant wearing rates somewhere in the order of 97%, however these rates drop below 70% for crashes where vehicle occupants are killed or seriously injured. A detailed literature review and case review of fatal crashes in South Australia were undertaken in order to seek some understanding of why the prevalence of seat belt use varies between observational studies and crash statistics.

LITERATURE REVIEW

A review of international published literature examined person, vehicle, environmental, and enforcement factors related to seat belt use. This revealed that those individuals least likely to wear seat belts are also most likely to be involved in crashes resulting in death or serious injury. The people least likely to wear seat belts are likely to:

- Be young males;
- Be rear seat passengers;
- Live in rural areas;
- Drive older cars;
- Engage in generally risky and sensation-seeking behaviours including substance use and unsafe driving behaviour;
- Not wear seat belts during night-time hours.

Therefore, to provide an accurate determination of restraint use observational methodologies must be able to capture the wearing rates of the population at risk of being killed in a crash.

The literature also indicated that the disparity in restraint use rates might be explained by the increased likelihood of injury for non-restrained vehicle occupants in crashes. Based on the observed prevalence of restraint use and the relative risk of being killed in a crash whilst unrestrained, it was estimated that 7.5% of fatally injured vehicle occupants could be expected to be unrestrained. Therefore, this possibility only partly explained the discrepancy.

REVIEW OF CORONER'S FILES

The second stage of the study involved the examination of South Australian Coroner's data with a view to exploring the extent to which the discrepancy in restraint use reported in observational surveys and fatal crashes is attributable to a) methods of data collection in observational studies and b) the over representation of individuals associated with risk-taking behaviour in crash statistics. Of the 63 vehicle occupants killed in 2008 for which restraint use was known, 23 (37%) were unrestrained at the time of the crash. Statistical analysis revealed that:

- Restraint use was least common in crashes outside of the Adelaide metropolitan area;
- Unrestrained vehicle occupants had a lower mean age than restrained vehicle occupants;
- Non-Indigenous Australians were more likely to be unrestrained in a crash, however 70% of Indigenous Australians killed in a crash were unrestrained;
- Individuals testing positive to at least one of the prescribed drugs (THC, MDMA, or methamphetamine) were more likely to be unrestrained than those who did not;
- Drivers engaging in extreme behaviours were more likely to be unrestrained;

- Individuals killed in rollover crashes were less likely to be restrained than those killed in other types of crashes. Furthermore, 70% of occupants killed in rollovers were ejected; 93% were unrestrained.

Given the relative risk of dying in a crash is 2.5 times higher for unrestrained occupants it was determined that 14 (60%) of the 23 fatalities detected in the Coroner's data may have been prevented through the use of seat belts, while the for the remaining 40% the crashes were so severe (i.e., intrusion or crush damage) that a seat belt would have made no difference to the outcome. Additionally, the frequencies at which crashes occurred in different locations and times revealed that many of the fatal crashes in South Australia in 2008 occurred outside of the time and location parameters followed by the observational study methodology of Wundersitz and Anderson (2009).

CONCLUSIONS

The findings of the present study suggest that the discrepancies between restraint use rates observed in observational and crash-based studies arise partially from differences in methodology and the characteristics of restraint non-wearing individuals that increase their risk of involvement in crashes, the severity of which may be increased due to their lack of restraint use. However, a large portion of these discrepancies remains unexplained. Public education and enforcement strategies may go some way to addressing these issues for some groups, however technologies such as seat belt interlocks and electronic stability control may be necessary to improve restraint use and crash rates among those at greatest risk.

Contents

1 Introduction

Seat belts are safety devices designed to prevent injury in case of a motor vehicle crash by preventing occupants striking interior elements of, or being ejected from, the vehicle and distributing the force of impact over the strongest areas of the body allowing occupants to ride-down a crash by lowering forces exerted on the body (de Lapparent, 2008). It has been estimated, based on US national data, that seat belts are around 50 to 60% effective at preventing fatalities and around 44% effective for preventing injuries (Evans, 1996). Evans also observed that the effectiveness of seat belts operates as a function of crash severity such that some aspect of the crash itself (e.g., crushing or intrusion damage) may negate the effectiveness of the seatbelt.

A UK study produced results similar to those of Evans (1996), suggesting that seat belts were 61% effective for preventing death and 32% effective for preventing serious injury (Richards et al., 2008). Taking the analysis of effectiveness one step further, Richards and colleagues (2008) estimated that increasing the prevalence of seat belt use by as little as 0.5% could reduce the economic costs of fatalities and injuries by over 18 million pounds per year in the UK. A population-based case control study from New Zealand that controlled for confounding variables (e.g., age, sex, ethnicity, education, hours driving, etc.) reported that non-use of seat belts was associated with a greater than ten-fold increase in crash injury, and 13% of all injuries caused by a crash were due to the non-use of a seat belt (Blows et al., 2005).

A recent observational survey of restraint use in South Australia reported vehicle occupant wearing rates somewhere in the order of 97% (Wundersitz & Anderson, 2009). However, rates drop below 70% for crashes where vehicle occupants are killed or seriously injured (Wundersitz, Hiranandani, & Baldock, 2009). It would appear that there is a sub-population of individuals who fail to use restraints and who are over-represented amongst crash fatalities and injuries.

The primary aim of this project was to understand why the prevalence of restraint use varies between observational studies and crash statistics. This report begins with a review of published international research to identify any factors that might explain the discrepancy in restraint wearing rates. The identification of individual and behavioural characteristics, vehicle factors, environmental conditions and enforcement practices associated with restraint non-use in the literature is followed by a discussion of factors likely to lead to the over-representation of vehicle occupants not wearing restraints in crashes. The methods used to estimate the prevalence of seat belt use and selective recruitment bias are considered within this discussion.

The second part of the report involves the examination of South Australian Coroner's data with a view to investigating the extent to which some of the proposed factors might lead to the discrepancy in restraint usage rates. The times and locations of fatal crashes were compared with those used in observational surveys. Following this, the crash, person and vehicle characteristics associated with unrestrained fatally injured vehicle occupants were identified to determine if these characteristics were consistent with those associated with a greater risk of crash involvement reported in the literature. The report concludes with a discussion of the factors likely to be responsible for the differences in restraint use reported in observational studies and crash statistics with reference to potential countermeasures to increase restraint use.

2 Literature review

2.1 Person factors

One of the predominant focuses of seat belt use research is the characteristics of individuals that are less likely to use restraints. Observational surveys show that males are less likely to wear seat belts than females (Begg & Langley, 2000; Chaudhary & Preusser, 2006; Cummings, 2002; de Lapparent, 2008; Matthews et al., 2001; McCartt & Northrup, 1004; Richards et al., 2008) and that younger people are less likely to use seat belts (Cummings, 2002; McCartt & Northrup, 2004; Preusser, Williams, & Lund, 1991; Richards et al., 2008; Wilson, 1990). Furthermore, a large proportion of seat belt non-users are young males (Eluru & Bhat, 2007; Palamara et al., 2009; Richards et al., 2008; Wundersitz, Hiranandani, & Baldock, 2009). Beyond age and gender, information about other characteristics of seat belt users, ethnicity for example, is somewhat lacking. However, research conducted in Australia has found that Indigenous Australians are less likely to use seat belts (Palamara et al., 2009), while in the US African Americans have been identified as most likely to ride in cars unrestrained (Matthews et al., 2001).

Demographic variables offer little in the way of understanding the behaviour and attitudes associated with the non-use of restraints. An adequate understanding of seat belt use requires a more comprehensive approach incorporating other relevant factors such as driver behaviour and other analogous behaviours (e.g., risk-taking and health behaviours), the presence of passengers, seating position, and attitudes.

Seat belt use has been related to other health and risk-taking behaviours. Such associations can be assessed by examining official driver records (i.e. crash and traffic offence databases) of unrestrained drivers. Studies utilising such methodologies have shown that individuals with a history of crashes or traffic offences or who self-report driving under the influence of alcohol or another substance are least likely to wear seat belts as a driver (Begg & Langley, 2000; Blackman et al., 2007; Eluru & Bhat, 2007) or rear seat passenger (Begg & Langley, 2000). Furthermore, there is evidence indicating that drivers with a history of speeding convictions are also significantly less likely to wear seat belts (see Preusser, Williams, & Lund, 1991; Simsekoglu & Lajunen, 2009; Steinhardt & Watson, 2007). Research has shown that seat belt non-using drivers report preferences for higher driving speeds and competitive speed than those that use seat belts (Wilson, 1990).

While it is clear that risky driving is associated with the non-use of seat belts, a number of studies have sought to determine if this relationship is the product of a general tendency to engage in risk-taking behaviour. Begg and Langley (2000) asked young New Zealand drivers about (amongst other general driving behaviours) the likelihood of engaging in what they described as risky behaviour (e.g., bungy jumping, sky diving, and white water rafting). While Begg and Langley hypothesised that individuals who comply with seat belt laws may be more cautious than those that do not, their findings refuted this: both users and non-users reported similar levels of sensation seeking and they did not differ in respect to driving fast for thrills or taking deliberate risks for fun. While their approach may be sufficient to determine thrill-seeking behaviour, a better assessment of risk-taking might focus on other behaviours such as substance use, gambling, and other anti-social behaviours that have been linked with sensation seeking and risk-taking behaviours.

