Federal Office of Road Safety

Analysis of Single Vehicle Rural Crashes

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Abstract

This study employed fatal crash data from the Federal Office of Road Safety 1988 *Fatality File*, serious crash data from the period 1989-90 for Victoria, Queensland and Western Australia and serious crash data for 1990-92 from the Northern Territory. Factors associated with the following groupings of crashes were identified: Overturns in remote regions, collisions with objects in remote regions, overturns in non-remote rural regions and collisions with objects in non-remote rural regions.

Keywords

Fatal crashes, road fatalities, rural crashes, single vehicle crashes, statistical analysis,

Notes

(1) FORS research reports are disseminated in the interests of information exchange.

(2) The views expressed are those of the authors and do not necessarily represent those of the Commonwealth Government

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EXECUTIVE SUMMARY

A disproportionate number of serious rural crashes involve vehicles overturning or hitting an object. This study identified factors associated with the following groupings of these crashes:

- overturns in remote regions
- collisions with objects in remote regions
- overturns in non-remote rural regions
- collisions with objects in non-remote rural regions.

The study employed fatal crash data from the Federal Office of Road Safety *Fatality File, 1988*, serious crash data of the period 1989-90 for Queensland, Victoria and Western Australia and serious crash data of the period 1990-92 for the Northern Territory. The serious crash data covered all crashes which resulted in at least one person being hospitalised or killed, and differ from the Fatality File in that these crashes predominantly resulted in non-fatal injuries.

This study is limited to single vehicle rural crashes involving passenger vehicles or car derivatives.

Characteristics of single vehicle rural crashes

Fatal crashes

- Fatal single vehicle rural crashes mostly occurred in fine weather on dry, straight and level roads.

- The crashes frequently involved high risk driver and occupant behaviour.
  - Speeding was recorded for one half of the crash vehicles for which speed information was available.
  - Drink driving was involved for up to one half of the crashes for which driver BAC readings were recorded. (In view of probable greater sobriety amongst drivers lacking recorded BACs, this may slightly overstate the incidence of drink driving but it is nevertheless unlikely to be less than 40%.)
  - Speeding and blood alcohol were highly correlated in these crashes. Of speeding drivers for whom BAC was recorded, some 64% had a value in excess of 0.05. (Again, this may be a slight overstatement but it is unlikely to be less than 50%.)
  - Seat belts were not used by 35% of the vehicle occupants for whom seat belt use was recorded.

- Drink driving in these crashes was relatively more common amongst those of labourer occupation followed by plant and machine operators, tradespersons and the unemployed.

- The left hand road shoulder was implicated in 23% of crashes.

- Survival in these crashes was much more likely for belted occupants. Male occupants in these crashes were more likely than female occupants to be unbelted (38% and 30% respectively) and occupants in vehicles with drunk drivers were more likely to be unbelted than those with sober drivers (58% and 28% respectively).

Serious crashes

- This group of crashes, predominantly resulting in non-fatal injuries, was characterised by somewhat lower prevalence of risky driver and occupant behaviour.
  - Excessive speed for conditions was determined to be a major contributing factor in 6% of Queensland crashes and 17% of Northern Territory crashes. Of Western Australian crash vehicles for which speed was recorded, some 27% were classified as speeding.
  - Of crashes for which driver BAC readings were available, drink driving was involved in as few as 14% of cases (Queensland) and as many as 50% of cases (Victoria).
  - For injured occupants in serious crashes for whom data are available, as few as 18% (Victoria) and as many as 54% (Northern Territory) were unbelted.

- Involvement of the left hand road shoulder was recorded for Western Australian serious crashes, and was less frequent than for fatal crashes Australia-wide (13% and 23% of crashes respectively).

- In common with Australian fatal crashes, male occupants in serious single vehicle rural crashes were more likely than females to be unbelted and occupants in vehicles with drunk drivers were more likely to be unbelted.

Differences between remote and non-remote crashes

The study detected no major systematic differences between remote and non-remote single vehicle crashes with the exception that remote area collisions were much more likely to involve an animal. However, major differences were observed between overturns and collisions with objects, as described below.

Comparison of overturn and hit-object crashes

- Unbelted vehicle occupants were much more likely to have been killed in overturns than in collisions with objects.

- The overall effect of a high risk when unbelted and a low rate of belt wearing is reflected in disparate numbers of unbelted and belted overturn fatalities for the period studied. Most notably, 72 unbelted people were killed in Northern Territory overturns compared with 5 belted people, and 25 unbelted people were killed in Victorian overturns compared with 6 belted people.

- Fatally injured occupants in these crashes were more likely to have received:
  - a head injury in an overturn than in a hit-object crash
  - an injury to the abdomen or pelvic contents in a hit-object crash than in an overturn.

- Involvement of the left hand road shoulder was more pronounced in fatal overturns than fatal hit-object crashes (37% and 19% of crashes respectively).

Implications for road safety countermeasures

- Countermeasures need to address the high risk driver and occupant behaviour prevalent in single vehicle rural crashes. Drink driving stands out as a major issue in view of its high incidence and its close relationship to other risk taking such as speeding and non wearing of seat belts.

- Seat belt wearing appears to be a major issue in its own right given the low overall rates of belt wearing and the fact that survival is much more unlikely when unbelted, as is clearly apparent in the relative counts of unbelted and belted fatalities in overturn crashes. With a few exceptions, male occupants in all types of fatal and serious single vehicle rural crashes were less likely to have worn seat belts than females.

- There is also a need to address the frequent involvement of the left hand road shoulder in single vehicle rural crashes, particularly those resulting in fatality.

A. LITERATURE REVIEW OF SINGLE VEHICLE RURAL CRASHES

A.1 Introduction

A wide selection of Australian and overseas literature is available on many aspects of road accidents. Studies specific to rural Australian conditions exist, mostly in the form of Federal Office of Road Safety reports. Overseas studies have been noted if they are relevant to the present examination of single vehicle rural crashes.

An examination of road fatalities in rural New South Wales (Renwick et al. 1982) led the authors to conclude that the primary cause of road accidents was driver failure, but that this was often exacerbated by road conditions. McAdie (personal communication), a senior sergeant with the Northern Territory police, suggested all accidents are solely due to driver failure. McAdie hypothesised that drivers judge the degree of risk involved under particular road and vehicle conditions. Accidents result because drivers are not completely accurate judges. A World Health Organisation study group report (1989) criticised this "common sense" approach however, indicating that a thorough knowledge of how accidents occur is essential. They suggest that accidents are "multifactorial" and that classifying accidents according to road user's error or traffic offence is not very meaningful.

The most recent attention worldwide has been on driver fatigue. A recent Australian interest has been road shoulders. Speed and alcohol, while unfortunately still implicated in many fatalities, have not been subject to much research in recent years.

A.2 Factors which cause fatal or serious injury crashes

A.2.1 Driver behaviour

A.2.1.1 Speeding

The dangers of speeding are now widely known and accepted. The recent literature focuses on driver perception of safe travelling speed.

In an Australian report, Fildes et al. (1987) found that the effect of travelling on an open, rural road compared to urban or semi-rural roads, was for drivers to perceive a faster speed as being safe.

A study by Fitzgerald (1989) examined whether an increase in the heavy vehicle speed limit in five Australian states in 1987 had increased truck speeds or road safety. Articulated vehicle speeds had increased in 4 states, but car speeds had not. Thus "speed dispersion" had decreased.

The speed limit was again raised in 1988 and a survey undertaken to determine the effects. Anderson and Adena (1989) concluded that articulated truck and car speeds were higher at most measurement sites, and that the mean speeds of the two types of vehicle were closer at most sites.

Another study sponsored by the Federal Office of Road Safety (Stevenson and Williamson 1988) surveyed truck drivers and found that speed was not considered to be a common cause of road crashes for trucks.

A 1989 study of rural highway fatalities in New Mexico in the United States (Gallaher et al. 1989) reported an increase in the rate of fatal accidents in the year after the speed limit was increased to 65 miles per hour. The rate increased to 2.9 per hundred million vehicle miles travelled, whereas the value predicted from the previous 5 years was 1.5 per hundred million vehicle miles travelled. The large increase was attributed to an increase in the rate of fatal single vehicle crashes. Mirate (1990) noted that there was an increase in the percent of victims ejected from the vehicle. The increase was from 53% to 70%. The corresponding reduction in seat belt use was from 11.9% to 10.5%.

A.2.1.2 Alcohol and drug use

Evans et al. (1991) reported that no specific form of punitive legislation has had an effect on motor vehicle fatalities. A combination of such laws seemed to be a deterrent. They noted that alcohol is over-represented in single vehicle fatal accidents.

The incidence of drink driving in the United States was found to have declined between 1973 and 1986 (Lund and Wolfe 1991). Similarly, a decline was found between 1982 and 1989 (Morbidity and Mortality Weekly Report, cited in From the Centres for Disease Control, JAMA, 1991). Both studies found that the most effective legislative measure was increasing the minimum drinking age.

A 1990 study (Evans 1990) considered the number of traffic fatalities due to alcohol. It was estimated that if alcohol was not available, the number of fatalities would be reduced by between 43% and 51%. For single vehicle crashes, eliminating alcohol use might reduce driver deaths by 55%.

Hyland et al. (1990) compared the eight year period from 1980 to 1987 with the years from 1952 to 1959. The authors studied the trends in blood alcohol levels of fatally injured drivers involved in single vehicle accidents. The mean age and the mean blood alcohol concentration were the same for drivers in both time periods. There was an increase in vehicle miles travelled over the two study periods, leading Hyland et al. to estimate that there may have been a reduction of between 20 to 25% in alcohol associated mortality.

Drink driving by women has become a focus of investigation recently. An Australian study by Holubowycz (1989) found that between 1981 and 1987 the proportion of female drivers on the road at night and the proportion of female drivers with blood alcohol concentrations above .08 increased significantly. However, the proportion of female drivers that were killed did not increase, and within the group of fatally injured female drivers there was no evidence of a trend over time in the proportion of accidents involving drink driving.

This is not supported in overseas studies.

Using United States data, Popkin (1991) found that although the alcohol involvement rate in all fatal crashes has been falling, this is not true for females been 21 and 24 years of age.

Zador (1991) examined the relative risk of fatal crash involvement at various blood alcohol concentrations. Females were found to have higher relative risks than males with a blood alcohol concentration above .05. For single vehicle crashes, the relative risk of a fatal crash with blood alcohol concentration greater than .15 was 300 to 600 times greater (for all drivers) than for 0 or near 0 blood alcohol concentration.

A.2.1.3 Fatigue

A recent Victorian study (Transport Accident Commission 1991, cited in Naughton and Pierce 1991) suggested 25% of accidents in that state are related to driver fatigue or pathological sleepiness. Since our understanding of sleep is very limited, researchers of fatigue as a cause of road fatality have not yet agreed if "highway hypnosis" or "driving without awareness", "underload" and "overload" are separate phenomena from sleep, or whether these are all fatigue related conditions (Horne 1992, Hewitt, personal communication 1992).

Haworth et al. (1988) reviewed available literature on the contribution of fatigue to road crashes in Australia. They concluded that the contribution of fatigue is probably highest in fatal crashes, with an estimated incidence of 25 to 35%. The incidence was thought to be higher still in fatal, single vehicle semi-trailer crashes.

In a United Kingdom pilot study conducted by Horne (1992), 58 accidents that seemed sleep related occurred in clusters during three two hour periods of the day: midnight to 2am, 4am to 6am and 2pm to 4pm. The second of these was the most dangerous time. When consideration is given to the low traffic density during the hours from 4am to 6am, the incidence of accidents at this time is 7 times higher than at other times of the day. There are 13 times more sleep related accidents between 4am and 6am than between 10am to noon or 8pm to l0pm.

Mitler et al. (1988) concluded that accidents and catastrophes were more likely than randomly expected to occur during the period from lam to about 8am. There was a second important time period between 2pm to 6pm.

Sleep apnoea has recently become a major focus in the research on driver fatigue. This is a respiratory disease which causes excessive daytime sleepiness. The disease is most prevalent in middle-aged males, among whom 5 to 10% are affected. Obesity is commonly associated with the disease and according to a study by Stradling (1989, cited in Horne 1992) long distance truck drivers often fall into this group.

Findley et al. (1988) studied the effects of sleep apnoea on driving record. Twenty-four percent of the sleep apnoea patients said that they fell asleep while driving at least once a week. The study showed that the group of subjects with sleep apnoea had a sevenfold greater rate of car accidents than the control group. Other studies have put the figure for single vehicle accidents at a twelvefold increase for sleep apnoea sufferers (Haraldsson et al. 1990, cited in Naughton and Pierce 1991).

A.2.1.4 Fatigue and the use of stimulants

Haworth (1989) reported on the use of stimulants by Australian truck drivers. A survey undertaken in Texas in the U.S.A. indicated that up to 80% of truck drivers used drugs to help themselves stay awake while driving. This and other studies led Haworth to conclude that 40 to 60% of long distance truck drivers had recently used stimulants. Haworth reported that dependence on amphetamines may lead to drivers being prone to falling asleep when the drug is not available. The author reported that very few studies have been carried out on the effect of stimulant use in fatal crashes because of the lack of data on stimulant use.

A.2.1.5 Inexperience/youth

A study by Matthews and Moran, reported in Dewar (1991), shows that young drivers over-rate their own driving ability, but do not feel as confident about the ability of their peers. Older drivers rated their ability comparably with their age group.

Dart and McKenzie (1982) investigated fatal, single vehicle, rural accidents in Louisiana and determined that human factors were the major cause of most of the accidents. Youthful drivers were more prone to be involved in the fatalities, rather than more experienced drivers. Some drivers tended to be "macho", with their driving behaviour involving drinking and speeding. Twenty percent of drivers were classified as inadequate performance types; they were inexperienced, fatigued or had lapses of attention.

A.2.2 Road and environmental conditions

A.2.2.1 Soft and unpaved shoulders

Armour (1990) examined alternative designs for rural roads with particular emphasis on the safety benefits of different shoulder types. Sealed shoulders resulted in lower accident rates. Loss of control accidents followed a distinct pattern; gravel shoulders on the near side of the road would cause a straying vehicle to lose control. The vehicle would then cross the road and, in the case of single vehicle accidents, run off the other side. The author had also noted this accident pattern in a previous study.

Other findings by Armour (1990) were that sealed shoulders increased the clearance distance between vehicles travelling in opposite directions and slightly increased vehicle speeds.

The author considered the economic savings of sealed shoulders. In new constructions, the provision of sealed shoulders would always be economically justified, and on existing roads it would be justified for medium volumes of traffic in easy terrain and high volumes in difficult terrain.

It was also found that if shoulders were sealed, it was possible to reduce lane width without losing any safety benefits.

A.2.2.2 Roadside objects

Ray et al. (1990) reported that one out of twelve accidents was a side impact of a vehicle with a roadside feature such as a tree, guardrail, embankment or a utility pole. One percent of occupants of cars involved in these collisions are fatally injured. Seventy-five percent of the objects hit are trees or utility poles. The authors suggested that systematically moving these objects is the solution.

A study by Brogan and Hall (1985) in New Mexico aimed to develop a procedure for ranking rural fixed-object accident sites in priority order for improvements. Fixed object accidents had accounted for 12% of the state's fatalities in 1982.

In a study of rural accidents in five regions of Queensland in 1984, King (1986) found that there was variation among regions in the type of object hit in single vehicle, run-off-road crashes. In the four rural regions about 50% of accidents involved hitting an object. In the northern region, the object hit was more likely to be man-made, while naturally occurring objects were more common in the western region. King noted that for accidents in which no object was hit, or the object hit was naturally occurring but yielding, the risk of fatality was 10% compared to 20% for accidents which involved hitting an unyielding roadside object.