At least two studies have directly assessed the relationship between risk taking behaviour and seat belt use. Wilson (1990) explored the possibility that non-use of seat belts is part of a syndrome of problem behaviour characterised by a risky lifestyle, deviant personality, irresponsible attitudes, and greater risk taking while driving. Using driver licence records and interview data, Wilson identified three primary groups: the first consisted of individuals reporting they never used seat belts, the second

group reported inconsistent use, while the third group reported always using seat belts. Analysis of the driving histories and other risk taking behaviour of these groups revealed that those who were least likely to use seat belts (i.e., never or inconsistent users) were found to score higher for sensation seeking and were more impulsive, consumed more alcohol and were more likely to be addicted to drinking, used greater number of drugs, experienced more personal and interpersonal problems, and accumulated more traffic violations (Wilson, 1990). These groups also showed tendencies towards greater driving speeds, were found to have higher levels of hostility, and placed less importance on responsible attitudes. Furthermore, those less likely to use seat belts were also more likely to be involved in collisions resulting in either injury or property damage.

A more recent study by Matthews, Zollinger, Przybylski, and Bell (2001) assessed the relationship between adolescent risk behaviours and the use of safety devices, including seat belts. Utilising data from the 1999 Centre for Disease Control's Youth Risk Behaviour Survey they found that all of the risk behaviours assessed in the study (alcohol use, cigarette smoking, fighting, drug use, and sexual behaviour) were associated with the non-use of seat belts amongst adolescents. These findings lead the authors to conclude that seat belt use may be yet one more manifestation of adolescent risk behaviour.

An analogous strain of research undertaken by Simsekoglu and Lajunen (2009) studied the relationship between seat belt use and health behaviours (such as diet, exercise and sleep, alcohol and tobacco use, and dental health) amongst a Turkish sample for which seat belt use is voluntary. They found that seat belt use in both front and rear seats was positively associated with health promoting behaviours suggesting that health conscious people are more likely to use seat belts. This research compliments the risk behaviour literature (e.g., Matthews et al., 2001; Wilson, 1990) by providing evidence that seat belt users are more health conscious than non-users and, by extension, risk-takers who generally have less regard for their own health as can be observed in their higher levels of alcohol and substance use.

Utilising the evidence above it is possible to infer that seat belt use is related to the general behavioural tendencies of drivers. Individuals who are predisposed towards taking risks in several aspects of their lives also tend to do so when they drive or ride in cars. However, the status of current knowledge is such that it is difficult to determine the causal link between restraint use and risk-taking behaviour. More research in this area is needed.

Research has further identified that an individual's use of seat belts is also influenced by their position in the car (i.e., driver, front passenger, or rear passenger), and the presence of passengers. Evidence suggests that drivers and front seat passengers are more likely to use seat belts than individuals sitting in the rear seat (Begg & Langley, 2000; Wundersitz & Anderson, 2009; Zhu et al., 2007). Limited evidence suggests that these differences are due to lower perceived risk of injury amongst back seat passengers and forgetfulness (Begg & Langley, 2000). Furthermore, McCartt and Northrup (2004) suggest that for teenage drivers the presence of passengers aged over 30 years increases the use of seat belts, while the presence of teenage passengers reduces the likelihood of wearing a seat belt by 10% for each teenage passenger present. While no explanation is provided for this it is possible to infer that adult passengers (such as parents) reduce the likelihood of risk-taking in cars, while the presence of similar aged peers increases the likelihood for risk-taking. The influence of both parents and peers on adolescent risk-taking behaviour have been examined elsewhere (see Catalano & Hawkins, 1996; Jaccard, Blanton, & Dodge, 2005; Kosterman et al., 2004).

While a propensity for risk-taking may explain the non-use of seat belts for some individuals it does not provide an adequate explanation for those who are not generally risk-takers but also do not use seat belts. Understanding the general behavioural tendencies associated with seat belt use can

benefit from examinations of the reasons people provide for not using restraints. A number of studies directly asking individuals to provide the reasons for not using seat belts suggest that the most commonly reported reasons include forgetting or not being in the habit of using, travelling a short distance, apathy, the perceived level of risk of crashing is low, lack of comfort, and concerns that seat belts themselves are dangerous (Arup, 1991; Begg & Langley, 2000; Steinhardt & Watson, 2007). It is likely that these reasons will be exhibited in varying levels amongst different road users, and that an individual's attitudes, judgement, and general behavioural tendencies play a role in their restraint use. As such, a number of strategies may be required to overcome these barriers to restraint use.

2.2 Vehicle factors

Vehicle age and type are two key factors that are consistently associated with seat belt use. In a study of the characteristics of belted and unbelted drivers Preusser, Williams and Lund (1991) found that seat belt use was lower in cars older than 10 years. Similarly McCartt and Northrup (2004) have found that vehicle age was significantly associated with restraint use. Specifically, seat belt use was least likely in vehicles aged over 10 years and was most likely in vehicles aged less than five years. The association between older vehicles and lower restraint use is likely to be the product of many factors.

With regard to vehicle type there is a general consensus amongst the literature that seat belt use is more common in some types of vehicles and less common in others. Chaudhary and Preusser (2006) observed that seat belt use was generally lower in pickup trucks (utilities) than in other vehicles, which is supported by Eluru and Bhat (2007) who found drivers of pickup trucks are least likely to wear seat belts while drivers of SUVs were more likely. Eluru and Bhat suggest that associations between vehicle type and seat belt use may be a manifestation of the link between safety consciousness and vehicle choice. Individual's more concerned with safety may drive vehicles perceived to be more safe (e.g., SUVs) and also engage in other safety practices such as wearing a seat belt (see Section 2.1). A further explanation of this link between restraint use and vehicle type may be that pickup trucks may be more prevalent amongst rural drivers who also have lower rates of seat belt use.

2.3 Environmental factors

A number of environmental factors are associated with seat belt use. Observational studies have revealed that seat belt usage rates differ according to time of day and day of week. An observational study of night-time seat belt use in Connecticut (Chaudhary & Preusser, 2006) revealed that seat belt use was significantly lower at night. Furthermore, McCartt and Northrup (2004) found that young drivers involved in crashes were least likely to be wearing seat belts between the hours of midnight and 6 am. These findings have also been replicated by studies examining crash data conducted in other jurisdictions including the UK (Richards et al., 2008), France (de Lapparent, 2008), and Australia (Steinhardt & Watson, 2007). Roberts and colleagues (2006) observed higher prevalence of correct seat belt use amongst Western Australian car occupants between 6 and 10am and again between 6 and 10pm, times when traffic volumes are generally greater. Night-time use of seat belts for this sample ranged from 95% to 97% in the late night and early morning hours (10pm to 6am). A South Australian study reported seat belt use rates of 96.7% for both drivers and front seat passengers between the hours of 10pm to 3am (Kloeden & McLean, 1997).

Comparison of seat belt use during weekdays and weekends offers mixed results. Recent observational surveys in South Australia (Wundersitz & Anderson, 2009) and Western Australia (Roberts et al., 2006) recorded comparable rates of seat belt use during both periods. However, other studies (e.g., McCartt & Northrup, 2004) have found lower seat belt use amongst people involved in crashes on weekends. Such differences may arise from differences in both the locales of the research and the methods used. The Australian studies (i.e., Roberts et al., 2005; Wundersitz & Anderson,

2009) utilised data that was based on vehicle occupants of all ages observed in jurisdictions that generally have high usage rates and primary enforcement practices. In contrast, McCartt and Northrup's study compared the seat belt use of teenage drivers in primary and secondary enforcement states in the US. A number of studies have demonstrated that age and enforcement practices influence seat belt wearing rates such that adolescents are less likely to wear seat belts than older people (see Section 2.1) while individuals in secondary enforcement jurisdictions are also less likely to wear seat belts (see Section 2.4).

One aspect of environment that has received little attention is the influence of speed limits on seat belt use. McCartt and Northrup (2004) reported that on roads where the speed limit is greater than 30mph there is a significantly lower likelihood of seat belt use amongst young people involved in crashes. While more research into this association is warranted, it is likely attributable to a combination of higher speed limits on rural roads, which may lead to more severe crashes, and generally low rates of seat belt use in rural and remote areas.

Examinations of seat belt use in rural areas from both observational and crash-based studies reveal consistently lower rates in rural compared to urban regions (Arup, 1991; McCartt & Northrup, 2004; Tziotis et al., 2006; Wundersitz & Anderson, 2009). Palamara and colleagues (2009) report that individuals killed or injured in crashes in rural Western Australia were 1.6 times more likely to not use a seat belt than those killed or injured in crashes in metropolitan areas. Observational information with regard to seat belt use compliance further indicated that seat belt use across the metropolitan region (i.e., Perth) ranged from 93% to 100%, whereas seat belt use in regional areas varied from 52% to 100% (Roberts, Taylor, & Sidebottom, 2006). Indeed, reports on seat belt usage rates suggest that the prevalence of seat belt use reduces with increasing distance from major population centres (Roberts, Taylor, & Sidebottom, 2006; Tziotis et al., 2006). While enforcement practices may play some part in this (see Section 2.4) there is evidence to suggest that the necessity and benefits of seat belts have not fully pervaded rural drivers' consciousness.

There is evidence to suggest that rural drivers are less likely to wear seat belts when travelling short distances (less than 10 km), or travelling for everyday or work-related purposes (Arup, 1991). Knight, Harris, and Iverson (2008) suggest young rural people who learn to drive on the family's property may adopt habits, such as not wearing a seat belt, that are then transferred to driving when on the road. Other studies have reported that some rural drivers report not using seat belts as they are a nuisance when work requires getting in and out of a vehicle repetitively and that they are believed to be dangerous in other circumstances, for example becoming trapped in the case of vehicle roll-overs (Steinhardt & Watson, 2007; Sticher, 2005). Such evidence provides a snapshot of rural attitudes and norms regarding seat belt use such that there appears to be an inherent belief that seat belts are not always required. Roberts and colleagues (2006) noted that poor compliance with seat belt laws in regional Western Australia was due to either a disregard, or lack of awareness, for road traffic laws. In a similar vein Tziotis, Roper, Edmonston, and Sheehan (2006) identified the need to improve road and driver safety in rural areas and have suggested that changes to attitudes and beliefs may be facilitated by concomitant enforcement practices.