A.2.2.3 Road alignment

Data on fatal, single-vehicle, rollover crashes from two states in America were investigated by Zador et al. (1987). The purpose was to determine whether horizontal or vertical road alignment influenced the number of accidents. The authors found that extreme roadway geometry, such as sharp curves, raised the likelihood of fatal rollover crashes by a factor of 50 or more. There were differences between the two states studied, but sharp left curves and steep down grades were prevalent among accident sites in both states.

Pak-Poy and Kneebone Pty. Ltd. (1988) reviewed Australian and overseas literature concerning road geometry. Most previous studies had found that horizontal curves and, to a lesser extent, vertical curves in the roadway are associated with high accident rates. Sight distance, which may be dependent on curvature, has also been studied. Pak-Poy and Kneebone Pty. Ltd. found that improving sight distances might be cost effective, but that more Australian investigation is needed.

In the rural Queensland study by King (1986), it was determined that single vehicle crashes were as likely to happen on a horizontal curve as on a straight section of road. No regional differences were found between the five areas of Queensland studied.

Grime (1987) stated that in rural areas of Britain, accidents tend to cluster on bends and the frequency of accidents increased with the degree of curvature. Where isolated bends had been realigned, injury accidents had decreased by 60% or more.

A.2.3 Vehicle properties

White (1986) asked whether vehicle inspection, and the possible ensuing vehicle repair, had an effect on the likelihood of the vehicle being involved in an accident. The study was conducted in New Zealand, where periodic vehicle inspection is mandatory. It was found that there was a safety benefit after vehicle inspections which decreased with time, irrespective of the age of the vehicle.

A.3 Factors which affect the nature of injuries

A.3.1 Non-use of seat belts

A comprehensive literature review of seat belt usage in Australia and overseas was recently carried out by Fildes et al. (1991). Seat belt usage in rural areas was not considered separately, however roll-over crashes were of interest to the authors. As a result of their own analysis, Fildes et al. concluded that not wearing seat belts results in more major and minor head injuries at all levels of injury severity including fatal injury. Wearing seat belts results in more chest and abdominal injury. Roll-over crashes had particularly severe outcomes. Fatal injuries from roll-over crashes involved severe injury to the head and chest.

Ryan et al. (1988) examined 80 rural crashes involving 103 vehicles within a 100 kilometre radius of Adelaide and to which an ambulance was called. It was found that almost half of the male drivers and one quarter of the female drivers were not wearing seat belts at the time of the accident. Among the group of non truck drivers, seat belt usage was significantly higher if the driver was not over the blood alcohol limit.

A New South Wales study of heavy vehicle accidents on major highways was carried out by Sweatman et al. (1990). The study concluded that in as many as 23% of crashes, the occupant of the heavy vehicles may have been saved if they had been wearing a seat belt. The authors cited difficulties with suspension seats and driver misconceptions as the main reasons why truck drivers have a low rate of wearing seat belts. An education campaign is suggested to try to convince drivers of the benefits of seat belt use.

Arup Transportation Planning (1991) undertook a survey of seat belt non-wearers in rural towns in three states of Australia. In part, this study followed up a 1988 survey by Ove Arup and Partners (1988), and a 1986 survey by Cameron McNamara Pty Ltd (1987). Non-wearers were interviewed in locations throughout the rural towns. The main findings were that seat belt non-wearers were generally on short, work related trips and were locals. Non-wearers had serious misconceptions about the cause of rural fatalities; speed, poor roads and unfamiliarity with the conditions were given as the assumed reasons for the high number of rural fatalities, while seat belt non-usage, drink driving and tiredness were under-rated. Another finding of the study was that seat belt wearing rates increased from 1988 to 1990.

A.3.2 Child restraints

Not all states have legislation enforcing the restraint of children in approved child restraints. All states do, however, require children to be restrained with at least an adult seat belt where one is available and to ride in the rear seat when no restraint is available (Heiman 1988).

The rural town study by Arup Transportation Planning (1991) found an increase in the seat belt wearing rate for all age groups between 1988 and 1990. In fact, there was a 74% increase in the proportion of children in the five to seven year age group wearing seat belts, but this group still had the lowest wearing rate of all the age groups.

A.3.3 Other vehicle occupant protection characteristics

Airbags springing from the dashboard or steering wheel area can instantly protect vehicle occupants in the event of an accident. Henderson (1991) claimed that airbags are not in common use in Australia because Australian Design Rules fall short of the requirements in the United States. It was estimated that if seat belts are worn as well, airbags could reduce the risk of a driver being killed in a crash from 36% to 22% (General Motors scientist, cited in Henderson 1991).

Nelson and Strueber (1991) investigated casualty rates of drivers and passengers in open backed vehicles in Papua New Guinea. It was found that utility vehicles were not over-represented in accidents, but these crashes led to an unusually high proportion of casualties and fatalities. This was considered to be due to the practice, in Papua New Guinea, of using open-backed vehicles for passenger transport. The potential reduction in the casualty rate (by not carrying passengers on ute trays or the trays of heavy goods vehicles) was calculated by subtracting the design limit number of passengers from the number of casualties. For utility vehicles, the reduction in the number of casualties would conservatively be 45%.

A summary report by the United States Department of Transport (1990) found that car size affected fatality risk in roll over crashes in the United States. This study did not determine which aspects of car size caused the smaller vehicles to be more prone to rolling over. In non-rollover crashes, smaller car size did not seem to increase the possibility of a fatality.

The National Highway Traffic Safety Administration in the United States (1991) examined factors causing vehicles to rollover, and factors influencing the likelihood of a fatality when a vehicle rolls over. The study noted that the static stability factor, that is, half the track width divided by the centre of gravity height, satisfactorily explained much of the difference in rollover rate between different vehicle makes and models. Several other measures of vehicle geometry were found to be important, and the orientation of the car as it left the roadway was also significant. Vehicles sliding sideways or spinning as they left the road were more likely to rollover than cars oriented in other ways. Thus, a vehicle's directional control and stability properties were noted to be other important factors in rollover accidents.

Given the significance of the static stability factor, two United States studies have recently reviewed the way in which this and similar factors are measured. Chrstos (1991) compared three different static rollover propensity measures, including the static stability factor, for 53 different vehicles. Winkler et al. (1991) compared the methods of measuring the height of the centre of gravity of light trucks.

A.3.4 Delay in ambulance response time

Ryan et al. (1973) suggested that ambulance response time is comprised of a detection to dispatch time and a time for the ambulance to arrive at the scene. A previous Australian study cited in Ryan et al. had estimated the proportion of injured people that received ambulance first aid within fifteen minutes on highways and other rural roads was half the proportion that received aid within fifteen minutes in country towns. From overseas studies, Ryan et al. suggested that 10% of road crash deaths occur in ambulance care. The authors concluded that ambulance services could influence a maximum of 5% of all road deaths, but that the figure is probably closer to 1 or 2%.

Brodsky and Hakkert (1983) examined road accident data from 62 rural Texas counties each with an area of approximately 48 square kilometres. The counties were classified as accessible, mixed or remote. Accessible meant that the county had at least one hospital and two ambulance locations. Remote meant no hospitals and at most one ambulance location. The mixed group had conditions better than remote but not as good as accessible, and data from this group was used for confirmation of results. Brodsky and Hakkert's analysis conjectured that 38% of fatal accidents in the remote counties might have been non-fatal in the accessible counties. They had found that figures for salvageable fatal accidents in other studies were smaller, but determined that these studies were probably done in less remote regions than the rural Texas counties. Brodsky and Hakkert's study found that the number of lives lost in low density rural areas because of inadequate emergency medical care is not negligible. The authors suggest that the problem should be tackled on two fronts: the ambulance notification time should be considered as well as regionalisation and categorisation of the administrative organisation of emergency medical services.

In 1988 Bianchi and Church (1988) reported on a method for locating ambulance services optimally with respect to easier dispatching, reduced facility costs and better crew load balancing. An example, of Austin, Texas, was made.

Another study by Brodsky (1990) splits the time taken for an ambulance to arrive at a road accident into communication time and travel time. Brodsky argues that travel time, in the USA at least, is not likely to decrease in the near future, and he suggests efforts should be concentrated on improving communication time. Communication time is further divided into call time and injury verification time. Brodsky states that in about 15% of fatal accidents, the police officer who is notified of the car accident incorrectly guesses that an ambulance is not required. He considers whether the responsibility for sending an ambulance to an accident should be given to the ambulance service, or whether perhaps an ambulance should be sent to all accident notifications.

A.3.5 Treatment available at rural hospitals

A British study reported in 1986 (Bentham 1986) considered whether mortality rates were higher than expected in areas which are relatively remote from a major hospital that has accident and emergency facilities. Bentham questions the benefits of a more centralised accident and emergency service, because the benefits to accident victims usually are hard to measure. Making emergency medical services accessible needs to be considered alongside the other reasons for providing these facilities.

Wenneker et al. (1990) reported a Californian study. After an improved level of care for trauma victims was established at a rural hospital, the preventable death rate for road accident victims, of causes other than central nervous system injuries, decreased from 42% to 14%.

Inadequate medical care is quantitative as well as qualitative in rural areas in the United States (Freilich and Spiegel 1990). The authors suggest that aeromedical emergency medical services could transport car accident victims to regional hospitals, as well as transporting highly skilled specialists to the rural areas. Often it is not the time taken for the patient to arrive at hospital, but the time until specialised treatment is available to the patient that is critical. Freilich and Spiegel cite one study in which it was found that helicopter rescue services transporting a nurse and physician to the patient reduced mortality in patients by 35% compared with teams of nurses and paramedics.

B. ANALYSIS OF FACTORS WHICH CAUSE FATAL OR SERIOUS INJURY CRASHES AND AFFECT THE NATURE OF INJURIES

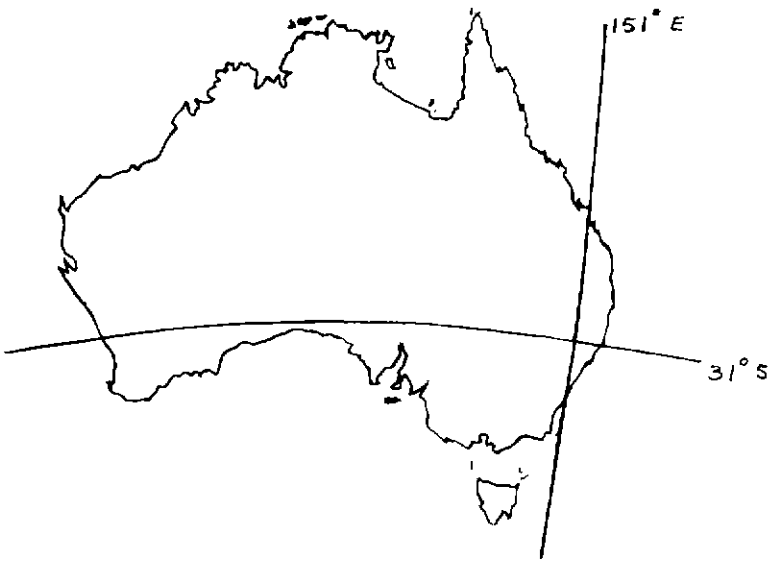
Introduction

This study identified factors associated with non-urban crashes within the following four crash types:

- overturn, remote
- hit-object, remote
- overturn, non-remote
- hit-object, non-remote

The study employed Australia-wide fatal crash data from the Federal Office of Road Safety *Fatality File, 1988,* serious crash data of the period 1989-90 for Queensland, Victoria and Western Australia and the period 1990-92 for Northern Territory. The serious crash data covered all crashes resulting in at least one person being hospitalised or killed, and differed from the Fatality File in that these crashes were predominantly of lower severity.

For the purposes of this study non-urban fatal crash data (identified by means of their land classification) were classified as either *remote* or *non-remote* on the basis of latitude and longitude information recorded in the Fatality File. As illustrated in the following map, all non-urban crashes west of 151 degrees longitude and north of 31 degrees latitude were classified as remote area crashes.



An analogous approach was adopted with the serious crash data for Queensland, Western Australia and Victoria, with two exceptions: (i) the overall set of non-urban crashes was identified somewhat less precisely as those occurring in speed zones of 100 kph or more, and (ii) crash latitude and longitude were unavailable and the classification of crashes into remote and non-remote was therefore based on the latitude and longitude of the local government area of each crash.

In the case of the Northern Territory a more precise approach was adopted with the serious crash data than that employed for the Northern Territory crashes in the Fatality File. Non-urban serious crashes (identified by means of the police traffic area recorded for each crash) were classified as either non-remote or remote on the basis of whether or not the crash site was speed limited.

Factors which appear to be important in causing fatal or serious injury crashes and those which affect the nature of injuries received in these crashes and the type of medical attention given were identified through discussions with FORS authorities, examination of a sample of original accident reports and a review of the literature.

The following 16 factors are identified as being important:

a) Speeding
b) Alcohol and drugs
c) Asleep and fatigue
d) Driver inexperience
e) Shoulders
f) Object type
g) Road alignment
h) Road conditions
i) Vehicle defects
j) Wearing of seat belts
k) Occupancy rate
l) Sex of driver
m) Road type
n) Weather
o) Seating position and injury severity
p) Point of impact for hit-object crashes

B.1 Fatality File 1988

B.1.1 Introduction

Data from the 1988 Fatality File is analysed to determine the importance of the 16 identified causal factors in each of the 4 types of single vehicle rural crashes.

Throughout the Fatality File database, many reported cases contain missing values for one or more variables. Cases are excluded from the analysis if the variable or factor under investigation has code 'unknown'. Cases are also excluded if they are subject to numerous 'unknown' variable entries. For example, there are large numbers of 'unknown' entries for the factors blood alcohol content and seat belt usage. The 'unknown' entries are excluded from the analyses involving these factors. The database contains information on 378 single vehicle fatal crashes involving passenger vehicles in non-urban areas. For these crashes, 92% of the vehicles are passenger cars, 3% are forward control vehicles and the remaining 5% are off road vehicles, all with less than 9 seats.

Information on 'exposure' to a fatal crash is not available to this study. For example, it is not known how many vehicle occupants (at any time) are not wearing seat belts when available or the number of drivers with high blood alcohol content. However, the relative odds of a fatally injured occupant wearing a seat belt as opposed to not wearing a seat belt can be computed for the different types of crashes. For example, of the 199 fatally injured occupants of vehicles involved in hit-object/non-remote rural crashes, 121 wore seat belts while 78 did not. For a fatally injured occupant in this type of crash, the odds of having worn a seat belt to not having worn a seat belt are 1.55 (121 divided by 78). In overturn/non-remote rural fatal crashes, 21 of the fatally injured occupants were wearing belts compared to 29 who did not. For a fatally injured occupant in this type of crash the odds of having worn a seat belt to not having worn a seat belt are 0.72 (21 divided by 29).

The individual odds by themselves are difficult to interpret meaningfully. However, they can be compared meaningfully in the form of the odds ratio, such that the odds of a fatally injured occupant wearing a seat belt to not wearing a seat belt are 2.13 times greater for a hit-object/non-remote rural crash than for an overturn/non-remote rural crash. The further the ratio of the odds is from one, the more different are the odds of the two categories being compared. Throughout this report, the odds ratio for a particular category will be the odds for that category divided by the odds for the last category listed in the table, unless otherwise indicated.

The chi-squared statistic (χ^2), computed for tables of observed frequencies throughout this report, tests the null hypothesis of no association between compared factors involved in fatal crashes, in this case crash type and use of seat belt. The larger the value of the χ^2 statistic, the more significant is the association. The p-value is the probability that the data is consistent with the null hypothesis and the larger the value of χ^2, the smaller the value of p. At the 5% level of significance, the null hypothesis of no association is rejected if $p < 0.05$. The general rule, that the chi-squared test is not appropriate if 20% or more of the table cells have expected frequencies of less than 5 (or if any cell has an expected frequency of less than 1), has been adopted in this report.