A further aspect affecting the use of seat belts in rural and remote regions appears to be the prevalence of recreational off road vehicle use. The recreational use of a vehicle off-road may be characterised by increased risk taking when driving, while the off road environment itself is often inherently dangerous (Steinhardt et al., 2006). For example, driving a four-wheel drive vehicle off road often entails the traversal of steep gradients, rocky terrain, and other hazards that entail some risk of vehicle rollover. These dangers may be further compounded by other risks including poor judgement, unfamiliarity with the terrain or vehicle, and non-use of a seat belt. A study of off and on road crashes in rural and remote Queensland revealed that individuals injured in an off-road crash were less likely

to be wearing a seat belt than those injured in on-road crashes (Steinhardt et al., 2006). Amongst the former 36% were not wearing a seat belt compared to only 10% amongst the latter, although it should be noted that this analysis was based on a small sample (14 in the off-road group and 71 in the on-road group). Potential explanations for these discrepancies in seat belt use may be that the risk of a crash or injury is perceived to be low, the likelihood of encountering enforcement while off-road is perceived to be low due to the fact that traffic laws do not apply to private property, and there is a belief that a seat belt may cause injury or prevent escape from an upturned vehicle.

The observed difference in seat belt use rates between urban and rural areas is one of the most conspicuous environmental factors, however it is likely that these differences are due to more than simply locale. Characteristics of the social environment such as enforcement of seat belt laws and community norms regarding the use of seat belts also play an important role in seat belt use. These factors are discussed further in the following section.

2.4 Seat belts and enforcement

Another important factor linked with the use of seat belts is seat belt legislation and enforcement practices. Historically the introduction of seat belt laws has seen the increase of seat belt use across jurisdictions where they have been implemented (Begg & Langley, 2000; Wundersitz & Anderson, 2009). However, this same research also shows that the uptake of seat belt wearing may also take some time to permeate regular vehicle occupant behaviour. In an analysis of seat belt related behaviours among young adults Begg and Langley (2000) found that in New Zealand the use of seat belts by rear seat passengers was low compared to seat belt use by drivers and front seat passengers. One of the main reasons for this was that many in their sample were not in the habit of using seat belts in the rear seat. Although New Zealand law has required the use of rear seat belts for nearly 30 years (20 years at the time the research was published) it appears that as children the adult participants were not required by law to wear seat belts, a habit they appear to have retained into their adulthood (Begg & Langley, 2000). As such it appears that changes in law do not immediately translate into behaviour change, especially where such behaviours are not the norm.

The relationship between enforcement and seat belt use is somewhat complicated incorporating issues related to the likelihood of detection and the punishment that follows. Indeed a number of reports have identified that enforcement practices play a key role in increasing seat belt use (see Arup, 1991; Steinhardt & Watson, 2007). For example, a number of Australian and international studies have found that seat belt use is consistently lower in rural compared to metropolitan regions (Arup, 1991; McCartt & Northrup, 2004; Tziotis et al., 2006; Wundersitz & Anderson, 2009). Evidence regarding the enforcement practices of police in rural versus urban regions also suggest that a combination of limited resources, social familiarity of police officers in rural communities, and the perceived importance of seat belt enforcement in comparison to other offences may contribute to lower rates of detection or enforcement in rural areas (Austroads, 2001; Cross, 2006; Tziotis, et al., 2006).

Further evidence of the effects of enforcement can be obtained through the examination of seat belt use in countries with jurisdictions operating on either primary or secondary enforcement practices. In primary enforcement jurisdictions police can directly enforce seat belt violations where and when they are detected, however in secondary enforcement jurisdictions police are only able to enforce seat belt laws when violations are detected after a driver has been stopped for some other violation (McCartt & Northrup, 2004). In their examination of seat belt use amongst teenage drivers involved in fatal crashes McCartt and Northrup (2004) compared belt use in primary enforcement states to secondary enforcement states and found that seat belt use amongst teenage drivers were highest in the former.

Another aspect of enforcement that has the potential to influence seat belt use, particularly amongst those that do not use them, is the penalties for breach of these laws. In order for enforcement to be effective the penalty associated with the behaviour needs to be sufficient to deter the behaviour and the perceived likelihood of being detected needs to be high. In interviews conducted with individuals observed on the New York Thruway in 1988 participants who did not regularly wear seat belts reported that rather than a monetary fine, licence demerit points were more likely to increase their use of seat belts (Preusser, Williams, & Lund, 1991). In South Australia drivers can receive on the spot fines and a loss of a minimum of 3 demerit points (DTEI, 2010), yet despite these penalties seat belt use prevalence, while high, is yet to reach 100% (Wundersitz & Anderson, 2009). One likely explanation is that, as demonstrated above, drivers whose lives are characterised by risk taking may also exhibit disdain and disregard for the law or its enforcers as evinced by their driving histories and general behaviour.

2.5 Differences in seat belt wearing rates

The prevalence of seat belt use among the general population is consistently reported as much higher than seat belt use observed among individuals involved in crashes in the research literature. For example, in South Australia the latest observational restraint survey results suggest around 2 to 4% of vehicle occupants do not wear restraints (Wundersitz & Anderson, 2009). However, crash data indicates that around 30% of fatally injured vehicle occupants in South Australia are recorded as not wearing restraints (Wundersitz, Hiranandani, & Baldock, 2009).

Seat belts have been proven highly effective at preventing around 50% of fatalities and reducing injuries resulting from crashes (see Introduction). If they are not worn then this protection is lost and more severe consequences may be expected. This is one possible reason why seat belt non-wearing vehicle occupants are more likely to appear in crash data than in observational data.

However, the discrepancy between these two rates is only partially explained by the increased likelihood of injury for non-restrained vehicle occupants in crashes. The relative risk of dying between unrestrained and restrained occupants in crashes is around 2.5 (Cummings, Wells, & Rivara, 2003). If the non-wearing rate amongst the population at risk was indeed 3% and the relative risk of being killed is indeed 2.5 for unrestrained occupants compared to restrained occupants, then, assuming restraint use is independent of crash involvement, we would expect to see (3% x 2.5) = 7.5% of occupant fatalities unrestrained. There are uncertainties in all of the related quantities that affect this relationship, however it is probable that the observational surveys do not capture the wearing rates of the population at risk of being killed in a crash. It is also apparent that certain groups of people are less likely to wear seat belts and possess other characteristics that increase their likelihood of becoming involved in crashes that are also more severe. As such it is pertinent to keep in mind that determining the efficacy of seat belts may be influenced by the over-representation of these people in data used to assess effectiveness. The discrepancy in the usage rates of seat belts may be the product of these aforementioned effects, an explanation of which can only benefit our current understanding.

Method for determining seat belt use

There are two key methods for determining seat belt use. The first is to undertake on-road observational studies of the restraint use of vehicle occupants. The second is to examine records of restraint use from crash data. As such the information obtained via each method are the product of the data collection process.

Observational studies are designed to provide a general indication of the prevalence of seat belt use among large groups of people. In order to obtain enough data from which the prevalence of restraint use can be estimated observations must be conducted in locations where traffic is sufficient to enable large numbers of observations. Furthermore, to obtain accurate observations, conditions must also provide a reasonable degree of visibility. For these reasons, observational studies are generally conducted in towns or cities at intersections or other locations where cars must slow down or stop (e.g., petrol stations, car parks, etc.) and are undertaken during daylight hours when traffic is generally at its heaviest. These methodological constraints are necessary to overcome a number of difficulties inherent in observing vehicle occupants, however, this does mean that observational studies are generally not conducted on rural roads with higher speed limits as conditions are not conducive to observation, nor are they conducted at night as the lack of lighting restricts visibility. As such, observational studies are generally undertaken in areas and at times when seat belt use is most likely to be at its highest.

Observing the prevalence of seat belt use in crashes presents a number of issues. First, considering the number of vehicles on the road at any given time, crashes are a relatively infrequent occurrence. Second, crash data is usually obtained from police crash databases that contain information about every crash of which the police are informed or have attended. These factors may influence the quality of the evidence or information available. For example, in South Australia police may not attend every crash however, it is required by law that police are informed where the damage caused by a crash exceeds $3000 or someone is injured as a result. When police do not attend the crash scene, crash information is provided by the individual reporting the incident and they may or may not accurately report seat belt use. When police do attend a crash the severity of the incident may influence the extent to which seat belt use is investigated. For example, in a minor crash police investigation may focus more on determining the cause of the crash, whereas the use of seat belts may be more thoroughly investigated in more severe crashes where it may also be necessary to determine the cause of injury. A further limitation of police crash data is the accuracy of methods for determining seat belt use, particularly so where investigators have only limited physical evidence on which to rely. Some types of evidence may be more accurate than others, for example, observing seat belt use first hand, or medical records showing injuries arising from the use of a seat belt (e.g., bruising) may provide a more accurate indication that a seat belt was worn than scuff marks on the belt itself. Evidence of seat belt use may also appear more obvious in crashes of higher severity.

Generally speaking police data is likely to be more extensive for crashes of higher severity as these attract a greater level of investigation. As such seat belt use will appear less frequent in these cases because the lack of use contributes to the severity of the crash itself.

Selective recruitment

The issue of selective recruitment arises from phenomena whereby the crashes of non-seat belt wearing drivers tend to be more severe and that non-seat belt users tend to be more dangerous drivers (see Section 2.1) with a higher propensity for involvement in crashes. Therefore drivers who would benefit the most from wearing seat belts are also least likely to wear them (Evans, 1996). For example, Steinhardt and Watson (2007) found evidence consistent with this hypothesis, identifying that those not wearing a seat belt were more likely to have alcohol and speeding listed as contributing factors for the crash.

The preceding discussion provides an insight into the factors that influence the use of seat belts among vehicle occupants. A number of studies have demonstrated the individual and environmental factors that influence seat belt wearing and have identifyied groups that are least likely to wear seat belts. Further analysis of crash data reveal that these individuals appear to be at a higher risk of

crashing and will also experience more severe outcomes when they do. For example, crashes resulting in fatality or injury are more likely to involve the non-use of seat belts in rural regions (McCartt & Northrup, 2004; Steinhardt & Watson, 2007), occur during the night (de Lapparent, 2008; McCartt & Northrup, 2004), and involve younger male drivers (McCartt & Northrup, 2004).

Taken as a whole and in light of the fact that the most severe crashes tend to be those where drivers are not wearing seat belts (Evans, 1996) it becomes clear that those who are least likely to use seat belts are also those most likely to become involved in serious crashes involving death or serious injury.

2.6 Summary

Studies examining the effectiveness of seat belts suggest that in the case of a crash wearing a seat belt can reduce the risk of death in the order of 38-46%, translating into enormous economic and social benefits. While seat belt use amongst the general population is generally quite high it appears that those who fail to use seat belts are over-represented in death and injury arising from crashes. The preceding discussion has outlined the factors and characteristics that have been identified to influence the use of seat belts. Drawing on this evidence it is possible to identify those person, vehicle, environment, and enforcement factors that influence the prevalence of seat belt use obtained through observational methods or crash data. Based on this evidence it becomes clear that discrepancies between observational and crash-based estimates of seat belt use arise partially as a function of the methodologies they employ for data collection. In short observational studies are generally undertaken at times and in locations where seat belt use is generally at its highest, while the nature of crashes and the people involved in them tend to produce a greater proportion of individuals who do not wear seat belts and for whom a confluence of factors contribute to a greater risk of crashing.

Based on the evidence collated for this review those individuals who are least likely to wear seat belts are also most likely to be involved in crashes resulting in death and/or serious injury. The people least likely to wear seat belts are likely to:

- Be young males;
- Be rear seat passengers;
- Live in rural areas;
- Drive older cars;
- Engage in risky and sensation-seeking behaviours including substance use and unsafe driving behaviour;
- Not wear seat belts during night-time hours.

Any observational studies of restraint use need to capture the seat belt wearing rates of the population at risk of being killed in a crash. The next part of the report will investigate the characteristics of this population and also examine the characteristics of their crashes.

3 Review of Coroner's files

In order to understand the sources of discrepancies between observational and crash-based accounts of restraint use an examination of South Australian Coroner's files was undertaken. State Coroner files are a useful source of detailed and diverse information about the people, vehicles and environments involved in fatal road crashes. Drawing on the evidence and information contained within these files, this part of the study will further explore the disparity between restraint use reported in observational studies and fatal crashes by:

- Determining whether the times and locations for the observational survey periods reflect the times and places when most fatal crashes occur; that is, examining whether the surveys capture individuals most at risk of fatal crash involvement.
- Exploring the extent to which the increased likelihood of injury when unrestrained contributes to the number of fatalities. The proportion of vehicle occupants that might have survived the crash if they had been wearing a seat belt will be estimated.
- Identifying the characteristics of unrestrained fatally injured vehicle occupants and specifically investigating whether being unrestrained is associated with risk-taking behaviour at the time of the crash.

3.1 Method

Sample

Files on 93 fatalities occurring in 2008 were obtained from the South Australian Coroner's Court. Of these, 25 were excluded from the present study because the deceased was either the rider of a motorcycle or a pedestrian. A further five cases (7%) were excluded from further analyses in this study because restraint use could not be determined.

Restraint use, demographic information, and vehicle and crash data were obtained for the 63 remaining fatally injured vehicle occupants (54 fatal crashes). Of this sample, 41 (65.1%) were male, 7 (11.1%) were identified as Indigenous Australians, and 41 (65.1%) were drivers. The mean age for the present study was 38.6 years (SD = 23.04) with a range of 1 to 93 years.

Measures

Seat belt use was determined based on evidence contained within the Coroner's files. This evidence included statements from police officers, ambulance or rescue personnel, or witnesses who observed the individuals in the vehicles, and autopsy evidence of injuries caused by seat belts. All other variables were drawn directly from the evidence contained within the file, including reports concerning investigations conducted by the Major Crash unit of the South Australia Police, mechanical vehicle inspections, forensic autopsy reports and forensic toxicology results.

For those cases where the deceased was found to be unrestrained at the time of the crash, survivability was estimated based on a review of the injuries sustained, the damage sustained by the vehicles involved (particularly intrusion or crush damage), and the estimated impact speed of the vehicle.

Risk taking behaviour was determined based on evidence indicating that the driver was involved in extreme behaviour that contributed to crash causation. Any definition of "extreme behaviour" relies on drawing an arbitrary line in terms of the risks posed by the behaviour. Where possible the authors

have drawn on research literature that has quantified the risk of crash involvement associated with extreme behaviours (i.e. alcohol, speed). Therefore, a driver was considered to be participating in "extreme behaviour" if one of any of the following conditions was deemed to contribute to the crash:

- A BAC level of 0.150mg/L or greater for drivers with a full licence (consistent with Category 3 drink driving penalties) and a BAC level of 0.100mg/L or greater for drivers with a learner permit or provisional licence.
- Travelling at a speed that is at least 50% over the speed limit (e.g. 90km/h in a 60km/h zone).
- A combination (two or more) of the following illegal driver behaviours: travelling at a speed of 30-35% or more over the speed limit (e.g. 80km/h in a 60km/h zone), positive for a prescribed drug (THC, MDMA, Methamphetamine), a BAC level of 0.100mg/L or greater and deliberate reckless driving behaviour (e.g. dangerous overtaking).

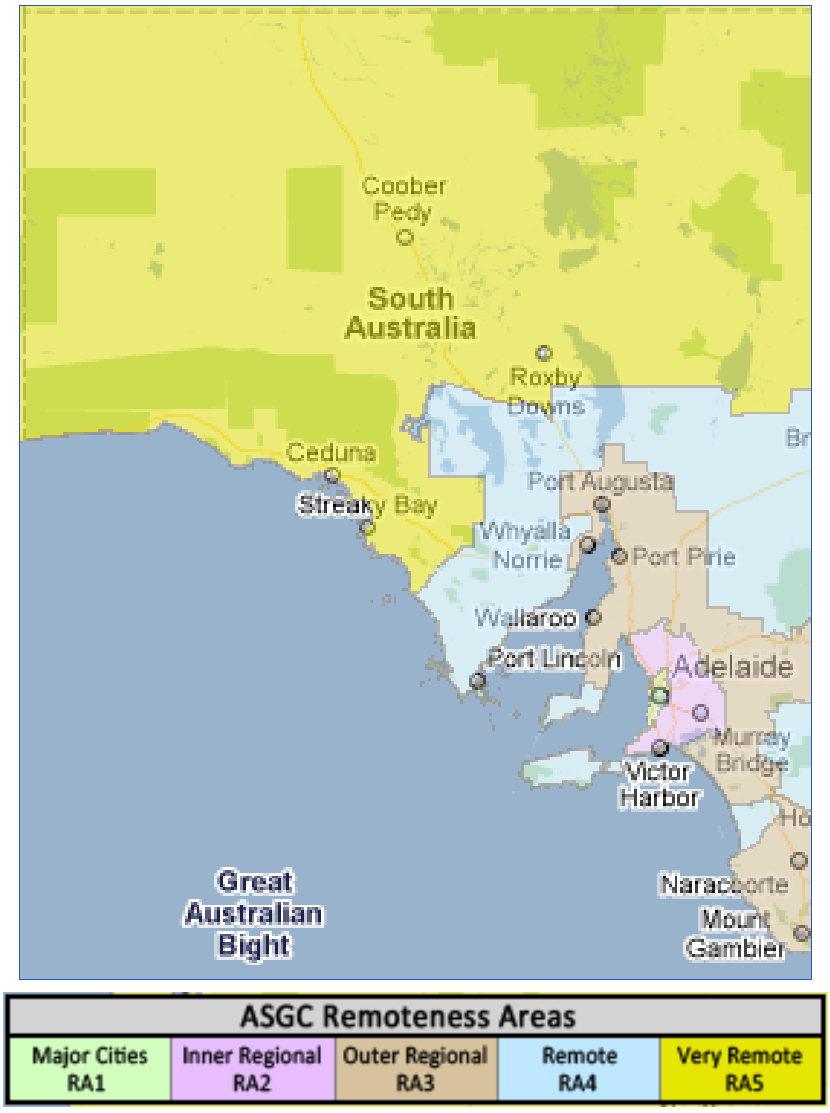
The Australian Bureau of Statistics Remote Areas classifications were used to determine the degree of remoteness for the fatal crashes in South Australia. The remote areas structure is based on the Accessibility/Remoteness Index of Australia (ARIA) developed by the National Key Centre for Social Applications of GIS (Trewin, 2001). ARIA scores are calculated using the distance along a road network people must travel in order to access services, goods, and opportunities for social interaction. As such it is a purely geographical concept. This distance is calculated using the ratio of the shortest distance to the mean shortest distance to each of five categories of service centre. These scores are then summed to produce the ARIA score for that population (see Trewin, 2001 for a more complete description). The ABS then uses these scores to classify a geographical region into categories representative of their degree of remoteness. Table 3.1 shows the remoteness code with its associated ARIA score.