Factors in the Fatality File that are not included in the analysis due to paucity of data, are those representing 'vehicle type' and 'vehicle towing an object'.

B.1.2 Speeding

Table 1 shows the number of vehicles involved in fatal crashes that were travelling faster than the speed limit or faster than conditions permitted for each of the four crash types. The percentage of crashes in which the vehicle was speeding (49%) is similar for all four crash types (p=0.46).

Table 1 *Observed frequencies of fatal crashes by speed and crash type (χ_3^2 = 2.6, p = 0.46)*

Crash type	Speeding	Not speeding	Odds on speeding	Odds ratio
Overturn/remote	10	16	0.63	0.6
Overturn/non-remote rural	21	28	0.75	0.7
Hit-object/remote	22	23	0.96	0.9
Hit-object/non-remote rural	105	97	1.08	

There was a high correlation between speeding and drink driving. It was found that 64% of the drivers that were speeding had blood alcohol content (BAC) of over 0.05 compared with 25% drunk among those who were not speeding. These percentages exclude drivers with no BAC data and thus possibly overestimate the drink driving rates. Assuming all drivers not tested were sober results in drink driving percentages of 50% and 18% for speeding and not speeding, respectively.

The data concerning speeding are cross-classified by whether the road was sealed or unsealed (Table 2).

Table 2 *Observed frequencies of vehicles involved in fatal crashes cross-classified by speed, road surface type and crash type.*

Crash type by road surface	Speeding	Not speeding	Odds on speeding	Odds ratio
a) Overturn/remote				
Unsealed	3	4	0.75	1.3
Sealed	7	12	0.58	
b) Overturned/non-remote rural				
Unsealed	6	4	1.50	2.4
Sealed	15	24	0.63	
c) Hit-object/remote				
Unsealed	1	5	0.20	0.2
Sealed	21	18	1.17	
d) Hit-object/non-remote rural				
Unsealed	5	10	0.50	0.4
Sealed	100	85	1.18	

A log-linear model was developed to explain the observed frequencies of vehicles with speed, overturn/hit-object, remote/non-remote rural and unsealed/sealed surface as explanatory factors. The model indicates that the remote/non-remote rural factor is not statistically significant in explaining the frequency of fatal single vehicle rural crashes, and so this factor was removed from the analysis (Table 3).

Table 3 *Observed frequencies of vehicles involved in fatal crashes cross-classified by speed and road surface type for overturn and hit-object type crashes (χ_3^2=8.7, p=0.03)*

Rural crash type by road surface	Speeding	Not speeding	Odds on speeding	Odds ratio
a) Overturn				
unsealed	9	8	1.13	1.8
sealed	22	36	0.61	
b) Hit-object				
unsealed	6	15	0.40	0.3
sealed	121	103	1.17	

There is a significant association between speeding, road surface and crash type. For a fatal overturn crash the odds of having been speeding are greatest on unsealed roads and for a fatal hit-object crash the odds of having been speeding are greatest on sealed roads.

B.1.3 Alcohol

Of drivers for whom BAC was recorded, some 54% had excessive values (ie above 0.05 gm/100ml), although, in view of a greater likelihood of sobriety amongst drivers lacking recorded BACs, this statistic may slightly overstate the incidence of drink driving involved in these crashes.

Table 4 shows that the odds ratio of drivers with high BAC is greater for overturn (38/21 = 1.8) than hit-object crashes (117/113 = 1.0) although the difference does not achieve a high degree of statistical uncertainty (χ_1^2 = 2.9, p = 0.09). For every 100 hit-object crashes in which the driver has BAC greater than 0.05 gm/100ml there are 175 overturn crashes in which the driver has a high BAC.

Table 4 *Observed frequencies of fatal crashes by blood alcohol content (BAC) of driver cross-classified by crash type (χ_3^2 = 3.7, p = 0.29)*

Rural crash type	High BAC of driver	Low BAC of driver	Odds on high BAC	Odds ratio
Overturn/remote	12	6	2.00	2.0
Overturn/non-remote	26	15	1.73	1.7
Hit-object/remote	17	14	1.21	1.2
Hit-object/non-remote	100	99	1.01	

Table 5 shows the number of occupants of vehicles involved in fatal crashes, categorised by type of crash, use of seat belt and driver's blood alcohol content. The odds ratios show that for each of the 4 crash types, the odds on belt not used are at least 3 times greater for occupants where the driver had high BAC than for occupants where the driver had low BAC. That is, for vehicles involved in single vehicle non-remote rural crashes it is significantly more likely that the occupants are not wearing seat belts if the driver has high BAC, than if the driver has low BAC.

Table 5 *Observed frequencies of occupants in fatal crashes by use of seat belt and driver blood alcohol content, BAC (χ_7^2=38.8, p<0.001)*

Rural crash type by driver's BAC	Belt not used	Belt used	Odds on belt not used	Odds ratio
a) Overturn/remote				
High BAC	15	3	5.00	8.3
Low BAC	6	10	0.60	
b) Overturn/non-remote				
High BAC	19	9	2.11	4.2
Low BAC	6	12	0.50	
c) Hit-object/remote				
High BAC	7	7	1.00	3.3
Low BAC	3	10	0.30	
d) Hit-object/non-remote				
High BAC	49	45	1.09	3.2
Low BAC	28	81	0.35	

Table 6 shows that when vehicle occupant numbers are pooled over crash type, then the odds of a seat belt not having been used by an occupant who was involved in a fatal single vehicle crash having a driver with high BAC is almost 4 times that for an occupant involved in a fatal single vehicle crash involving a driver with low BAC.

Table 6 *Observed frequencies of occupants involved in fatal crashes by use of seat belt and blood alcohol content (BAC) (χ_1^2 = 28.9, p<0.001)*

BAC	Belt not used	Belt used	Odds on belt not used	Odds ratio
High BAC	90	64	1.41	3.7
Low BAC	43	113	0.38	

Table 7 gives a cross-classification of vehicle drivers by high and low BAC and employment status/occupation. The odds on high BAC are greatest for vehicle drivers employed as labourers and related workers (odds = 4.00). Drivers classified as unemployed and plant and machine operators have the next highest odds (odds = 2.33) followed by tradespersons (odds = 1.91). The category 'employed: other occupation' is ignored as it may consist of several smaller occupation groups.

Table 7 *Observed frequencies of vehicle drivers in fatal crashes cross-classified by BAC and employment status/occupation*

Employment status/occupation	High BAC	Low BAC	Odds on high BAC	Odds ratio
Manager/Administrator	7	10	0.70	0.8
Professional	4	7	0.57	0.6
Para-professional	1	6	0.17	0.2
Tradespersons	21	11	1.91	2.1
Clerical	0	4		
Sales & personal service worker	11	11	1.00	1.1
Plant and machine operator	7	3	2.33	2.5
Labourers and related workers	32	8	4.00	4.3
Keeping house	2	12	0.17	0.2
Employed: other occupation	8	3	2.67	2.9
Employed: unspecified	3	0		
Unemployed	21	9	2.33	2.5
At school, university, college	6	7	0.86	0.9
Retired	3	12	0.25	0.3
Other	3	5	0.60	0.7
Services: Tradespersons	2	0		
Unknown	24	26	0.92	

B.1.4 Asleep and fatigue

Unless the driver of a vehicle involved in a single vehicle rural crash survives and admits fatigue or sleep, or a passenger survives and states that the driver was tired or asleep, determining whether driver fatigue contributed to the cause of a fatal crash is difficult. Forty-one crashes were recorded as having been caused by driver fatigue compared to 264 other known causes with another 48 described as for 'other' reasons (undefined) and 25 of 'unknown' reasons. Of the cases for which the cause of the crash is known, 11.6% were attributed to driver fatigue. Table 8 categorises these crashes by the 4 crash types. Due to the low number of driver asleep/fatigued records, no statistical significance can be attributed to the differences between crash types.

Table 8 *Observed frequencies of fatal crashes cross-classified by driver fatigue and crash type*

Rural crash type	Fatigued	Not fatigued	Odds on fatigued	Odds ratio
Overturn/remote	4	26	0.15	0.9
Overturn/non-remote	2	53	0.04	0.3
Hit-object/remote	3	39	0.08	0.5
Hit-object/non-remote	32	194	0.16	

B.1.5 Driver inexperience

The literature review, section A.2.1.5, suggests that youthful drivers are more prone to be involved in fatal crashes than more experienced drivers. A driver's predisposition to a fatal crash cannot be tested from the Fatality File, however the odds on a driver involved in a fatal crash, being aged under 25 years, can be compared between the 4 crash types.

Tables 12 and 13 show the frequency of fatal crashes by driver age (categorised as 'under 25 years' or '25 years and over') for each of the 4 crash types. For each crash type, drivers aged under 25 years are less likely to be involved in single vehicle fatal crashes than older drivers, particularly in remote locations. However, this result may be due to fewer drivers aged under 25 driving in non-urban locations than drivers aged 25 and over.

Table 12 *Observed frequencies of drivers involved in fatal crashes cross-classified by age category and crash type ($\chi_3^2 = 6.7, p = 0.08$).*

Rural crash type	Under 25 years	25 years and over	Odds on under 25	Odds ratio
Overturn/remote	5	19	0.26	0.3
Overturn/non-remote	26	33	0.79	1.0
Hit-object/remote	11	25	0.44	0.6
Hit-object/non-remote	110	141	0.78	

Table 13 *Observed frequencies of drivers involved in fatal crashes cross-classified by age and location (non-remote rural or remote) ($\chi^2_1 = 5.5, p=0.02$)*

Location	Under 25 years	25 years and over	Odds on under 25	Odds ratio
Remote	16	44	0.36	0.5
Non-remote rural	136	174	0.78	

Licence type may also indicate a driver's inexperience. However, Table 14 shows no significant association between licence type and crash type, where the category 'other' refers to learner, provisional or disqualified licence.

Table 14 *Observed frequency of drivers involved in fatal crashes cross-classified by licence type and crash type ($\chi_3^{\,2}= 1.4, p=0.70$)*

Rural crash type	Full licence	Other	Odds on full licence	Odds ratio
Overturn/remote	20	2	10.0	1.9
Overturn/non-remote	44	11	4.0	0.8
Hit-object/remote	26	5	5.2	1.0
Hit-object/non-remote	179	34	5.3	

B.1.6 Vehicle lost control on the shoulder

Table 15 shows the number of vehicles involved in fatal crashes that lost control on the 'shoulder' of the road.

Table 15 *Observed frequencies of vehicles involved in fatal crashes cross-classified by shoulder contribution to loss of control and crash type ($\chi_3^2 = 15.6, p=0.001$)*

	Shoulder Contributed to Loss of Control			
Rural crash type	Yes	No	Odds on yes	Odds ratio
Overturn/remote	6	18	0.33	1.3
Overturn/non-remote	24	34	0.71	2.9
Hit-object/remote	3	28	0.11	0.4
Hit-object/non-remote	46	186	0.25	

There is a significant association between crash type and causal involvement of the road shoulder. This leads to the formulation of the hypothesis that loss of control on the shoulder is significantly more likely to contribute to overturn crashes than to hit-object crashes, regardless of location. This is confirmed by collapsing Table 15 across crash location (Table 16). The odds of loss of control on the road shoulder contributing to a fatal road crash are 2.5 times greater for overturn type crashes than for hit-object crashes.

Table 16 *Observed frequencies of vehicles involved in fatal crashes cross-classified by shoulder contribution to loss of control and crash type (overturn vs hit-object) ($\chi_1^2 = 10.4, p=0.001$)*

	Shoulder Contributed to Loss of Control			
Crash type	**Yes**	**No**	**Odds on yes**	**Odds ratio**
Overturn	30	52	0.58	2.5
Hit-object	49	214	0.23	

B.1.7 Type of object

Table 17 shows the frequency of hit-object crashes cross-classified by object type and location.

Table 17 *Observed frequencies of fatal crashes involving an object cross-classified by object type and location ($\chi_1^2 = 9.5, p=0.002$)*

Location	Pedestrian/ animal	Inanimate object	Odds on pedestrian/ animal	Odds ratio
Remote	10	30	0.33	4.0
Non-remote rural	19	227	0.08	

There is a significant association between type of object and crash location. In remote areas the odds of the object hit being an animal or pedestrian are 4 times that in non-remote rural areas.

B.1.8 Road alignment

Sixty-one percent of fatal overturns and 52% of fatal collisions with objects in non-urban areas occurred on straight sections of road (54% combined).

Eighty percent of fatal overturns and 73% of fatal collisions with objects in non-urban areas occurred on level sections of road (75% combined).

B.1.9 Road surface conditions

Ninety-one percent of fatal overturns and 86% of fatal collisions with objects in non-urban areas occurred on dry roads (87% combined).

B.1.10 Weather conditions

Ninety-five percent of fatal overturns and 91% of fatal collisions with objects in non-urban areas occurred in fine weather (92% combined).

B.1.11 Vehicle defects and condition

Table 22 shows the number of fatal crashes in which vehicle defects were determined to be the major factor causing the crash. Overall, 3.7% of fatal crashes were attributed to vehicle defects. As the number of crashes caused by vehicle defects is extremely small, no statistical significance can be ascribed to differences between the crash types.

Table 22 Observed frequencies of fatal crashes cross-classified by crash-type and whether vehicle defect was the primary factor in causing the crash.

Rural crash type	Vehicle defect	No vehicle defect	Odds on vehicle defect	Odds ratio
Overturn/remote	1	29	0.03	1.9
Overturn/non-remote	4	51	0.08	4.4
Hit-object/remote	4	38	0.11	5.8
Hit-object/non-remote	4	222	0.02	

B.1.12 Vehicle age and driver age

Table 23 examines the association between vehicle age and driver age for overturns and collisions with objects. A significant association between vehicles aged 10 years and over, and drivers aged under 25 years exists for hit-object crashes ($p<0.001$) but not for overturn crashes.

Table 23 Observed frequencies of drivers involved in fatal crashes cross-classified by driver age group and vehicle age for each crash type

Vehicle age by crash type	Under 25 years	25 years and over	Odds on under 25	Odds ratio
Overturn				
10 years and over	9	16	0.56	0.9
Under 10 years	11	17	0.64	
Hit-object				
10 years and over	52	39	1.33	2.9
Under 10 years	28	61	0.46	

B.1.13 Seat belt wearing

Table 24 shows that for all fatal crash types, the odds of occupant fatality are higher when a seat belt is not worn.

Table 24 *Observed frequencies of occupants involved in fatal crashes cross-classified by fatally/not fatally injured, use of seat belt and crash type.*

Use of seat belt by crash type	Fatally injured	Not fatally injured	Odds on fatality	Odds ratio
a) Overturn/remote				
Belt not worn	20	11	1.82	5.0
Belt worn	8	22	0.36	
b) Overturn/non-remote rural				
Belt not worn	29	22	1.32	3.0
Belt worn	21	47	0.45	
c) Hit-object/remote				
Belt not worn	17	5	3.40	1.5
Belt worn	22	10	2.20	
d) Hit-object/non-remote rural				
Belt not worn	78	31	2.52	2.0
Belt worn	121	97	1.25	

Table 24 also shows ($p<0.001$) that occupants not wearing seat belts are more likely to be fatally injured in overturn crashes than in hit-object crashes.

Survivable crashes are defined as those crashes in which at least one vehicle occupant survives. Table 25 shows the numbers of fatally and not fatally injured occupants in survivable crashes by use of seat belt for each crash type. The odds of being fatally injured to not being fatally injured in a survivable crash are smaller for each crash type if the occupant wears a seat belt. Table 25 also shows that for survivable crashes, the odds of a fatality with belt not worn are greater for overturn crashes than for hit-object crashes.