For the present study Remote Area (RA) classifications were collapsed into three groups such that inner and outer regional RAs were simplified to regional, with both remote RAs classified as remote. These classifications were further simplified to metropolitan and rural, with a rural classification including regional and remote areas. Figure 3.1 provides a map depicting Remote Areas for South Australia.

Table 3.1
ABS Remote Area categories and associated ARIA score

Remote Area category	ABS code	ARIA score	Current study
Major cities	0	0 - 0.2	Metropolitan
Inner regional	1	0.3 > 2.4	Regional
Outer regional	2	2.4 < 5.92	Regional
Remote	3	5.92 < 10.53	Remote
Very remote	4	> 10.53	Remote

Figure 3.1
Map of South Australia remote areas
(Note: RA codes do not match ABS Remote Area codes) (Source: Department of Health and Ageing, 2010)



Procedure

Coroner's files for road crash-related deaths were obtained for crashes occurring in 2008 that were closed at the time of the study's commencement. Coroner's files were reviewed and all relevant details related to the crash (e.g., location, speed limit, road alignment and characteristics), the people involved (e.g., age, sex, seat belt use, injuries sustained), and the vehicles involved (e.g., type, age, safety features – airbags, seat belts, etc.) recorded in a database constructed specifically for the study. Data were then exported into a spreadsheet and SPSS for further analysis. Using this data a profile of the times and locations of crashes was produced to enable comparisons with the observational study methodology of Wundersitz and Anderson (2009).

3.2 Results

3.2.1 Characteristics of fatal crashes

In order to determine whether observational surveys were conducted at the times and in the places where fatal crashes occur, the first stage of the analysis involved identifying the times and places at which all fatal crashes involving passenger vehicles (excluding crashes involving motorcyclists or pedestrians) occurred. Figure 3.2 shows the distribution of fatal crashes by time of day. It shows that the highest proportion of crashes occurred between the hours of 8am - 10am and 6pm – 12am. Crashes involving unrestrained casualties appear to occur most frequently after 6pm. These vary slightly from the observational surveys times of 7am - 10am and 3pm - 6pm. Figure 3.3 shows the distribution of fatal crashes by day of week. A relative decline in fatal crashes from Sunday to Wednesday with a steady increase from Thursday to Saturday was observed. The greatest proportion of fatal crashes occurred over the weekend period, from Friday through to Sunday. Crashes involving unrestrained fatalities occurred throughout the week, however the majority appear to occur on Friday and Sunday.

Figure 3.2
Distribution of fatal crashes by time of day, 2008

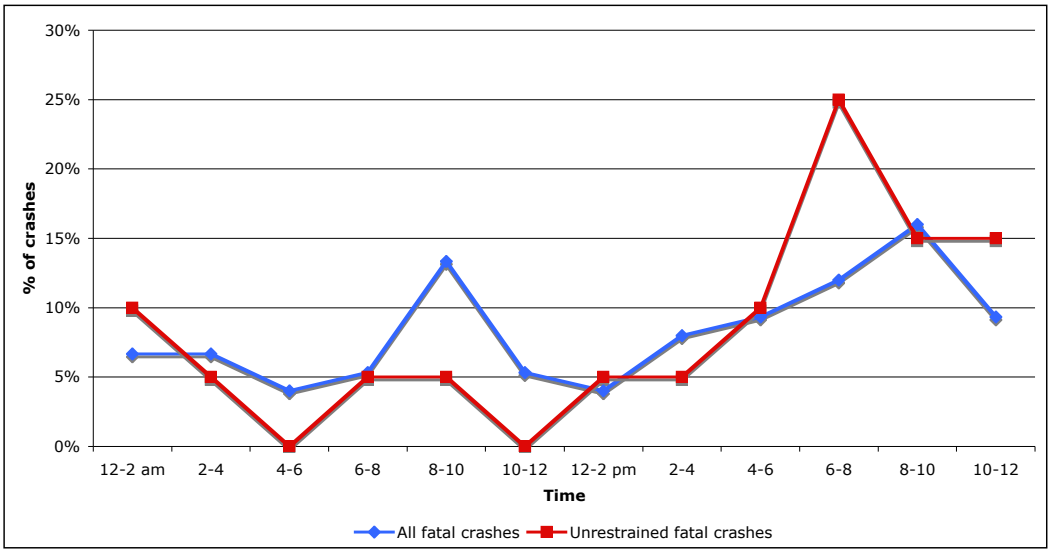
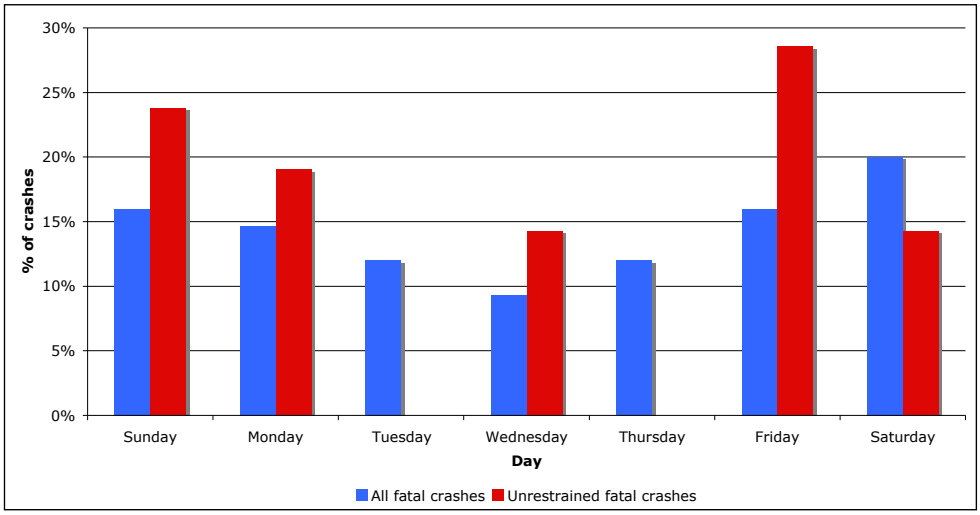


Figure 3.3
Distribution of fatal crashes by day of week, 2008



Assessment of crash locations revealed that over half of all fatal crashes occurred outside of the Adelaide metropolitan area (Figure 3.4), with remote and regional areas combined accounting for 57% of fatal crashes. Figure 2.4 also shows the incidence of crashes involving unrestrained fatalities in remote areas was about three times the rate of all fatal crashes in that region. The distribution of crashes by speed of road (Figure 3.5) shows that the preponderance of fatal crashes occurred on roads with a high-posted speed limit (over 80 km/h) with 100km/h and 110km/h roads accounting for the majority of these. For lower speed roads (i.e., roads with speed limits of 50-70km/h) the greatest proportion of fatal crashes occurred on roads with a speed limit of 60km/h. The majority of crashes involving unrestrained fatalities occurred on roads with a speed limit of 100 km/h.

Figure 3.4
Distribution of crashes by Remote Area category, 2008

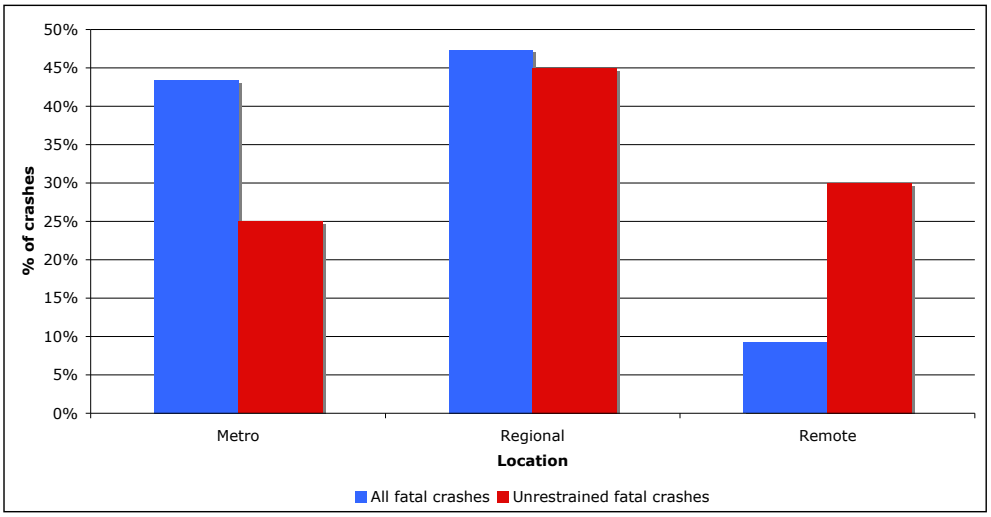
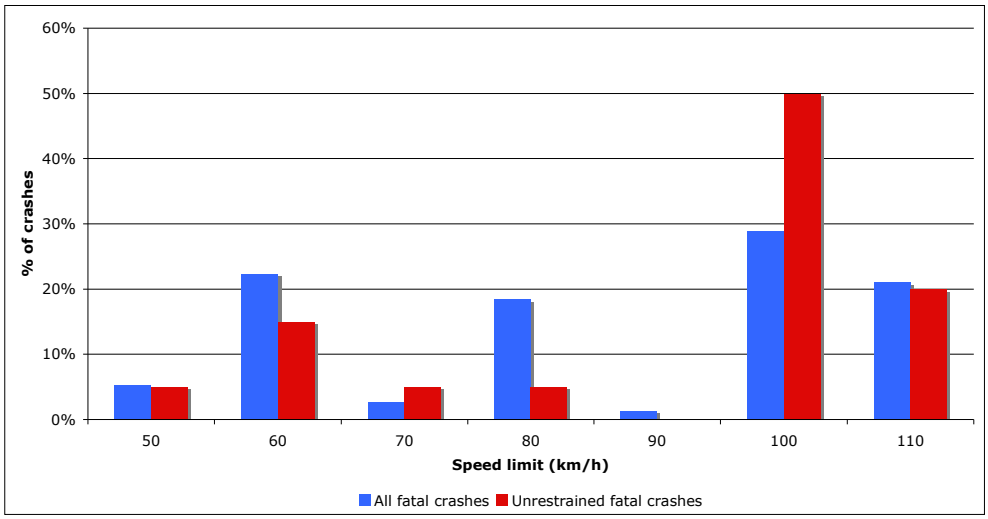


Figure 3.5
Distribution of crashes by speed of road, 2008



3.2.2 Seat belt wearing rates and survivability

A total of 23 (37%) vehicle occupants were unrestrained at the time of the crash, of which one occupant had no seat belt available. A review of all of the evidence available for these cases suggested that six would have survived the crash had they been wearing a seat belt, with a further eight deemed as probably surviving if they had used a seat belt. Amongst these cases a total of 12 (86%) individuals were ejected or partially ejected from the vehicle. Of the remaining cases, seat belts would have made no difference for three vehicle occupants (i.e., definitely would not have survived) and probably had little influence for a further six cases. This indicates that 14 (61%) of the 23 unrestrained fatalities would potentially have been avoided had the individual been wearing a seat belt at the time of the crash.

3.2.3 Characteristics of fatally injured vehicle occupants by restraint use

CRASH VARIABLES

To fully understand the discrepancies in restraint use across observational and crash-based studies the characteristics of fatal crashes were identified in order to determine the degree of concordance with observational methodologies. A series of chi-square tests for independence were conducted comparing the use of seat belts across a number of crash characteristics. The frequency and chi-square statistics for these analyses are provided in Table 3.2. Statistically significant differences in the use of seat belts was observed for the location of the crash and the number of vehicles involved in the crash. It would appear that more fatalities are unrestrained in crashes in regional areas than anywhere else and that more unrestrained individuals died in single vehicle collisions than in collisions involving multiple vehicles. Of those fatalities in remote areas 89% were unrestrained.

Table 3.2
Crash-related characteristics of fatally injured vehicle occupants by restraint use, 2008

Crash characteristic		Restrained (N=40)	Unrestrained (N=23)	X^2	*df*
Location	Metropolitan	13	5	12.43**	2
	Regional	26	10		
	Remote	1	8		
Time of Day	Day	18	8	0.63	1
	Night	22	15		
Observation study times	7-10am & 3-6pm	14	5	1.22	1
	All other times	26	18		
Day of week	Weekend	15	8	0.05	1
	Week day	25	15		
Speed of road	50-70 km/h	10	5	0.09	1
	80-110 km/h	30	18		
No. of vehicles^	Single	21	19	5.71*	1
	Multiple	19	4		

Note: Observation study times based on Wundersitz & Anderson (2009).
*p<.05, **p<.01, ^one or more cells contain fewer than 5 cases.

While none of the other analyses were significant a cursory examination of the time of day, speed limit, location of crash, and day of week reveal that the majority of fatal crashes occurred during the night (59%), more fatal crashes occurred outside of Wundersitz and Anderson's (2009) observational study times (70%), and fatal crashes were more common on roads with a posted speed limit of at least 80 km/h (76%). Comparisons of weekdays to weekends reveal that the majority of the crashes occurred during the week (63%) however, looking at the number of crashes during these periods reveals that during the week an average of eight crashes per day were observed, whereas an average of 12 crashes per day were observed over the weekend.

PERSON VARIABLES

Having identified salient crash characteristics further analyses were undertaken in order to determine the characteristics of individuals least likely to be restrained in a crash. Chi-square tests for independence were conducted to determine differences in seat belt use as a function of the characteristics of the person involved. Frequency and chi-square statistics for fatally injured vehicle occupants are provided in Table 3.3. Statistically significant associations with restraint use were observed for age, Indigenous status, and position in vehicle (front seat occupants versus rear seat occupants).

The significant association between Indigenous status and seat belt use suggests that non-Indigenous Australians are unrestrained more often than Indigenous Australians, however 71% of Indigenous Australians killed in a crash were unrestrained compared to 32% of non-Indigenous fatalities.

The significant association observed between restraint use and position in vehicle (front seat occupants versus rear seat occupants) indicates that fatally injured rear seat occupants (67%) were more likely to be unrestrained at the time of the crash than front seat occupants (31%). However, of all unrestrained occupants the majority (74%) were either a driver or front seat passenger.

The analysis of the age of fatally injured vehicle occupants revealed that people who were wearing seat belts were older (Mean age = 43.85 years, SD = 23.53) than those who were not (Mean age = 29.35, SD = 19.36), $t(61) = 2.51$, $p < .05$. Further comparison of occupants under the age of 25 years to those aged 25 years or more revealed no significant differences, however 78% of all unrestrained occupants were under the age of 25.

Although the association between restraint use and sex was not statistically significant, 70% of unrestrained fatalities were male.

Table 3.3
Person-related characteristics of fatally injured vehicle occupants by restraint use, 2008

Person-related characteristic		Restrained (N=40)	Unrestrained (N=23)	X^2	*df*
Sex	Male	25	16	0.32	1
	Female	15	7		
Indigenous status^	Indigenous Australian	2	5	4.14*	1
	Non-indigenous Australian	38	18		
Age	<25 years	26	18	1.22	1
	25 years and over	14	5		
Position in vehicle^	Driver	29	12	4.48	2
	Front passengers	8	5		
	Rear passengers	3	6		
	Front occupants	37	17	4.12*	1
	Rear occupants	3	6		

*p<.05, ^one or more cells contain fewer than 5 cases.

The results of analyses examining the influence of risk-taking behaviours on restraint use for fatally injured vehicle occupants are displayed in Table 3.4. Blood alcohol concentration (BAC) data was missing for two cases and drug data was missing for three cases. Vehicle speed at the time of the crash was not included as an individual variable in the present study due to inconsistencies in the rate at which it was reported in Coroner's files. While there was evidence of speed as a contributing factor in a number of crashes, only a limited number of crashes were reconstructed to estimate actual travelling and/or impact speeds.

Analysis revealed that individuals who tested positive for at least one of the three prescribed drugs (THC, MDMA, methamphetamine) were significantly more likely to be unrestrained than those who tested negative. The majority of unrestrained occupants (62%) were found to have an illegal BAC reading (over 0.05g/100ml for fully licensed drivers and over 0.00 for drivers with a Learner's or Probationary licence) however the difference in BAC status by restraint use status was not statistically significant.

Table 3.4
Risk-taking behaviours of fatally injured vehicle occupants by restraint use, 2008

Risk-taking behaviour		Restrained	Unrestrained	X^2	*df*
		(N=40)	(N=21)		
BAC	Legal BAC	23	8	2.08	1
	Illegal BAC	17	13		
		(N=40)	(N=20)		
Drug use^	Yes	3	6	5.29*	1
	No	37	14		

*p<.05, **p<.01, ^one or more cells contain fewer than 5 cases.

Restraint use was assessed separately for drivers exhibiting extreme behaviours and their passengers, as seen in Table 3.5 Of the 41 drivers in the study a total of 16 were identified as engaging in extreme behaviour at the time of the crash. Chi-square analysis revealed a significant association between extreme behaviour and restraint use such that drivers engaging in extreme behaviours were less likely to use seat belts. A separate analysis of the passengers of drivers exhibiting extreme behaviours revealed that no passengers who died were travelling with drivers exhibiting extreme behaviours. All 4 fatalities that were passengers in vehicles being driven in an extreme manner were restrained at the time of the crash.

The frequencies for types of extreme behaviours observed in the present study are provided in Table 3.6. Note that in many of these cases a combination of extreme behaviours were identified, as such the numbers in Table 3.6 exceed a total of 16. The extreme behaviours observed included alcohol intoxication (BAC >0.15mg/L), high speed (at least 50% over the posted speed limit), drug use (testing positive to THC, MDMA, or methamphetamine), and reckless driving.