Unlike the comparable result for Table 24, this finding can not be simply attributed to the fact that hit-object crashes have a higher proportion of driver-only occupancy (ie probability of fatality is one) than do overturn crashes (Table 31).

Table 25 Observed frequencies of occupants involved in 'survivable' crashes cross-classified by fatally/not fatally injured, use of seat belt and crash type.

Use of seat belt by crash type	Fatally injured	Not fatally injured	Odds on fatality	Odds ratio
a) Overturn/remote				
Belt not worn	14	9	1.56	3.9
Belt worn	8	20	0.40	
b) Overturn/non-remote rural				
Belt not worn	20	18	1.11	3.1
Belt worn	17	47	0.36	
c) Hit-object/remote				
Belt not worn	13	5	2.60	2.4
Belt worn	11	10	1.10	
d) Hit-object/non-remote rural				
Belt not worn	36	31	1.16	1.8
Belt worn	58	89	0.65	

A comparison of seat belt benefit between non-remote rural and remote crashes of each type (overturn and hit-object) does not achieve statistical significance.

The Fatality File is also examined for associations between the wearing of seat belts and other factors. Tables 26, 27, 28 and 29 show the number of vehicle occupants involved in single vehicle fatal crashes cross-classified by use of seat belt, and each of driver BAC, purpose of journey, and sex and age group of occupant for each crash type, respectively.

As shown earlier (Tables 5 and 6), there is a significant association between use of seat belt and driver BAC for crash types overturn/remote ($p=0.02$), overturn/non-remote rural ($p=0.05$) and hit-object/non-remote rural ($p<0.001$). For each of these crash types, the odds on a vehicle occupant having worn a seat belt when the driver has a low BAC, are at least 3 times greater than the odds on a vehicle occupant having worn a seat belt when the driver has a high BAC. There is also a significant association between use of seat belt and sex of occupant for crash type overturn/non-remote rural ($p=0.08$).

Table 26 *Observed frequencies of occupants involved in fatal overturn/remote type crashes by use of seat belt cross-classified with each of driver blood alcohol content (BAC), purpose of journey, and sex and age group of occupant*

Vehicle occupant classification	Belt used	Belt not used	Odds on belt used	Odds ratio
Driver BAC				
High BAC	3	15	0.20	0.1
Low BAC	10	6	1.67	
Purpose				
Recreational	16	20	0.80	1.0
Other	4	5	0.80	
Sex				
Male	24	22	1.09	0.8
Female	13	9	1.44	
Age group				
Under 25	19	13	1.46	1.1
25 and over	18	14	1.29	

Table 27 *Observed frequencies of occupants involved in fatal overturn/non-remote rural type crashes by use of seat belt cross-classified with each of driver blood alcohol content (BAC), purpose of journey, and sex and age group of occupant*

Vehicle occupant classification	Belt used	Belt not used	Odds on belt used	Odds ratio
Driver BAC				
High BAC	9	19	0.47	0.2
Low BAC	12	6	2.00	
Purpose				
Recreation type	31	30	1.03	0.4
Other	15	6	2.50	
Sex				
Male	44	40	1.10	0.4
Female	27	11	2.45	
Age group				
Under 25	35	29	1.21	0.7
25 and over	36	20	1.80	

Table 28 Observed frequencies of occupants involved in fatal hit-object/remote type crashes by use of seat belt cross-classified with each of driver blood alcohol content (BAC), purpose of journey, and sex and age group of occupant

Vehicle occupant classification	Belt used	Belt not used	Odds on belt used	Odds ratio
Driver BAC				
High BAC	7	7	1.00	0.3
Low BAC	10	3	3.33	
Purpose				
Recreation type	20	11	1.82	1.8
Other	4	4	1.00	
Sex				
Male	27	15	1.80	1.0
Female	14	8	1.75	
Age group				
Under 25	14	4	3.50	2.5
25 and over	27	19	1.42	

Table 29 Observed frequencies of occupants involved in fatal hit-object/non-remote rural type crashes by use of seat belt, cross-classified with each of driver blood alcohol content (BAC), purpose of journey, and sex and age group of occupant

Occupant classification	Belt used	Belt not used	Odds on belt used	Odds ratio
Driver BAC				
High BAC	45	49	0.92	0.3
Low BAC	81	28	2.89	
Purpose				
Recreation type	124	57	2.18	0.8
Other	37	14	2.64	
Sex				
Male	157	77	2.04	0.7
Female	90	33	2.73	
Age group				
Under 25	117	62	1.89	0.7
25 and over	127	47	2.70	

From Tables 26, 27, 28 and 29 it appears that for fatal single vehicle crashes in non-remote rural locations, the odds on the use of a seat belt are lower for drivers aged under 25 years than for drivers aged 25 years and over, while for fatal single vehicle crashes in remote locations, the reverse appears to be true. A chi-squared test shows that there is no statistically significant association between the use of a seat belt, occupant age group and crash type (χ_7^2=11.5, p=0.12).

Table 31 shows the number of occupants involved in fatal crashes, by seating position and belt use for each of the 4 crash types. As occupant numbers are low for front and rear seating positions for 2 of the crash types, frequencies for these seating positions are combined to allow a comparison between drivers and passengers for each crash type. Tests of significance show that for single vehicle fatal crashes there is no association between driver belt use and crash type (p=0.78) or between passenger belt use and crash type (p=0.15).

From Table 31 it appears that the odds on a vehicle occupant having worn a seat belt are greater for hit-object than overturn type crashes. After aggregating frequencies over location, tests of significance show that passengers are more likely (p=0.03) to have worn a seat belt in a hit-object crash than in an overturn crash, but there is no association between driver's belt use and crash type (p=0.45).

Table 31 Observed frequencies of occupants involved in fatal crashes cross-classified by use of seat belt and seating position for each crash type.

Seating position by crash type	Belt used	Belt not used	Odds on belt used	Odds ratio
a) Overturn/remote				
Driver	16	12	1.25	0.9
Front	9	6	1.50	1.1
Rear	10	7	1.43	
b) Overturn/non-remote rural				
Driver	31	19	1.63	1.1
Front	21	11	1.91	2.5
Rear	16	12	1.25	
c) Hit-object/remote				
Driver	21	12	1.75	1.8
Front	11	2	5.50	5.5
Rear	4	4	1.00	
d) Hit-object/non-remote rural				
Driver	126	64	1.97	0.8
Front	76	23	3.30	1.4
Rear	39	16	2.43	

B.1.14 Occupancy rate

Table 32 shows the frequencies, and Table 33 the percentages, of fatal crashes cross-classified by the number of vehicle occupants and crash type.

Table 32 Observed frequencies of fatal crashes cross-classified by vehicle occupancy and crash type (χ_9^2 =29.1, p<0.001)

Rural crash type	Number of Vehicle Occupants			
	One	Two	Three	More than three
Overturn/remote	6	9	4	5
Overturn/non-remote	14	14	13	20
Hit-object/remote	19	6	5	6
Hit-object/non-remote	116	78	31	30

The χ^2 test shows that there is a significant association between crash type and the number of vehicle occupants.

Table 33 Observed percentages of fatal crashes cross-classified by vehicle occupancy and crash type

Rural crash type		Number of vehicle occupants			
		One	Two	Three	More than three
Overturn/remote	(%)	25	38	17	21
Overturn/non-remote	(%)	23	23	21	32
Hit-object/remote	(%)	53	17	14	16
Hit-object/non-remote	(%)	45	31	12	12

The percentage of fatal hit-object crashes in which the driver is the only vehicle occupant is approximately twice that for overturn type crashes. This association was tested by aggregating the number of fatal crashes by number of vehicle occupants over location for each of the overturn and hit-object type crashes. The association between crash type (hit-object or overturn) and vehicle occupancy is statistically significant ($\chi_3^2=22.9$, $p<0.001$).

The average occupancy per vehicle is 2.7 for overturn/remote, 2.8 for overturn/non-remote rural, 2.1 for hit-object/remote and 2.0 for hit-object/non-remote rural fatal crashes.

B.1.15 Sex of driver

Table 34 shows that the proportions of male and female drivers do not differ significantly between crash types.

Table 34 Observed frequencies of fatal crashes cross-classified by sex of driver and crash type ($\chi_3^2 = 2.9, p = 0.41$)

Rural crash type	Male	Female	Odds on male	Odds ratio
Overturn/remote	27	5	5.4	1.5
Overturn/non-remote	45	11	4.1	1.1
Hit-object/remote	29	13	2.2	0.6
Hit-object/non-remote	193	54	3.6	

B.1.16 Driver occupation

The association between driver occupation and crash type is investigated using the following occupation categories:

(i) ADMIN - manager/administrator; clerical; sales person and personal service worker
(ii) PROF - professional; para-professional
(iii) TRADE/LAB - tradespersons; plant and machine operator, labourers and related workers.
(iv) UNEMP/RET - unemployed; retired.
(v) OTHER - keeping house; at school, university, college; other.

In Table 35, 28% of driver occupations are unknown. If we assume that the distribution of the 'unknown' driver occupations is equivalent to that of the 'known' driver occupations then it is possible to make comparisons between occupations and crash types. Table 36 shows the percentages of driver occupations within each crash type after deletion of cases having unknown driver occupation. As many of the occupation categories contain expected frequencies of less than 5 a statistical test of association is not valid. However, for all crash types, drivers with occupations in the trades/labourers category account for more than one third of all crashes (34% to 41%).

Table 35 Observed frequencies of fatal crashes cross-classified by driver occupation and crash type

Rural crash type	Occupation					
	Admin	Prof	Trade/lab	Unemp/ret	Other	Unknown
Overturn/remote	4	1	7	3	2	7
Overturn/non-remote	4	4	16	7	8	21
Hit-object/remote	6	1	8	3	4	14
Hit-object/non-remote	35	20	65	40	31	63

Table 36 Observed percentages of fatal crashes by driver occupation within crash type

Rural crash type	Occupation				
	Admin	Prof	Trade/lab	Unemp/ ret	Other
Overturn/remote (%)	24	6	41	18	12
Overturn/non-remote (%)	10	10	41	18	21
Hit-object/remote (%)	27	5	36	14	18
Hit-object/non-remote (%)	18	10	34	21	16

B.1.17 Road type

Table 37 shows frequencies of fatal crashes by road type and crash type. A test of significance shows that there is no association between crash type and the road types national highway, state highway and other rural road.

Table 37 Observed frequencies of fatal crashes classified by road type and crash type ($\chi_6^2 = 4.6, p = 0.59$)

Rural crash type	National highway	State highway	Other rural road
Overturn/remote	6	9	17
Overturn/non-remote	6	13	37
Hit-object/remote	3	14	26
Hit-object/non-remote	22	73	150

B.1.18 Injury severity and seating position of occupants

Table 38 examines the association between injury level and seating position by crash type, for fatal crashes in which there was more than one vehicle occupant.

Table 38 Observed frequencies of occupants, in fatal crashes with more than one occupant, cross-classified by injury level, seating position and crash type.

Seating position within crash type	Not injured	Injured (not hospitalised)	Injured (hospitalised)	Fatally Injured
a) Overturn/remote				
Driver	2	5	7	12
Front	1	4	6	7
Rear	4	1	10	5
b) Overturn/non-remote rural				
Driver	3	7	15	12
Front	0	10	12	13
Rear	1	9	16	10
c) Hit- object/remote				
Driver	5	2	9	9
Front	3	0	9	9
Rear	2	1	3	3
d) Hit-object/non-remote rural				
Driver	18	11	44	62
Front	12	7	39	57
Rear	7	6	29	26

For hit-object/non-remote rural crashes (this crash type consists of approximately 60% of all occupants in the Fatality File) in which there is more than one occupant, there is no association between injury level and seating position. For the remaining 3 crash types, a number of the expected frequencies are less than 5 and so no statistical significance can be ascribed to differences between injury level and seating position.

B.1.19 Timing of death

Table 39 shows timing of death for fatally injured occupants by crash type. The literature review (section A.3.4) reports on studies (Ryan, 1973; Brodsky and Hakkert, 1983) which conjecture that a higher proportion of fatalities may occur in crashes in remote areas due to a greater ambulance arrival time. However, Table 39 shows no significant difference in the odds of death before treatment for remote and non-remote rural crashes.

Table 39 Observed frequencies of vehicle occupants in fatal crashes cross-classified by timing of death and crash type.

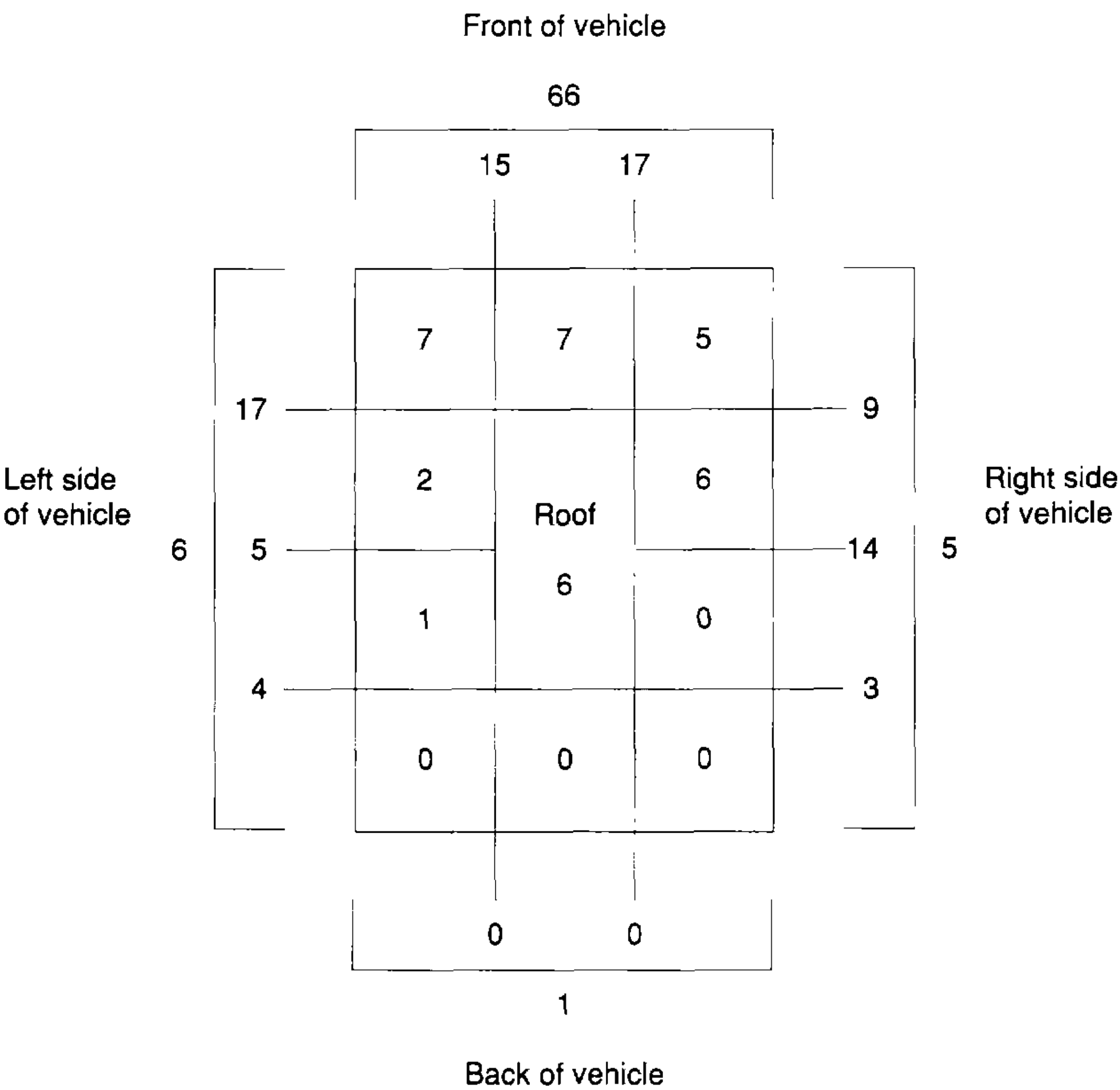
Rural crash type	Died before treatment	Died after treatment	Odds on dying before treatment	Odds ratio
Overturn/remote	7	2	3.50	1.8
Overturn/non-remote	29	8	3.63	1.9
Hit-object/remote	9	6	1.50	0.8
Hit-object/non-remote	114	59	1.93	

B.1.20 Point of impact

Diagram 1 shows the frequencies of vehicles involved in fatal hit-object crashes, by point of impact (defined as the point of impact that is thought most likely to have caused the fatality rather than the area of most damage to the vehicle). The undercarriage of the vehicle is not depicted in the diagram. However, 3 fatal single vehicle hit-object crashes involved an impact to the undercarriage.

From Diagram 1 59% of all fatal hit-object crashes involve an impact to the front of the vehicle. Other points of impact occur equally as often to the left and right hand sides of vehicles involved in single vehicle hit-object crashes.

Diagram 1: Frequency of points of impact on a vehicle involved in a fatal hit-object crash



B.1.21 Interaction of time of day by day of week

As a person's daily routine may differ on a weekend to a weekday, Table 40 was constructed to examine the association between time of day and day type across crash type. Table 40 contains too many expected frequencies less than 5 to enable significance testing, but the odds on a fatal crash occurring in the early morning (midnight to 6am) compared to later in the day are greater on the weekend than on a week day for all crash types except overturn/remote. To test this hypothesis frequencies are aggregated over crash type and a test of significance shows that there is an association ($p<0.001$) between day type and time of day.

Table 40 Observed frequencies of fatal crashes cross-classified by time of day, day type and crash type.

Rural crash type by day type	Early morning	Not early morning	Odds on early morning	Odds ratio
a) Overturn/remote				
weekend	1	8	0.13	0.9
weekday	3	20	0.15	
b) Overturn/non-remote				
weekend	8	9	0.89	4.5
weekday	6	30	0.20	
c) Hit-object/remote				
weekend	5	8	0.63	15.8
weekday	1	23	0.04	
d) Hit-object/non-remote				
weekend	32	68	0.47	2.9
weekday	19	116	0.16	

B.1.22 Injury site

The Abbreviated Injury Score (AIS) is a six digit code which describes the general body region, organ or specified area and the severity level of injuries received by fatally injured crash victims. Up to 10 AIS scores are recorded for each fatally injured crash victim. Table 41 shows the frequencies of injuries received by fatally injured occupants by region of the body and crash type. Table 42 shows the distribution of injuries as a percentage of the crash type total. Of the 2420 AIS values in the Fatality File, 35% describe injuries to the head region and 27% describe injuries to the thorax.

Table 41 Observed frequencies of injuries among fatally injured occupants cross-classified by body region and crash type (Note: a person can be injured in more than one region and can have more than one injury recorded for a single region)

Rural crash type	External	Head	Face	Neck	Thorax	Abdomen &Pelvic Contents	Spine	Upper Extr-emeties	Lower Extr-emeties
Overturn/remote	20	79	6	1	38	17	3	3	3
Overturn/non-rem	20	147	9	3	89	31	18	13	11
Hit-object/remote	18	89	8	0	72	43	8	13	18
Hit-object/non-rem	99	530	42	5	455	217	52	80	160

Table 42 Observed percentages of injuries among fatally injured vehicle occupants by body region for each crash type

Rural crash type	External	Head	Face	Neck	Thorax	Abdomen &Pelvic Contents	Spine	Upper Extr-emeties	Lower Extr-emeties
Overturn/remote	12	46	4	1	22	10	2	2	2
Overturn/non-rem	6	43	3	1	26	9	5	4	3
Hit-object/remote	7	33	3	0	27	16	3	5	7
Hit-object/non-rem	6	32	3	0	28	13	3	5	10

Table 42 shows that for each crash type the largest proportion of injuries occur to the head, thorax, abdomen and pelvic contents (although for overturn/remote crashes, external injuries occur more often than abdomen and pelvic contents injuries).

Tables 43 to 47 give a test of association between injury type received or not received and crash type for injuries to the head, thorax, abdomen and pelvic contents and external and facial injuries respectively among fatally injured occupants. A significant association is present for head injuries, abdomen and pelvic content injuries and external injuries.

Table 43 Observed frequencies of head injuries among fatally injured occupants by crash type ($\chi_3^2 = 25.3$, $p<0.001$)

Rural crash type	Head	Not head	Odds on head	Odds ratio
Overturn/remote	79	91	0.87	1.8
Overturn/non-remote	147	194	0.76	1.6
Hit-object/remote	89	180	0.49	1.0
Hit-object/non-remote	530	1110	0.48	

Table 44 Observed frequencies of thorax injuries among fatally injured occupants by crash type ($\chi_3^2 = 2.45, p=0.48$)

Rural crash type	Thorax	Not thorax	Odds on thorax	Odds ratio
Overturn/remote	38	132	0.29	0.8
Overturn/non-remote	89	252	0.35	0.9
Hit-object/remote	72	197	0.37	1.0
Hit-object/non-remote	455	1185	0.38	

Table 45 Observed frequencies of abdomen and pelvic content injuries among fatally injured occupants by crash type ($\chi_3^2 = 8.14, p=0.04$)

Rural crash type	Abdomen - pelvic	Not abdomen - pelvic	Odds on abdomen - pelvic	Odds ratio
Overturn/remote	17	153	0.11	0.7
Overturn/non-remote	31	310	0.10	0.7
Hit-object/remote	43	226	0.19	1.3
Hit-object/non-remote	217	1423	0.15	

Table 46 Observed frequencies of external injuries among fatally injured occupants by crash type (χ_3^2 =8.59, p=0.04)

Rural crash type	External	Not external	Odds on external	Odds ratio
Overturn/remote	20	150	0.13	2.2
Overturn/non-remote	20	321	0.06	1.0
Hit-object/remote	18	251	0.07	1.2
Hit-object/non-remote	99	1541	0.06	

Table 47 Observed frequencies of facial injuries among fatally injured occupants by crash type (χ_3^2 = 0.65, p=0.89)

Rural crash type	Face	Not face	Odds on face	Odds ratio
Overturn/remote	6	164	0.04	1.3
Overturn/non-remote	9	332	0.03	1.0
Hit-object/remote	8	261	0.03	1.0
Hit-object/non-remote	42	1598	0.03	

The odds on head injuries are greatest for overturn crashes, the odds on abdomen and pelvic content injuries are greatest for hit-object crashes and the odds on external injuries are greatest for overturn/remote crashes.

B.2 Queensland serious single vehicle crashes for 1989 and 1990

B.2.1 Introduction

For the purpose of this analysis, serious road crashes refer to those in which at least one vehicle occupant is hospitalised or fatally injured as a result of injuries sustained during the crash. During 1989 and 1990, 2368 single vehicle road crashes were reported in Queensland. Of these road crashes, 2202 were serious of which 1267 or 57% occurred in non-remote rural and remote areas.

The data collected for road crashes occurring in Queensland are recorded on the Queensland Police Department's traffic accident report form and subsequently transferred to a computer database. Data on occupants of vehicles involved in a road crash are restricted to age, sex, severity of injuries, type of road user and seat belt usage at the time of the crash. A further difficulty is that injury details of only four vehicle occupants are recorded and there are no details of occupants that are not injured at all. Throughout this section of the report, findings should be regarded with some caution in view of the substantial incidence of missing data.

B.2.2 Speeding

Table 48 shows the number of serious crashes in which excessive speed was judged to be the major factor contributing to the cause of the crash. The odds on speeding are much smaller than those for solely fatal crashes (Table 1), but in common with those results, do not differ significantly between the four crash types. However, aggregation over location shows a statistically significant higher likelihood of speeding among the vehicles hitting objects ($\chi_1^2 = 5.6$, $p = 0.02$)

Table 48 Observed frequencies of serious crashes cross-classified by speed and crash type ($\chi_3^2 = 6.2$, $p = 0.10$)

Rural crash type	Speeding	Not speeding	Odds on speeding	Odds ratio
Overturn/remote	21	382	0.06	0.6
Overturn/non-remote	16	318	0.05	0.5
Hit-object/remote	18	190	0.10	1.0
Hit-object/non-remote	27	295	0.09	

To investigate whether this result holds for differences in road surface, the data are cross-classified by speed, road surface type (sealed or unsealed) and crash type (Table 49).

Table 49 Observed frequencies of serious single vehicle crashes cross-classified by speed, road surface type and crash type

Rural crash type	Speeding	Not speeding	Odds on speeding	Odds ratio
a)Overturn/remote				
Unsealed	8	77	0.10	2.5
Sealed	13	304	0.04	
b)Overturn/non-remote				
Unsealed	2	49	0.04	0.8
Sealed	14	266	0.05	
c)Hit-object/remote				
Unsealed	9	32	0.28	4.7
Sealed	9	158	0.06	
d)Hit-object/non-remote				
Unsealed	1	49	0.02	0.2
Sealed	26	245	0.11	

For all crash types at least one cell in the speed by road surface type table contains an expected frequency of less than 5, so that a test of association is not appropriate for individual crash types. In section B.1.2, the location factor (remote or non-remote rural) was removed from the analysis as a log-linear model showed that the factor was not significant in explaining crash frequency. If the cell frequencies in Table 49 are aggregated over location then a test of significance shows that there is no association between speeding and road surface type for overturn crashes ($p=0.25$) or for hit-object crashes ($p=0.47$).

B.2.3 Alcohol

Examination of the role of alcohol in single vehicle rural crashes was hindered by the fact that only 444 drivers involved in the 2368 serious crashes had blood alcohol measurements recorded in the data file. The median BAC reading for these drivers was 0.16gm/100ml. BAC levels greater than 0.05gm/100ml are classified here as 'high' and lower or unrecorded BAC levels are classified as 'low'.

Table 50 Observed frequencies of vehicle drivers involved in serious single vehicle crashes cross-classified by BAC and crash type ($\chi^2_3 = 7.5, p=0.06$)

Rural crash type	High driver BAC	Low driver BAC	Odds on high driver BAC	Odds ratio
Overturn/remote	43	335	0.13	0.6
Overturn/non-remote	42	278	0.15	0.7
Hit-object/remote	37	162	0.23	1.1
Hit-object/non-remote	49	241	0.20	

The odds on high driver BAC are higher for hit-object crashes than for overturn crashes. Table 50 shows that there is a significant association between driver BAC and crash type. This contradicts the results obtained for the Fatality File (Table 4) where the odds on high BAC are greater for overturn crashes than for hit-object crashes, and where there is no association between crash type and driver BAC. To test this hypothesis, the data in Table 50 are aggregated over crash location to give Table 51.

Table 51 Observed frequencies of vehicles involved in serious single vehicle crashes cross-classified by driver BAC and crash description (χ_1^2=6.4, p=0.01)

Crash Description	High driver BAC	Low driver BAC	Odds on high driver BAC	Odds ratio
Overturn	85	613	0.14	0.7
Hit-object	86	403	0.21	

Table 51 shows that there is a significant association between crash description and driver BAC such that in a hit-object crash it is more likely that the driver has a high BAC than in an overturn crash.

In the Queensland database, BAC is recorded for the vehicle driver only and the use of a seat belt is recorded for injured occupants only. Table 52 shows the number of drivers injured in serious single vehicle crashes by crash type, BAC and seat belt use.

Table 52 Observed frequencies of vehicle drivers injured in serious single vehicle crashes cross-classified by crash type, driver BAC and seat belt use (χ_7^2=59.8, p<0.001)

Driver BAC within rural crash type	Belt not worn	Belt worn	Odds on belt not worn	Odds ratio
a)Overturn/remote				
High BAC	16	14	1.14	1.8
Low BAC	131	212	0.62	
b)Overturn/non-remote				
High BAC	8	20	0.40	1.8
Low BAC	38	171	0.22	
c)Hit-object/remote				
High BAC	13	10	1.30	3.8
Low BAC	34	100	0.34	
d)Hit-object/non-remote				
High BAC	17	19	0.89	4.0
Low BAC	33	150	0.22	

There is a significant association between use of seat belt by injured drivers and driver BAC by crash type. As is the case for solely fatal crashes (Tables 5 and 6), for each crash type, the odds on a driver not having worn a seat belt are greater for drivers with high BAC than for drivers with low BAC.

B.2.4 Asleep and fatigue

A contributing factor to a single vehicle crash may be driver fatigue. Table 53 shows the number of serious single vehicle crashes cross-classified by driver fatigue and crash type.

Table 53 *Observed frequencies of serious single vehicle crashes cross-classified by driver fatigue and crash type (χ_3^2 = 5.0, p=0.17)*

Rural crash type	Fatigued	Not fatigued	Odds on fatigued	Odds ratio
Overturn/remote	30	373	0.08	0.6
Overturn/non-remote	27	307	0.09	0.7
Hit-object/remote	22	186	0.12	0.9
Hit-object/non-remote	38	284	0.13	

There is no significant association between driver fatigue and crash type.

B.2.5 Road alignment

Sixty-two percent of serious overturns and 58% of serious collisions with objects occurred on straight sections of road (60% combined).

Ninety-one percent of serious overturns and 91% of serious collisions with objects occurred on sections of road that were level or of slight grade.

B.2.6 Weather conditions

Ninety percent of serious overturn crashes and 88% of serious collisions with objects occurred in fine weather.

B.2.7 Seat belt wearing

The Queensland database has no records for vehicle occupants that are not injured. As a result, information on seat belt wearing is available only for those occupants who are injured in a crash. There is the further restriction that details of only four vehicle occupants involved in the crash are recorded.

Table 59 shows that there is a significant association between the use of a seat belt and crash type for injured occupants involved in a serious single vehicle crash.

Table 59 *Observed frequencies of injured occupants involved in serious single vehicle crashes cross-classified by use of seat belt and crash type (χ_3^2=20.9, p<0.001)*

Rural crash type	Belt worn	Belt not worn	Odds on belt worn	Odds ratio
Overturn/remote	370	156	2.37	0.7
Overturn/non-remote	322	85	3.79	1.2
Hit-object/remote	189	34	5.56	1.7
Hit-object/non-remote	293	90	3.26	

The odds of an injured occupant having been wearing a seat belt at the time of the crash are greatest for a hit-object/remote crash (odds = 5.56) and least for an overturn/remote crash (odds = 2.37).

Table 60 adds classification of seriously injured (fatal or hospitalised) and not seriously injured. No significant association is apparent between injury severity and use of seat belt over crash types, although it should be borne in mind that this analysis does not include uninjured occupants.

Table 60 Observed frequencies of injured occupants involved in serious single vehicle crashes cross-classified by injury severity, use of seat belt and crash type (χ_7^2=8.8, p=0.27)

Use of seat belt within rural crash type	Seriously injured	Not seriously injured	Odds on seriously injured	Odds ratio
a)Overturn/remote				
Belt worn	296	74	4.00	1.0
Belt not worn	124	32	3.89	
b)Overturn/non-remote				
Belt worn	251	71	3.54	0.6
Belt not worn	72	13	5.54	
c)Hit-object/remote				
Belt worn	156	33	4.73	0.5
Belt not worn	31	3	10.33	
d)Hit-object/non-remote				
Belt worn	241	52	4.63	0.6
Belt not worn	79	11	7.18	

A survivable crash is defined as a crash in which at least one vehicle occupant survives. Table 61 shows the number of fatally and not fatally injured occupants involved in survivable serious single vehicle crashes, cross-classified by use of seat belt for each crash type.