Table 3.5
Extreme behaviour of fatally injured vehicle occupants by restraint use, 2008

Extreme behaviour	Restrained	Unrestrained	X^2	*df*
Driver	(N=29)	(N=12)		
Yes	7	9	9.28**	1
No	22	3		
Passenger with driver exhibiting extreme behaviour	(N=11)	(N=11)		
Yes	4	0	4.89*	1
No	7	11		

*p<.05, **p<.01

Table 3.6
Extreme behaviours exhibited by restrained and unrestrained drivers

Extreme behaviour	Restrained	Unrestrained
High BAC	7	10
High speed	4	6
Drug use	-	5
Reckless driving	2	3

VEHICLE VARIABLES

Finally, analyses were conducted to determine the relationship between vehicle characteristics and restraint use. Chi-square tests for independence were conducted to determine differences in seat belt use as a function of vehicle characteristics. The frequency and chi-square statistics are provided in Table 3.7. These analyses produced statistically significant associations between restraint use, main impact type, rollover crashes, and ejection from a vehicle. Main impact type was known for 57 of the 63 cases in the study. The significant association between restraint use and main impact type revealed that all individuals who died in crashes where the main impact was a rollover were unrestrained. The discerning reader will note that Table 3.7 provides two different totals with regard to rollover crashes. This is due to a subtle variation in the manner in which the two variables are measured. In the case of main impact type rollover refers to any crash where the main cause of damage was the vehicle rolling over independent of impact with other vehicles or objects (e.g., a single car overturning due to loss of control). The other rollover variable includes all vehicles that rolled over regardless of main impact type (e.g., a vehicle is struck side on and then rolls over).

The significant association between restraint use and rollover crash type suggests that individuals who die in a rollover crash were more likely to be unrestrained at the time of the crash. A similar association was observed for individuals who were ejected from the vehicle such that those who were ejected from the vehicle were more likely to be unrestrained (89%) than those who were not (16%). Further analysis undertaken to examine differences in restraint use and ejection status for vehicle occupants who were involved in a rollover revealed that occupants who were ejected were statistically significantly more likely to be unrestrained at the time of the rollover (93%). The cross-tabulation of this analysis is provided in Table 3.8.

Table 3.7
Vehicle characteristics of fatally injured vehicle occupants by restraint use, 2008

		Restrained (N=40)	Unrestrained (N=23)	X^2	*df*
Type of Vehicle^	Car	35	15	6.20	3
	SUV	1	2		
	Utility	3	6		
	Van	1	-		
Main impact type^		(N=39)	(N=18)		
	Front	13	6	27.08**	4
	Side	22	4		
	Rear	2	-		
	Roll-over	-	11		
	Side swipe	2	-		
Roll-over	Yes	6	14	14.18**	1
	No	34	9		
Ejected^	Yes	2	16	28.83**	1
	No	38	7		

*p<.05, **p<.001, ^one or more cells contain fewer than 5 cases.

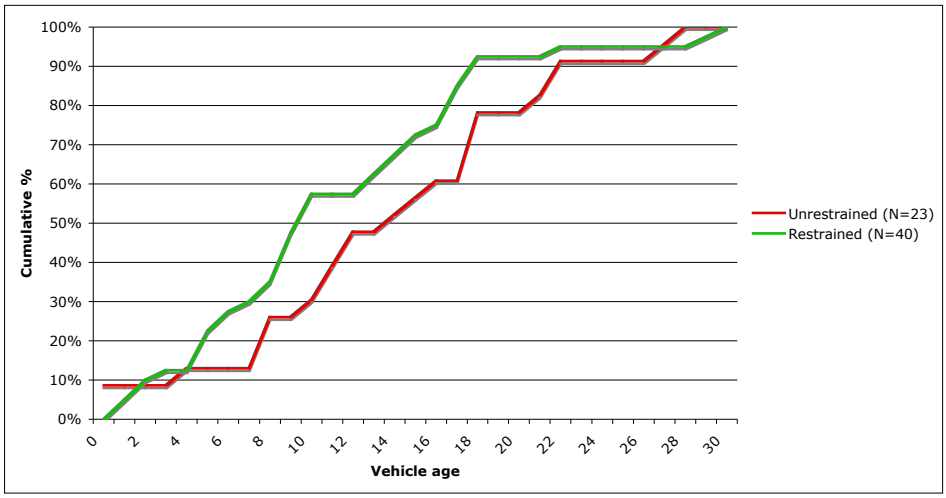
Table 3.8
Vehicle ejection status of fatally injured vehicle occupants involved in a rollover by restraint use

	Restrained (N=6)	Unrestrained (N=14)	X^2	*df*
Ejected	1	13	11.61*	1
Not ejected	5	1		

Note: Two cells contain fewer than 5 cases. *p<.01

Figure 3.6 shows the cumulative distribution of vehicle age for restrained and unrestrained fatally injured vehicle occupants. The mean age of passenger vehicles registered in South Australia is around 11.2 years (Anderson et al., 2009), while the median age of vehicles in the present study was found to be 12.5 years. While there was no statistically significant difference in vehicle age between restrained (Mean vehicle age = 11.38, SD = 6.8) and unrestrained (Mean vehicle age = 13.96, SD = 7.55) fatally injured vehicle occupants, approximately 58% of those who were restrained were travelling in a vehicle under 11 years old at the time of the crash compared to approximately 40% of those who were unrestrained.

Figure 3.6
Cumulative distribution of vehicle age for fatally injured vehicle occupants by restraint use, 2008



3.3 Discussion

A review of South Australian fatal crashes revealed some associations between restraint use and the characteristics of the crash. These findings are particularly useful for understanding how, and potentially why, restraint use rates reported in observational studies differ to those reported in crash statistics.

Assuming crash involvement and restraint use were independent (i.e., factors contributing to one do not contribute to the other), and levels of restraint use are 97% (as reported in recent survey results) then the expected rate of non-use of seat belts in fatal crashes would be 7.5%. However, the present study observed that 37% of fatalities were not wearing restraints. This disparity may arise from two potential causes. First, survey methodologies may over-estimate the prevalence of restraint use. Second, if restraint use and crash involvement are not independent it would be expected that the factors contributing to an individuals lack of restraint use may also increase their risk of crashing. Furthermore, given the increased severity of injury due to the lack of restraint use these crashes would be expected to be more severe, thus contributing to inflated rates of non-use in fatal crashes.

If, as suggested by Cummings, Wells, and Rivara (2003), the relative risk of dying between restrained and unrestrained vehicle occupants is 2.5 then it is expected that 60% of unrestrained fatalities should survive a crash. These estimates are in keeping with the survivability rates identified through a case-by-case review in the present study. Based on data from the Coroner's files it was, therefore, estimated that for nine (40%) of the unrestrained fatally injured, the severity of the crash exceeded the protective ability of the seat belt suggesting these crashes may have involved severe crush or intrusion damage. Furthermore, 60% of the fatalities appear to arise due to the lack of restraint use inflating the severity of the crash. Thus, it may be expected that the factors contributing to the individual's restraint non-use also increase their risk of crashing. As such, the present study provides further evidence of the selective recruitment effect. While it is evident that wearing a seat belt improves the chances of surviving a crash, the increased risk of death when unrestrained does not singularly account for the observed discrepancies in restraint use prevalence.

Examination of the geographical and temporal characteristics of crashes revealed that 89% of fatalities in remote areas were unrestrained compared to 28% for both rural and metro areas. Furthermore, over 70% of fatal crashes occurred outside of the Adelaide metropolitan area. Restraint use in non-metropolitan, and particularly remote, areas is clearly a significant problem that needs to be addressed. A simple examination of crash frequency also reveals that 70% of all fatal crashes occurred outside of observational study time periods, that is, outside the times of 7 - 10am and 3 - 6pm. Thus it is clear that the majority of fatal crashes occur at times and places current observational methodologies fail to address. There is, however, much more to this story.

It is apparent that observational methodologies are somewhat lacking in the capacity to detect individuals least likely to use restraints. However, it would also appear that the inflated rates of restraint non-use evident in fatal crash data might be due to a confluence of person factors. Based on the cases reviewed for the present study a number of factors were associated with an individuals restraint use. Although accounting for only 22% of unrestrained fatalities, Indigenous Australians were significantly more likely to be unrestrained when killed in a crash than were non-Indigenous Australians (71% versus 32% respectively). It was further identified that amongst all fatally injured vehicle occupants those who were unrestrained were significantly younger than those who were restrained, indeed 78% of all unrestrained fatalities were under the age of 25. Males accounted for 65% of all fatalities and 70% of all unrestrained fatalities, however restraint use did not differ significantly for male and female occupants. This may indicate that the predominance of young unrestrained males observed in fatal crashes is a product of this groups greater involvement in crashes in general. In addition to these demographic profiles, individuals engaging in risk-taking behaviours were also identified as having a higher level of non-use of restraint.

Individuals engaging in risk-taking behaviours were less likely to be restrained such that two thirds of individuals with toxicology reporting the presence of illicit substances (i.e., THC, methamphetamines, and MDMA) were unrestrained compared to approximately one quarter of individuals with a drug negative toxicology screen. Drivers engaging in extreme behaviours were more likely to be unrestrained. Of the 41 drivers in the study 16 (40%) were identified as engaging in extreme behaviour at the time of the crash, of these 9 were unrestrained and accounted for the majority (82%) of all unrestrained driver fatalities. Interestingly all passengers of drivers engaging in extreme behaviour killed in a crash were restrained. Amongst drivers exhibiting extreme behaviours high levels of intoxication, excessive speed, drug use, and reckless driving were observed. It is possible that some level of impairment due to intoxication influences the decision to use a seat belt, although the present study is unable to confirm this hypothesis. There is also the possibility that the individuals propensity for risk-taking behaviour in general further manifests itself in conscious decisions to not wear a seat belt, however the function of such behaviour in the context of risk-taking is unclear (e.g., does it

heighten the sensations associated with driving fast, or does non-use of restraint form an integral part of the risk-takers self-concept).

Taken as a whole these findings suggest that those who do not wear seat belts may have an increased risk for crashes of increased severity which may be either exacerbated by the lack of restraint use (e.g., a rollover crash), or exceed the protective effects of the seat belt (e.g., severe crush or intrusion damage). These risks may be linked with geographical environments (e.g., high speed roads) or the individual's behaviour, attitudes, social norms, or some other factor. Any attempt to ameliorate the harms associated with non-use of restraint should target these factors.