Table 61 Observed frequencies of injured occupants involved in serious survivable crashes cross-classified by crash type, use of seat belt and whether fatally injured or not (χ_7^2=95.7, p<0.001)

Use of seat belt within crash type	Fatally injured	Not Fatally injured	Odds on fatally injured	Odds ratio
a)Overturn/remote				
Belt worn	10	142	0.07	0.1
Belt not worn	32	42	0.76	
b)Overturn/non-remote rural				
Belt worn	9	139	0.06	0.3
Belt not worn	5	20	0.25	
c)Hit-object/remote				
Belt worn	10	60	0.17	0.1
Belt not worn	7	4	1.75	
d)Hit-object/non-remote rural				
Belt worn	26	98	0.27	0.3
Belt not worn	18	22	0.82	

The odds of being fatally injured to not being fatally injured in a serious survivable crash, are smaller for all crash types if the vehicle occupant wears a seat belt.

B.2.8 Occupancy rate

Table 63 shows that for serious single vehicle crashes there is no association between the number of injured occupants and crash type.

Table 63 *Observed frequencies of serious single vehicle crashes cross-classified by vehicle occupancy and crash type ($\chi_9^2=10.6, p=0.30$)*

	Number of Injured Vehicle Occupants			
Rural crash type	One	Two	Three	More than three
Overturn/remote	130	113	50	108
Overturn/non-remote	117	79	40	95
Hit-object/remote	86	50	17	55
Hit-object/non-remote	129	81	36	74

B.2.9 Sex of driver

Table 64 shows that, as for the Fatality File, there is no significant association between sex of driver and crash type for serious single vehicle crash types.

Table 64 *Observed frequencies of serious single vehicle crashes cross-classified by sex of driver and crash type ($\chi_3^2=4.7, p=0.19$)*

Rural crash type	Male	Female	Odds on male	Odds ratio
Overturn/remote	282	119	2.37	0.8
Overturn/non-remote	222	112	1.98	0.7
Hit-object/remote	146	62	2.35	0.8
Hit-object/non-remote	239	83	2.88	

Table 65 shows the numbers of injured occupants cross-classified by sex of occupant, use of seat belt and crash type. There is a significant association between sex of occupant and use of seat belt by crash type. The odds of an injured occupant having been wearing a seat belt are greater if the occupant is a female, for all crash types.

Table 65 *Observed frequencies of injured occupants of vehicles involved in serious single vehicle crashes cross-classified by use of seat belt, sex of occupant and crash type ($\chi_7^2=38.4, p<0.001$)*

Sex of occupant within rural crash type	Belt worn	Belt not worn	Odds on belt worn	Odds ratio
a)Overturn/remote				
Male	218	78	2.80	0.5
Female	152	28	5.43	
b)Overturn/non-remote				
Male	174	32	5.44	0.5
Female	148	14	10.57	
c)Hit-object/remote				
Male	102	16	6.38	0.7
Female	87	10	8.70	
d)Hit-object/non-remote				
Male	169	42	4.02	0.4
Female	124	13	9.54	

B.3 Victoria serious single vehicle crashes for 1989 and 1990

B.3.1 Introduction

During 1989 and 1990, details of 4162 serious single vehicle road crashes were recorded in Victoria. A serious road crash refers to one in which at least one vehicle occupant is hospitalised or fatally injured as a result of injuries sustained during the road crash. Of these road crashes, 88% occurred in rural (non-urban) locations. By definition, Victoria does not contain any remote areas. Therefore the analyses in section B.3 make comparisons between the two crash types overturn/rural and hit-object/rural only.

The Victorian road crash database does not contain information on factors contributing to a crash such as speeding, driver fatigue or vehicle defects. Furthermore, detailed information is available only for those vehicle occupants that receive fatal or serious injuries which result in hospitalisation. As a result, it is not possible to classify a crash as survivable, where a survivable crash is defined to be a crash in which at least one vehicle occupant is not fatally injured. Throughout this section of the report, findings should be regarded with some caution in view of the substantial incidence of missing data.

B.3.2 Alcohol

Table 66 shows that there is a significant association between driver BAC and crash type.

Table 66 Observed frequencies of vehicles involved in serious single vehicle crashes cross-classified by driver BAC and crash type (χ_1^2 = 4.3, p=0.04)

Crash type	High driver BAC	Low driver BAC	Odds on high driver BAC	Odds ratio
Overturn/rural	56	80	0.70	0.7
Hit-object/rural	456	436	1.05	

Drivers of vehicles involved in serious hit-object single vehicle crashes are significantly more likely to have a high BAC than drivers involved in serious overturn crashes.

B.3.3 Road alignment

Table 67 indicates that the odds of a serious overturn crash occurring on curved section of road are significantly greater (more than 3 times as likely) than for hit-object crashes. Only 51% of serious overturns occurred on straight sections of road compared with 78% of collisions with objects.

Table 67 Observed frequencies of serious single vehicle crashes occurring on straight and curved sections of road cross-classified by crash type (χ_1^2 = 75.0, p<0.001)

Crash type	Straight	Curve	Odds on straight	Odds ratio
Overturn/rural	117	111	1.05	0.3
Hit-object/rural	1327	373	3.56	

No information is available on the vertical road alignment of crash sites.

B.3.4 Road surface conditions

Eighty-four percent of serious overturns and 79% of serious collisions with objects occurred on dry roads.

B.3.5 Weather and light conditions

Table 70 Observed frequencies of serious single vehicle crashes occurring in dark (including dawn, dusk) and light conditions cross-classified by crash type (χ_1^2 = 15.0, p<0.001)

Crash type	Dark	Light	Odds on dark	Odds ratio
Overturn/rural Hit-object/rural	176 1604	252 1529	0.70 1.05	0.7

Eighty-six percent of serious overturns and 86% of serious collisions with objects occurred in clear weather conditions.

Fifty-nine percent of serious overturns and 49% of serious collisions with objects occurred in daylight (Table 70).

B.3.6 Vehicle age

Table 71 indicates that vehicle age has no association with the crash type in which the vehicle is involved.

Table 71 Observed frequencies of vehicles involved in serious single vehicle crashes cross-classified by vehicle age and crash type (χ_1^2=0.05, p=0.82)

Crash type	Vehicle aged 10 years or more	Vehicle aged less than 10 years	Odds on vehicle aged 10 years or more	Odds ratio
Overturn/rural Hit-object/rural	171 870	182 957	0.94 0.91	1.0

B.3.7 Seat belt wearing

Table 73 shows that there is no association between crash type and the use of seat belts by seriously injured occupants.

Table 73 Observed frequencies of seriously injured occupants involved in serious single vehicle crashes cross-classified by use of seat belt and crash type (χ_1^2=0.14, p=0.71)

Crash type	Belt worn	Belt not worn	Odds on belt worn	Odds ratio
Overturn/rural Hit-object/rural	237 1160	54 245	4.38 4.73	0.9

Table 74 shows that there is a significant association between whether a vehicle occupant is fatally injured or not and the use of a seat belt.

Table 74 Observed frequencies of seriously injured occupants involved in serious single vehicle crashes cross-classified by injury severity (fatal or not fatal) and crash type ($\chi_3^2 = 160, p<0.001$)

Use of seat belt within crash type	Fatally injured	Not fatally injured	Odds on fatally injured	Odds ratio
a)Overturn/rural				
Belt worn	6	231	0.03	0.03
Belt not worn	25	29	0.86	
b)Hit-object/rural				
Belt worn	145	1015	0.14	0.24
Belt not worn	90	155	0.58	

There is a significantly greater likelihood of a seriously injured occupant being fatally injured when a seat belt is not worn than when a seat belt is worn. For overturn crashes, the likelihood of a vehicle occupant being fatally injured is 33 times greater if a seat belt is not worn than if a seat belt is worn. For hit-object crashes, the likelihood of being fatally injured is 4 times greater if a seat belt is not worn than if a seat belt is worn. The finding that relatively fewer fatalities occur when occupants are wearing seat belts in overturn crashes than for hit-object crashes is unlikely to be fully attributed to the higher proportion of driver only vehicle occupancy for hit-object crashes (see Table 79).

Table 75 shows that there is a significant association between driver BAC and non use of seat belts by seriously injured occupants for both crash types.

Table 75 Observed frequencies of seriously injured occupants involved in serious single vehicle crashes cross-classified by use of seat belt, driver BAC and crash type ($\chi_3^2 = 65.0, p<0.001$)

Driver BAC within crash type	Belt worn	Belt not worn	Odds on belt worn	Odds ratio
a)Overturn/rural				
High BAC	276	120	2.30	0.3
Low BAC	478	65	7.35	
b)Hit-object/rural				
High BAC	41	19	2.16	0.2
Low BAC	116	11	10.55	

Within each crash type, the odds of a seriously injured occupant having worn a seat belt to not having worn a seat belt are much greater if the vehicle driver has a low BAC rather than a high BAC.

Table 76 shows that the use of seat belts by seriously injured occupants of serious single vehicle crashes is significantly different for males and females. For both crash types, the odds on a seriously injured occupant having worn a seat belt are greater if the occupant is female.

Table 76 *Observed frequencies of seriously injured occupants involved in serious single vehicle crashes cross-classified by use of seat belt and sex of occupant (χ_3^2=20.0, p<0.001)*

Sex of occupant within crash type	Belt worn	Belt not worn	Odds on belt worn	Odds ratio
a)Overturn/rural				
Male	132	36	3.67	0.6
Female	105	18	5.83	
b)Hit-object/rural				
Male	715	186	3.84	0.5
Female	443	59	7.50	

Table 78 shows that there is no association between use of seat belt and seating position of seriously injured occupants.

Table 78 *Observed frequencies of seriously injured occupants involved in serious single vehicle crashes cross-classified by use of seat belt, seating position and crash type (χ_5^2=4.0, p=0.54)*

Seating position within crash type	Belt worn	Belt not worn	Odds on belt worn	Odds ratio
a)Overturn/rural				
Driver	142	31	4.58	0.9
Front	63	16	3.93	0.8
Rear	31	6	5.17	
b)Hit-object/rural				
Driver	757	139	5.45	1.5
Front	266	56	4.75	1.3
Rear	119	32	3.72	

B.3.8 Occupancy rate

Table 79 shows the numbers of vehicles (cars, station wagons, taxis, utility and panel vans) involved in serious single vehicle crashes classified by vehicle occupancy rate. There is a significant association between the number of vehicle occupants and crash type. A higher percentage of single vehicle hit-object crashes involved a driver only (74%) than for overturn crashes (61%).

Table 79 *Observed frequencies of vehicles involved in serious single vehicle crashes cross-classified by number of persons in the vehicle and crash type (χ_3^2 = 26.0, p<0.001)*

	Number of Persons in Vehicle			
Crash type	One	Two	Three	More than three
Overturn/rural	178	81	18	15
Hit-object/rural	1700	373	122	108

B.3.9 Point of impact

The point of impact for a serious crash is defined as the point of impact that is thought most likely to have caused the serious injury rather than the area of most damage to the vehicle. Table 80 shows that 70% of serious overturn crashes and 80% of hit-object crashes involve an impact to the front of the vehicle.

Table 80 Observed frequencies of serious single vehicle crashes cross-classified by initial point of vehicle impact and crash type

Point of impact	Overturn/rural	Hit-object/rural
Right front corner	68	247
Right side - forwards	3	127
Right side - rearwards	0	29
Right rear corner	1	10
Left front corner	55	209
Left side - forwards	4	102
Left side - rearwards	0	35
Left rear - corner	2	15
Front	77	1028
Rear	20	9
Top	56	48

B.3.10 Time of day

Table 81 shows that there is no association between the time of day (early morning to 6am or later) in which a serious crash occurs and crash type.

Table 81 Observed frequencies of vehicles involved in serious single vehicle crashes cross-classified by time of day and crash type ($\chi_1^2=1.9, p=0.17$)

Crash type	Early morning	Later	Odds on early morning	Odds ratio
Overturn/rural	76	350	0.22	0.8
Hit-object/rural	654	2480	0.26	

B.3.11 Interaction of time of day by day of week

Tables 82 and 83 show that for aggregated crashes there is a significant association between day of week and time of day of crash with the proportion of serious single vehicle crashes that occur early in the morning increasing during the weekend to a level 3 times that for weekdays. That is, the odds on a serious single vehicle crash occurring early in the morning are 3 times greater on the weekend than during the week.

Table 82 *Observed frequencies of serious single vehicle crashes cross-classified by time of day and day of week (χ_6^2=211, p<0.001)*

Day of week	Early morning	Later	Odds on early morning	Odds ratio
Monday	57	377	0.15	0.3
Tuesday	57	356	0.16	0.3
Wednesday	39	436	0.09	0.3
Thursday	74	458	0.16	0.3
Friday	101	549	0.18	0.4
Saturday	234	623	0.38	0.7
Sunday	268	516	0.52	

Table 83 *Observed frequencies of serious single vehicle crashes cross-classified by time of day and day type (weekday or weekend) (χ_1^2=188.3, p<0.001)*

Day type	Early morning	Later	Odds on early morning	Odds ratio
Weekday	328	2176	0.15	0.3
Weekend	502	1139	0.44	

B.4 Western Australia serious single vehicle crashes for 1989 and 1990

B.4.1 Introduction

During 1989 and 1990 a total of 1751 serious single vehicle crashes were recorded in Western Australia, of which 931 (53%) were non-urban crashes. A serious road crash refers to one in which at least one vehicle occupant is seriously injured (fatally injured or hospitalised) as a result of injuries sustained during the crash. In the Western Australia road crash database, detailed information is available only for those vehicle occupants that are seriously injured. Further, there is no information on whether driver fatigue may have been a cause of the crash. Throughout this section of the report, findings should be regarded with some caution in view of the substantial incidence of missing data.

B.4.2 Speeding

Table 84 Observed frequencies of serious single vehicle crashes cross-classified by vehicle speed and crash type ($\chi_3^2 = 4.5, p<0.21$)

Rural crash type	Speeding	Not speeding	Odds on speeding	Odds ratio
Overturn/remote	21	61	0.34	0.8
Overturn/non-remote	31	116	0.27	0.6
Hit-object/remote	15	35	0.43	1.0
Hit-object/non-remote	65	146	0.45	

Table 84 shows that there is no significant association between vehicle speed and the four crash types, which is similar to the result in the Fatality File. However, similar to the Queensland data, aggregating over location, there is a tendency for a higher likelihood of speeding among the drivers hitting objects than those overturning (χ_1^2=3.5, p=0.06).

Table 85 Observed frequencies of vehicles involved in serious single vehicle crashes cross-classified by speed, crash type and road surface (χ_3^2= 4.3, p=0.24)

Road surface within crash type	Speeding	Not speeding	Odds on speeding	Odds ratio
a)Overturn				
Unsealed	14	40	0.35	1.3
Sealed	38	136	0.28	
b)Hit-object				
Unsealed	12	27	0.44	1.0
Sealed	68	153	0.44	

Table 85 further classifies serious single vehicle crashes by road surface (sealed or unsealed). The odds on a vehicle having been speeding at the time of a crash are similar for sealed and unsealed surfaces within overturn and hit-object crashes respectively. However, the odds on a vehicle having been speeding are greatest for hit-object crashes as indicated in Table 84.

B.4.3 Alcohol

Table 86 shows that there is no association between driver BAC and crash type. This result agrees with that obtained for the Fatality File.

Table 86 Observed frequencies of vehicles involved in serious single vehicle crashes cross-classified by driver BAC and crash type (χ_3^2=1.9, p=0.59)

Rural crash type	High driver BAC	Low driver BAC	Odds on high driver BAC	Odds ratio
Overturn/remote	19	123	0.15	0.7
Overturn/non-remote	42	199	0.21	1.0
Hit-object/remote	13	53	0.25	1.1
Hit-object/non-remote	55	250	0.22	

B.4.4 Vehicle lost control on the shoulder

Table 87 shows that there is no association between whether the road shoulder contributed to loss of control of vehicle and crash type. This result does not agree with that obtained for the Fatality File.

Table 87 Observed frequencies of vehicles involved in serious single vehicle crashes cross-classified by road shoulder contribution to loss of control of vehicle and crash type (χ_3^2 = 5.8, p=0.12)

Rural crash type	Road shoulder contributed to loss of control	Road shoulder did not contribute to loss of control	Odds on shoulder contribution to loss of control	Odds ratio
Overturn/remote	18	125	0.14	1.1
Overturn/non-remote	40	208	0.19	1.4
Hit-object/remote	4	67	0.06	0.4
Hit-object/non-remote	38	276	0.14	

B.4.5 Type of object

Table 88 shows the frequencies of serious single vehicle hit-object crashes cross-classified by object type and location. There is no significant association between object type and location. This result does not agree with that obtained for the Fatality File.

Table 88 Observed frequencies of vehicles involved in serious single vehicle hit-object crashes cross-classified by type of object (animate vs inanimate) and crash location (χ_1^2 = 0.91, p=0.34)

Rural crash type	Animal	Inanimate object	Odds on animal	Odds ratio
Hit-object/remote	6	65	0.09	1.9
Hit-object/non-remote	15	301	0.05	

B.4.6 Road alignment

Sixty-three percent of serious overturns and 59% of serious collisions with objects occurred on straight sections of road.

Seventy-three percent of serious overturns and 66% of serious collisions with objects occurred on level sections of road.

B.4.7 Road surface conditions

Eighty-nine percent of serious overturns and 82% of serious collisions with objects occurred on dry roads.

B.4.8 Weather and light conditions

Ninety-two percent of serious overturns and 88% of serious collisions with objects occurred in clear weather conditions.

Table 94 shows that there is a significant association between light conditions and crash type. The odds on a serious crash occurring in the dark rather than in light conditions are greatest for hit-object/remote followed by hit-object/non-remote rural crashes. For both non-remote rural and remote locations, overturn crashes are more frequent in light conditions than in dark conditions (59% in light conditions), and conversely, hit-object crashes are more frequent in dark conditions than in light conditions (46% in light conditions).

Table 94 Observed frequencies of serious single vehicle crashes cross-classified by light conditions and crash type ($\chi_3^2=16.9, p<0.001$)

Rural crash type	Dark	Light	Odds on dark	Odds ratio
Overturn/remote	54	89	0.61	0.6
Overturn/non-remote	107	143	0.75	0.7
Hit-object/remote	45	26	1.73	1.6
Hit-object/non-remote	162	152	1.07	1.0

B.4.9 Vehicle age

Table 95 shows that there is a significant association between vehicle age and crash type. The odds that a vehicle involved in a serious remote overturn crash was of age 10 years or more are at least 3 times smaller than the odds for the other crash types.

Table 95 Observed frequencies of vehicles involved in serious single vehicle crashes cross-classified by vehicle age (10 years or more and less than 10 years) and crash type ($\chi_3^2=14.5, p=0.002$)

Rural crash type	Vehicle aged 10 years or more	Vehicle aged less then 10 years	Odds on vehicle aged 10 years or more	Odds ratio
Overturn/remote	13	56	0.23	0.3
Overturn/non-remote	55	73	0.75	0.9
Hit-object/remote	13	19	0.68	0.9
Hit-object/non-remote	64	80	0.80	

B.4.10 Seat belt wearing

Table 98 shows the numbers of seriously injured occupants of serious single vehicle crashes cross-classified by use of seat belt and crash type. There is a significant association between use of seat belt and crash type. The odds on a seriously injured occupant having worn a seat belt are greatest for hit-object/non-remote rural crashes.

Table 98 Observed frequencies of seriously injured occupants of serious single vehicle crashes cross-classified by use of seat belt and crash type (χ_3^2=11.0, p=0.01)

Rural crash type	Belt worn	Belt not worn	Odds on belt worn	Odds ratio
Overturn/remote	125	59	2.12	0.5
Overturn/non-remote	200	80	2.50	0.6
Hit-object/remote	55	20	2.75	0.7
Hit-object/non-remote	253	62	4.08	

Table 99 shows that the odds of being fatally injured to not being fatally injured in a 'survivable' crash are lower when a seat belt is worn for all crash types. Aggregating over all crash types, the odds of being fatally injured to not being fatally injured when a seat belt is worn are 0.03 compared to 0.14 when a seat belt is not worn (χ_1^2=23.0, p<0.001).

Table 99 Observed frequencies of seriously injured occupants involved in a serious 'survivable' single vehicle crash cross-classified by injury severity, use of seat belt and crash type.

Use of seat belt within crash type	Fatally injured	Not fatally injured	Odds on fatally injured	Odds ratio
a)Overturn/remote				
Belt worn	5	118	0.04	0.2
Belt not worn	8	46	0.17	
b)Overturn/non-remote rural				
Belt worn	4	192	0.02	0.1
Belt not worn	12	61	0.20	
c)Hit-Object/remote				
Belt worn	0	54	0.00	0.0
Belt not worn	2	17	0.12	
d)Hit-object/non-remote rural				
Belt worn	11	234	0.05	0.8
Belt not worn	3	51	0.06	

Table 100 shows that there is no significant association between the use of a seat belt and driver BAC within crash type.

Table 100 Observed frequencies of drivers involved in serious single vehicle crashes cross-classified by use of seat belt and BAC ($\chi_7^2=9.4, p=0.22$)

Driver BAC within crash type	Belt not worn	Belt worn	Odds on belt not worn	Odds ratio
a)Overturn/remote				
High BAC	0	10	0.00	0.0
Low BAC	15	50	0.30	
b)Overturn/non-remote rural				
High BAC	6	10	0.60	2.6
Low BAC	21	91	0.23	
c)Hit-object/remote				
High BAC	2	5	0.40	1.0
Low BAC	10	25	0.40	
d)Hit-object/non-remote rural				
High BAC	3	20	0.15	0.7
Low BAC	25	120	0.21	

Table 101 shows that there is a significant association between use of seat belt and the sex of a seriously injured occupant within crash type. For overturn/remote crashes, the odds on a seriously injured occupant having worn a seat belt are approximately equivalent for males and females. For all other crash types, the odds are at least twice as great for females than for males.

Table 101 Observed frequencies of seriously injured occupants of serious single vehicle crashes cross-classified by use of seat belt, sex of occupant and crash type ($\chi_7^2=27.3, p<0.001$)

Sex of occupant within rural crash type	Belt worn	Belt not worn	Odds on belt worn	Odds ratio
a)Overturn/remote				
Male	70	33	2.12	1.0
Female	54	26	2.08	
b)Overturn/non-remote				
Male	116	59	1.97	0.5
Female	83	21	3.95	
c)Hit-object/remote				
Male	35	16	2.19	0.4
Female	20	4	5.00	
d)Hit-object/non-remote				
Male	154	51	3.02	0.3
Female	98	11	8.90	

B.4.11 Occupancy rate

In Western Australia, information on the number of occupants travelling in a vehicle involved in a single vehicle crash was not recorded before January 1991.

B.4.12 Time of day

Table 103 shows that there is no significant association between time of day at which the crash occurs and crash type. Although hit-object crashes appear more likely to occur in the early morning than do overturn crashes, even after aggregating frequencies over location no significant association is found (χ_1^2=2.0, p=0.16).

Table 103 Observed frequencies of vehicles involved in serious single vehicle crashes cross-classified by time of day and crash type (χ_3^2=2.7, p=0.44)

Rural crash type	Early morning	Later in the day	Odds on early morning	Odds ratio
Overturn/remote	8	53	0.15	0.5
Overturn/non-remote	17	83	0.20	0.7
Hit-object/remote	11	39	0.28	1.0
Hit-object/non-remote	32	114	0.28	

B.4.13 Interaction of time of day by day of week

Table 104 shows that for serious single vehicle crashes there is a significant association between the time of day and the day of the week that the crash occurs. As for the other states examined here, there is a larger proportion of early morning crashes on the weekend than on weekdays.

Table 104 Observed frequencies of vehicles involved in serious single vehicle crashes cross-classified by day of week and time of day (χ_6^2=37.7, p<0.001)

Day of week	Early morning	Later in the day	Odds on early morning	Odds ratio
Monday	27	142	0.19	0.6
Tuesday	17	106	0.16	0.5
Wednesday	23	123	0.19	0.5
Thursday	31	144	0.22	0.6
Friday	36	189	0.19	0.5
Saturday	90	190	0.47	1.4
Sunday	72	209	0.34	

These data are aggregated in Table 105 into the categories Weekday and Weekend. The odds on a serious crash having occurred early in the morning as compared to later in the day are twice as great for weekend days than for week days.

Table 105 Observed frequencies of vehicles involved in serious single vehicle crashes cross-classified by day type and time of day (χ_1^2=32.7, p<0.001)

Day type	Early morning	Later in the day	Odds on early morning	Odds ratio
Weekday	134	704	0.19	0.5
Weekend	162	399	0.41	

B.5 Northern Territory serious single vehicle crashes for 1990-1992

B.5.1 Introduction

A total of 411 serious single vehicle crashes involving passenger vehicles* and no pedestrians were recorded in rural areas of the Northern Territory in the three year period 1990-92. At least one person was either fatally injured or hospitalised as a result of these crashes. This represents 73% of serious single vehicle crashes involving passenger vehicles in the whole of the territory for this period.

Defining remote rural as areas with no posted speed limit, 84% of single vehicle crashes occurred in remote areas. Information on whether or not there was a posted speed limit at the crash site was missing for 6 crashes. For 59 of the single vehicle rural crashes, the coding was not sufficiently detailed to determine whether the car overturned or hit an object. Of the remainder (352 crashes), 86% percent were overturn crashes.

Cross-classifying these two factors results in the four categories overturn/remote (259), overturn/non-remote rural (40), hit-object/remote (39) and hit-object/non-remote rural (8) with 65 crashes unable to be categorised. The resultant small number of crashes in the last category precludes detailed comparison of the four groups. However, where necessary, exact p-values are included with the standard chi-squared tests.

The Northern Territory database does not contain information on whether driver fatigue or vehicle defects were contributing factors in the crash. Nor is the model year of the vehicle coded. Seat belt information is coded only for drivers or passengers who are killed or injured. Age, sex and BAC are coded for drivers, regardless of their injury outcome.

B.5.2 Speeding

In the Northern Territory database, a vehicle was recorded as speeding if speed was thought to be a contributing factor in the crash. There was a statistically significant association between speeding and crash type (Table 106). Overturn non-remote rural crashes were more likely than the other crash types to have speed recorded as a contributing factor.

Table 106 Observed frequencies of serious single vehicle crashes by speeding as a contributing factor and crash type($\chi_3^2 = 7.7, p = 0.05, p_{exact} = 0.05$).

Rural crash type	Speeding	Not speeding	Odds on speeding	Odds ratio
Overturn/remote	43	216	0.20	1.7
Overturn/non-remote	12	28	0.43	3.8
Hit-object/remote	4	35	0.11	
Hit-object/non-remote	0	8	0	0

Further analysis showed that the likelihood of speeding depended on road surface for the different crash types and this was consistent in non-remote rural and remote rural areas (Table 107). The pattern was similar to that found for fatal crashes; the odds for speeding contributing to overturn crashes were highest on unsealed roads, whereas the odds for speeding contributing to hit-object crashes were highest on sealed roads.

* Passenger vehicles include sedans, station wagons, hatchbacks, utilities and panel vans.

Table 107 Observed frequencies of serious single vehicle crashes cross-classified by speeding, road surface type and crash type (χ_3^2 = 15.1, p = 0.002, p_{exact} = 0.002).

Crash type by road surface	Speeding	Not speeding	Odds on speeding	Odds ratio
a) Overturn				
Unsealed	31	82	0.38	2.7
Sealed	23	166	0.14	
b) Hit-object				
Unsealed	1	21	0.05	0.4
Sealed	3	23	0.13	

B.5.3 Alcohol

Blood alcohol levels (BAC) were coded for only 61% of the drivers. A total of 35% were not tested and the result of the test or whether the a test was done was unknown for a further 4%. Among those that were tested, there is a statistically significant association between drink driving and the four crash types (χ_3^2 = 12.6, p = 0.006, p_{exact} = 0.005). There was no consistent pattern in the difference between overturn and hit-object crashes. The major distinction was between locations with drivers involved in serious single vehicle crashes in *non-remote* rural areas having over 3 times the odds of being over the limit (BAC > 0.05) compared with drivers involved single vehicle crashes in *remote* areas (Table 108). It was thought that this may be biased by being less likely to be tested in remote areas. Certainly, there was a smaller percentage of drivers tested in remote regions compared with non-remote rural areas, but this difference was not statistically significant.

Table 108 Observed frequencies of serious single vehicle crashes by blood alcohol content (BAC) of driver cross-classified by crash location(χ_1^2 = 12.4, p = 0.004)

Crash location	High BAC of driver	Low BAC of driver	Odds on high BAC	Odds ratio
Remote	67	138	0.49	0.3
Non-remote rural	28	17	1.65	

Seat belt status was only available for the drivers who were killed or injured. Based on these drivers, there is a significant association between seat belt use and BAC. The injured drunk drivers were much less likely to be wearing a seat belt than the drivers within the legal limit (Table 109). This was the case for all crash types

Table 109 Observed frequencies of drivers injured or killed in serious single vehicle crashes by use of seat belt and blood alcohol content (BAC) (χ_1^2 = 28.1, p = 0.00)

BAC	Belt not used	Belt used	Odds on belt not used	Odds ratio
High BAC	38	18	2.11	7.2
Low BAC	21	72	0.29	

B.5.4 Driver inexperience

Overall, there were similar proportions of younger drivers among the four crash groups ($\chi_3^2 = 5.4$, $p = 0.14$). Aggregation showed there was a similar tendency to that observed in the Fatality File (Table 13) with higher odds for younger drivers in non-remote rural as opposed to remote areas (Table 110).

Table 110 Observed frequencies of drivers involved in serious single vehicle crashes cross classified by age and crash location (non-remote rural or remote) ($\chi_1^2 = 2.9$, $p = 0.09$)

Crash location	Under 25 years	Over 25 years	Odds on under 25 years	Odds ratio
Remote	116	224	0.52	0.6
Non-remote rural	30	35	0.86	

B.5.5 Type of object

The high odds ratio for hitting an animal versus an inanimate object in remote versus non-remote rural areas is consistent with the Fatality File (Table 17). Due to the small number of crashes, it is not statistically significantly greater than one.

Table 111 Observed frequencies of serious single vehicle crashes involving an object cross-classified by object type and crash location

Crash location	Animal	Inanimate object	Odds on animal	Odds ratio
Remote	14	25	0.56	3.9
Non-remote rural	1	7	0.14	

B.5.6 Road alignment

Seventy-eight percent of serious overturns and 81% of serious collisions with objects occurred on straight sections of road.

Seventy-six percent of serious overturns and 81% of serious collisions with objects occurred on level sections of road.

B.5.7 Road surface conditions

Ninety-three percent of serious overturns and 98% of serious collisions with objects occurred on dry roads.

B.5.8 Weather and light conditions

Ninety-two percent of serious overturns and 94% of serious collisions with objects occurred in clear weather conditions.

Tables 120 and 121 show that there are highly statistically significant associations between crash types and light conditions, and between crash location and light conditions. The odds for a serious crash occurring in the dark rather than in light conditions are greater for hit-object crashes than for overturn crashes (49% of hit-object crashes compared with 27% of overturns) and for non-remote rural crashes than for remote crashes (47% of non-remote rural crashes compared with 29% of remote crashes).