There is some evidence that the attitudes of rural people influence their restraint use and contribute to the lower rates of restraint use observed in rural areas. The higher incidence of unrestrained fatalities in rural, and remote areas indicates that public education campaigns specifically targeting the awareness and importance of restraint use amongst rural drivers may be required. Furthermore, the evidence indicates that Indigenous Australians may require particular attention given the greater risk of dying unrestrained in a crash. Any intervention needs to address the risk factors of the intended population and it is possible that indigenous Australians may require a specialised approach. Other potential targets of educational campaigns may include restraint use amongst younger occupants, including rear seat passengers. Any comment on the causal mechanisms underpinning the risk of dying unrestrained is limited due to the available evidence and is largely beyond the scope of the present research. At any rate it is evident that more research in this area is required.

It is also evident that interventions to minimise the harms of restraint non-use should be targeted at males and younger drivers given their over-representation in the present study. These groups are also known to have increased involvement in other risk-taking behaviours, such as substance use, that may further influence their lack of restraint use due to the impairment of cognitive processes or other disinhibiting effects (Begg & Langley, 2000; Matthews et al., 2001). Given the difficulties inherent in changing the behaviours and attitudes of this population, strategies to improve the usage of restraints could make use of technological advancements in vehicle safety. It should be noted that such technologies would benefit all drivers, not just those predisposed to risk-taking.

Technology is playing an increasing role in vehicle safety and would be a logical approach to improving restraint use rates or reducing fatalities given that, when fitted, they form an integral part of a vehicles operation. Seat belt reminders are a passive technology that entails the use of a light, noise, or both to remind the driver to wear a seat belt or inform drivers of the restraint use (or lack thereof) of their passengers. Such devices are becoming increasingly common and have been associated with restraint use rates ranging from 90 - 98.9% in vehicles fitted with such technology in the United States and Sweden (Ferguson, Wells, & Kirley, 2007; Kraaft et al., 2006). Clearly there remains a small percentage of individuals for whom such technology remains ineffective, indicating at the very least that some 10% of individuals make a conscious decision to drive unrestrained despite reminders. Such findings demonstrate the need to identify the reasons why some choose not to use seat belts when they are available and are presented with reminders to do so. It also suggests that other technologies or interventions may be more effective for these individuals.

The results of the present study indicate that in 2008, 20 of the fatalities happened in a crash where the vehicle rolled over, 70% of which were unrestrained at the time. Furthermore, 13 of the 14 fatalities that were ejected during a rollover were unrestrained. Approaches to reducing fatalities arising from such circumstances may involve active safety technologies fitted to vehicles that either increase restraint use in general or prevent crashes occurring. For example, seat belt interlocks prevent a car from starting unless a seat belt is worn. As such it appears to offer a simple solution to the problem of drivers and passengers who actively choose not to wear a seat belt. Another technology that is

proving successful at preventing loss of control crashes (including roll-overs) is electronic stability control (Papelis, Watson, & Brown, 2010). It is evident that the adoption of these technologies has the potential to reduce the number of unrestrained fatalities in general, while the prevention of specific crash types (e.g., loss of control) is preferable to reliance on secondary safety systems such as seat belts. Indeed, the findings of the present study further demonstrate the importance of crash prevention. However, due to the manner in which new vehicle technologies become available there is a significant latency period after the uptake of these technologies before they become readily accessible to the wider community. The modal age of vehicles included in the present study was 12.5 years, indicating that it would take at least this long for new technologies to pervade 50% of the vehicle fleet, assuming, of course, that all new vehicles are fitted with them.

The present study also describes the times and locations where most fatal crashes occur, that is, during the night, on roads with higher posted speed limits, and in rural areas. This provides some indication that enforcement strategies may have greater influence if undertaken at these times and in these places. Other researchers (e.g., Austroads, 2001; Cross, 2006; Tziotis, et al., 2006) have identified that enforcement practices in rural areas may be more lax than those in metropolitan regions, which may be one factor that contributes to the higher incidence of restraint non-use in these areas. However, it is unclear whether restraint use in rural areas is due to the lack of enforcement, the decreased likelihood of restraint use being detected on high-speed roads, or some other factor. Improved methods of detecting and enforcing the behaviours of drivers exhibiting extreme behaviours clearly has road safety benefits beyond simply addressing restraint use, however other strategies may be revealed by developing an ability to identify these individuals prior to their involvement in a fatal crash.

3.4 Summary

The non-use of restraints was observed for 37% of crash fatalities included in the study, far more than the 7.5% expected from calculations based on restraint use observed in a recent survey (Wundersitz & Anderson, 2009). The current observational approaches provide an assessment of restraint use compliance in general, however any value to such studies may be limited due to a potential failure to detect those individuals least likely to use restraints. Future observational studies may address these shortcomings by refining existing methodologies to include observations during the night and in remote areas; observation sites should also incorporate high-speed roads. Observation sites should continue to include metropolitan areas and observations should continue to be undertaken throughout the week and weekend. Such changes are not without difficulty as issues regarding the practicality of conducting observations (i.e., visibility concerns under poor lighting conditions and observing vehicles at high speed) and the logistics of observing (i.e., selecting sites with sufficient traffic) must also be considered. It is possible that future surveys incorporating these aspects into existing methodologies will be more likely to capture those individuals least likely to be restrained and provide a more refined picture of the prevalence of restraint use. However, any alteration to methodology limits the ability to detect change over time (i.e., by comparing findings across studies). Given that recent findings indicate the general restraint use compliance is consistently around 97% a new approach capable of more accurate detections of unrestrained individuals may be warranted.

The present study provides a valuable insight into the restraint use of individuals fatally injured in crashes. It was identified that unrestrained individuals had a lower mean age, are more likely to be drivers engaging in extreme behaviour, and are more likely to have used drugs. Non-use of restraint was also identified as a significant issue for Indigenous Australians, the overwhelming majority of whom were unrestrained at the time of the crash. The protective benefits of seat belts was also evident in the increased fatalities amongst unrestrained individuals involved in rollover crashes, and especially amongst those who are ejected during a rollover.

The findings of the present study suggest that discrepancies between restraint use rates observed in observational and crash-based studies arise partially from differences in methodology and the crashes of some unrestrained individuals, the severity of which is inflated due to the lack of restraint use. It would appear that a number of person and crash characteristics related to restraint use and crash involvement may also contribute to these differences. Public education and enforcement strategies may go some way to addressing these issues for some groups, however technologies such as seat belt interlocks and electronic stability control may be an important measure to improve restraint use and crash rates among those at greatest risk.

4 Conclusion

Observational surveys of restraint use in South Australia have reported vehicle occupant wearing rates somewhere in the order of 97% but these rates decrease below 70% for crashes where vehicle occupants are killed or injured. The primary aim of this study was to seek some understanding of why the prevalence of seat belt use varies between observational studies and fatal crash statistics.

A detailed review of restraint use literature examined person, vehicle, environmental, and enforcement factors related to seat belt use. This revealed that those individuals least likely to wear seat belts are also most likely to be involved in crashes resulting in death or serious injury. The people least likely to wear seat belts are likely to:

- Be young males;
- Be rear seat passengers;
- Live in rural areas;
- Drive older cars;
- Engage in risky and sensation-seeking behaviours including substance use and unsafe driving behaviour;
- Not wear seat belts during night-time hours.

A review of closed Coroner's files for fatal crashes occurring during 2008 produced a sample of 63 fatally injured vehicle occupants for whom restraint use was known. Of this sample 23 (37%) were unrestrained at the time of the crash. Statistical analysis revealed that:

- Restraint use was least common in crashes outside of the Adelaide metropolitan area;
- Unrestrained vehicle occupants had a lower mean age than restrained vehicle occupants;
- Non-Indigenous Australians were more likely to be unrestrained in a crash, however 70% of indigenous Australians killed in a crash were unrestrained;
- Individuals testing positive to any of the prescribed drugs (THC, MDMA, or methamphetamine) were more likely to be unrestrained than those who did not;
- Drivers engaging in extreme behaviours were more likely to be unrestrained;
- Individuals killed in rollover crashes were least likely to be restrained than those killed in other crashes. Furthermore, 70% of occupants were ejected during a rollover, of which 93% were unrestrained. Of those not ejected 83% were restrained.

It is apparent that individuals least likely to be wearing restraints may be travelling and crashing at times and in places outside of the parameters set by existing observational methodologies. Refinement of surveys to include observations during the night, in remote areas, and on high-speed roads may capture a more accurate representation of restraint use than they currently produce although there are some practical issues to consider.

Based on the observed prevalence of restraint use and the relative risk of being killed in a crash whilst unrestrained it was estimated that 7.5% of fatally injured vehicle occupants could be expected to be unrestrained, whereas the actual rate detected in Coroner's data was 37%. It is possible that survey methodologies may overestimate restraint use. However, estimates based on the effectiveness of seat belts predicted that 60% of the unrestrained fatalities detected in the present study may have survived if they had been using a seat belt, while 40% of these crashes were so severe restraint use would have made no difference to the outcome. Such findings suggest that the characteristics of unrestrained individuals may also increase their likelihood for crashing. Public education campaigns

and strategic enforcement initiatives might assist in addressing these issues for some groups. In addition, new technologies such as seat belt interlocks and electronic stability control may be necessary to achieve significant improvements in restraint use among those at greatest risk although, it will take some time for these features to dominate the vehicle fleet.

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