Table 120 Observed frequencies of serious single vehicle crashes occurring in dark and light conditions cross-classified by crash type ($\chi_1^2 = 7.86, p = 0.005, p_{exact} = 0.004$)

Crash type	Dark	Light	Odds on dark	Odds ratio
Overturn	83	219	0.38	0.4
Hit-object	23	24	0.96	

Table 121 Observed frequencies of serious single vehicle crashes occurring in dark and light conditions cross-classified by crash location ($\chi_1^2 = 24.7, p < 0.001, p_{exact} < 0.001$)

Crash location	Dark	Light	Odds on dark	Odds ratio
Remote	98	242	0.40	0.5
Non-remote rural	30	34	0.88	

B.5.9 Seat belt wearing

Seat belt status was only recorded for those vehicle occupants who were killed or injured in a crash. There was no statistically significant difference between crash types in the proportion of these occupants who were wearing seat belts (Table 122). Almost one-half of those killed or injured in either an overturn (46%) or a hit-object crash (48%) were doing so.

Table 122 Observed frequencies of injured occupants involved in serious single vehicle crashes cross-classified by use of seat belt and crash type ($\chi_1^2 = 0.02, p = 0.9, p_{exact} = 0.8$)

Crash type	Belt worn	Belt not worn	Odds on belt worn	Odds ratio
Overturn	189	221	0.86	0.9
Hit-object	27	29	0.93	

The proportion of victims who were wearing seat belts in non-remote rural crashes (29%) is much lower than that for remote crashes (49%). This difference is highly statistically significant (Table 123).

Table 123 Observed frequencies of injured occupants involved in serious single vehicle crashes cross-classified by use of seat belt and crash location ($\chi_1^2 = 8.8, p = 0.003, p_{exact} = 0.002$)

Crash location	Belt worn	Belt not worn	Odds on belt worn	Odds ratio
Remote	220	231	0.95	2.3
Non-remote rural	21	51	0.41	

Table 124 shows that the odds of being fatally injured to being hospitalised in an overturn crash are much lower when a seat belt is worn (Table 124). The proportion of injuries that were fatal is 3% for seat belt wearers and 33% for non-wearers, and this result is highly statistically significant ($\chi_1^2 = 57.9$, $p < 0.001$). The same trend is apparent for hit-object crashes, however there are too few fatal injuries for a statistical test.

Table 124 Observed frequencies of injured occupants involved in serious single vehicle crashes cross-classified by injury severity, use of seat belt and crash type

Crash type by seat belt	Fatally injured	Hospitalised	Odds on fatally injured	Odds ratio
a) Overturn				
Belt worn	5	184	0.03	0.1
Belt not worn	72	149	0.48	
b) Hit-Object				
Belt worn	2	25	0.08	0.4
Belt not worn	5	24	0.21	

The odds of being fatally injured to being hospitalised in a remote location crash are also much lower when a seat belt is worn (Table 125). The proportion of injuries that were fatal is 3% for seat belt wearers and 32% for non-wearers. This difference is highly statistically significant ($\chi_1^2 = 63.0$, $p < 0.001$). The same trend is apparent for non-remote rural crashes, but again there are too few fatal injuries for a statistical test.

Table 125 Observed frequencies of injured occupants involved in serious single vehicle crashes cross-classified by injury severity, use of seat belt and crash location

Crash location by seat belt	Fatally injured	Hospitalised	Odds on fatally injured	Odds ratio
a) Remote				
Belt worn	6	214	0.03	0.1
Belt not worn	73	158	0.46	
b) Non-remote rural				
Belt worn	1	20	0.05	0.5
Belt not worn	5	46	0.11	

B.5.10 Occupancy rate

In contrast to the results for the Fatality File (Section B.1.14) and the Victorian data (Section B.3.8), the number of vehicle occupants does not differ statistically significantly for overturn and hit-object crashes (Table 128). The percentage of crashes in which the driver is the only occupant is similar for the two crash types (25% and 23% respectively; the mean occupancy per vehicle cannot be calculated exactly because crashes with four or more occupants were given the same code in the Northern Territory database, however both overturn and hit-object crashes had a mean occupancy of at least 2.5. Thus, the mean occupancy for hit-object crashes is higher than found for the Fatality File.

On the other hand, the number of vehicle occupants appears to be associated with crash location (Table 129). The proportion of non-remote rural crashes in which the driver is the only occupant (32%) is greater than that for remote crashes (21%). An exact trends tests suggests that this difference is not due to chance ($p = 0.02$; this test is not definitive due to the grouping of four or more occupants).

Table 128 Observed frequencies of serious single vehicle crashes cross classified by vehicle occupancy and crash type ($\chi_3^2 = 0.52, p = 0.9$)

	Number of vehicle occupants			
Crash type	One	Two	Three	Four or more
Overturn	76	96	47	85
Hit-object	11	16	9	12

Table 129 Observed frequencies of serious single vehicle crashes cross classified by vehicle occupancy and crash location (χ_3^2 = 5.9, p = 0.1)

Crash location	Number of vehicle occupants			
	One	Two	Three	Four or more
Remote	72	109	54	105
Non-remote rural	21	21	11	12

B.5.11 Sex of driver

Three to four times as many serious single vehicle crashes have involved male drivers as have involved female drivers. There is no statistically significant difference for this ratio between crash types (Table 130) or between crash locations (Table 131).

Table 130 Observed frequencies of serious single vehicle crashes cross-classified by sex of driver and crash type (χ_1^2 = 0.2, p = 0.7, p_{exact} = 0.6)

Crash type	Male	Female	Odds on male	Odds ratio
Overturn	228	76	3.00	0.8
Hit-object	38	10	3.80	

Table 131 Observed frequencies of serious single vehicle crashes cross-classified by sex of driver and crash type (χ_1^2 = 0.24, p = 0.6, p_{exact} = 0.5)

Crash location	Male	Female	Odds on male	Odds ratio
Remote	254	86	2.95	0.8
Non-remote rural	51	14	3.64	

The following two tables show the numbers of injured occupants cross-classified by sex and use of seat belt, and crash type (Table 132) or crash location (Table 133). For overturn crashes, the odds that an injured occupant had been wearing a seat belt are greater if the occupant is a female (χ_1^2 = 7.0, p = 0.008). For hit-object crashes, there are too few females with seat belt status recorded to draw any conclusions.

Table 132 Observed frequencies of injured occupants involved in serious single vehicle crashes cross-classified by use of seat belt, sex of occupant and crash type

Crash type by seat belt	Belt worn	Belt not worn	Odds on belt worn	Odds ratio
a) Overturn				
Male	64	53	1.21	0.4
Female	41	12	3.42	
b) Hit-object				
Male	13	8	1.63	1.6
Female	1	1	1.00	

For non-remote rural crashes, the odds that an injured occupant had been wearing a seat belt are greater if the occupant is a female (χ_1^2 = 3.7, p = 0.054). For remote crashes, there are too few females with seat belt status recorded to draw any conclusions.

Table 133 Observed frequencies of injured occupants involved in serious single vehicle crashes cross-classified by use of seat belt, sex of occupant and crash location

Crash location by seat belt	Belt worn	Belt not worn	Odds on belt worn	Odds ratio
a) Remote				
Male	82	50	1.64	0.5
Female	40	11	3.64	
b) Non-remote rural				
Male	6	14	0.43	0.1
Female	6	2	3.00	

B.5.12 Injury severity and seating position of occupants

Tables 134 and 135 show the frequencies of injured occupants classified by injury level and seating position, and crash type or crash location. There are too many missing data for adequate conclusions to be made about associations between these factors. However, there appears to be no evidence of an association between seating position and injury level.

Table 134 Observed frequencies of occupants, in serious single vehicle crashes with more than one occupant, cross-classified by injury level, seating position and crash type

Crash type by seating position	Fatally injured	Hospitalised	Odds on fatally injured	Odds ratio
a) Overturn				
Driver	18	114	0.16	0.7
Front	20	119	0.17	0.7
Rear	14	61	0.23	
b) Hit-object				
Driver	3	17	0.18	
Front	2	27	0.07	
Rear		4		

Table 135 Observed frequencies of occupants, in serious single vehicle crashes with more than one occupant, cross-classified by injury level seating position and crash location

Crash location by seating position	Fatally injured	Hospitalised	Odds on fatally injured	Odds ratio
a) Remote				
Driver	21	130	0.16	0.8
Front	22	134	0.16	0.8
Rear	13	61	0.21	
b) Non-remote rural				
Driver	0	17	0	
Front	0	28	0	
Rear	0	10	0	

B.5.13 Interaction of time of day by day of week

Table 136 gives the frequency of crashes classified by day of week and time of day. The odds on a serious crash having occurred early in the morning as compared to later in the day are lower for each week day than for Saturday or Sunday. The numbers in some cells of the table are too small for this difference to be statistically significant, however there is a statistically significant association when the data are aggregated into weekdays and weekend (Table 137). As for Western Australia, the odds for a crash having occurred early in the morning are twice as great for weekend days than for week days.

Table 136 Observed frequencies of serious single vehicle crashes cross-classified by day of week and time of day ($\chi_6^2 = 9.4, p = 0.2$)

Day of week	Early morning	Later in the day	Odds on early morning	Odds ratio
Monday	7	46	0.15	0.7
Tuesday	2	38	0.05	0.2
Wednesday	4	41	0.10	0.4
Thursday	9	52	0.17	0.8
Friday	4	47	0.09	0.4
Saturday	17	66	0.26	1.2
Sunday	14	63	0.22	

Table 137 Observed frequencies of serious single vehicle crashes cross-classified by sex of driver and crash type ($\chi_1^2 = 5.8, p = 0.02$)

Weekend	Early morning	Later in the day	Odds on early morning	Odds ratio
Weekday	26	224	0.12	0.5
Weekend	31	129	0.24	

The same association between time of day and day of week is evident for each of the two crash types considered separately (Table 138), although it is not statistically significant (overturn crashes: $\chi_1^2 = 0.9$, $p = 0.4$, $p_{exact} = 0.3$; hit-object type crashes: $\chi_1^2 = 1.7$, $p = 0.2$, $p_{exact} = 0.2$).

For remote crashes, the odds ratio is similar to that for all crashes and is statistically significantly different from 1 ($\chi_1^2 = 4.3$, $p = 0.04$, $p_{exact} = 0.03$). The same pattern occurs again for non-remote rural crashes ($\chi_1^2 = 2.6$, $p = 0.11$, $p_{exact} = 0.07$).

Table 138 Observed frequencies of serious single vehicle crashes cross-classified by time of day, day type and crash type

Crash type by weekend	Early morning	Later in the day	Odds on early morning	Odds ratio
a) Overturn				
Weekday	18	169	0.11	0.7
Weekend	16	100	0.16	
b) Hit-object				
Weekday	6	25	0.24	0.3
Weekend	7	10	0.70	

Table 139 Observed frequencies of serious single vehicle crashes cross-classified by time of day, day type and crash location

Crash location by weekend	Early morning	Later in the day	Odds on early morning	Odds ratio
a) Remote				
Weekday	18	186	0.10	0.5
Weekend	23	113	0.20	
b) Non-remote rural				
Weekday	7	36	0.19	0.3
Weekend	8	13	0.62	

C. COMPARATIVE SUMMARY OF RESULTS FOR THE FATALITY FILE, QUEENSLAND, VICTORIA, WESTERN AUSTRALIA AND THE NORTHERN TERRITORY

C.1 Introduction

In section B, sixteen factors are identified as being major causes of serious crashes or primary in affecting the nature of injuries received in these crashes. Single vehicle rural crash data from the FORS Fatality File and from the states of Queensland, Victoria and Western Australia, and the Northern Territory are analysed to determine the importance of the factors in the 4 types of single vehicle rural crashes. In this section, the results obtained for the Fatality File and the states are compared.

When making comparisons, it is necessary to be aware of the differences in the data, between the Fatality File and the four states and territories. The Fatality File contains extensive information about fatal crashes which occurred in Australia during 1988. The data analysed for each of the states contain information about serious crashes which occurred during the years 1989 and 1990, and for the Northern Territory from 1990 to 1992. In general, the state data contain less information about causal factors than does the Fatality File and so data for only a subset of the 16 identified causal factors are able to be analysed for the states. The state databases also do not provide details of occupants that are not injured at all. However, information on driver age, sex and blood alcohol levels is available in the Northern Territory database, regardless of injury outcome. In addition, the Queensland road crash database contains information on the driver and up to four injured occupants only.

The Victoria road crash database differs from the other two state databases in that none of the crashes are classified as being remote. Therefore, comparisons are made between overturn/rural and hit-object/rural crash types only.

C.2 Comparisons between the results obtained for the Fatality File, Queensland, Victoria, Western Australia and the Northern Territory, by causal factor

C.2.1 Speeding

Fatality File

- There is no association between speed and crash type.
- When crashes are aggregated over location, there is a significant association between speed and road surface type by crash type. The odds on a vehicle having been speeding for a fatal overturn crash are significantly greater on unsealed roads than on sealed roads and conversely, the odds on a vehicle having been speeding for a fatal hit-object crash are significantly greater on sealed roads than on unsealed roads.

Queensland

- There is a significant association between speed and crash type. The odds on speed being a contributing factor are greater for hit-object crashes than overturn crashes.
- When crashes are aggregated over location, there is no association between speed and road surface type by crash type.

Western Australia

- There is a weakly significant association between speed and crash type. The odds on a vehicle having been speeding are greater for hit-object crashes than for overturn crashes.
- When frequencies are aggregated over location, there is no significant association between speed and road surface type by crash type.

Northern Territory

- There is a significant association between speed and crash type. The odds on speed being a contributing factor are greatest for overturn non-remote rural crashes.
- When frequencies are aggregated over location and the road surface is taken into account, there is a significant association between speeding and road surface type by crash type. The pattern is similar to that found for fatal crashes. Speed contributes to a greater degree to overturn crashes on unsealed roads and hit-object crashes on sealed roads.

C.2.2 Alcohol

Fatality File

- There is no association between driver BAC and crash type, where BAC is classified as high (greater than 0.05gm/100ml) and low (0.05gm/100ml or lower).
- There is a significant association between a vehicle occupant's use of a seat belt and driver BAC, for a vehicle involved in a fatal single vehicle crash. It is more likely that occupants are not wearing seat belts if the driver has a high BAC than low (See Section C.2.8).
- For vehicles involved in fatal single vehicle crashes, the odds on a driver having a high BAC are greatest for drivers employed as 'labourers and related workers' followed by 'plant and machine operators', 'tradespersons' and the unemployed.

Queensland

- There is a significant association between a driver's BAC and crash type. The driver in a hit-object crash, is more likely to have had a high BAC than one in an overturn crash.
- There is a significant association between the driver's use of a seat belt and driver BAC. The odds on a driver having worn a seat belt are significantly greater for drivers with low BAC than those with high BAC.

Victoria

- There is a significant association between driver BAC and crash type. Drivers involved in serious hit-object crashes are significantly more likely to have had high BAC than drivers involved in serious overturn crashes.

Western Australia

- There is no association between driver BAC and crash type.

Northern Territory

- There is a statistically significant association between driver BAC and location. Drivers in single vehicle crashes in remote areas are less likely to be found to have elevated BAC levels.
- Drunk drivers injured or killed in single vehicle rural crashes are significantly less likely to be wearing a seat belt than sober drivers injured or killed in single vehicle rural crashes.

C.2.3 Asleep and fatigue

Fatality File

- No statistical significance could be attributed to differences between crash types, due to the small number of driver asleep/fatigued records.

Queensland

- There is no association between driver fatigue and crash type.

C.2.4 Driver inexperience

Fatality File

- There is no association between driver licence type (full licence or other) and crash type.

C.2.5 Vehicle lost control on the shoulder

Fatality File

- There is a significant association between loss of vehicle control on the road shoulder and crash type. The odds of loss of vehicle control on the road shoulder being the major cause of a fatal crash is 2.5 times greater for overturn type crashes than for hit-object crashes.

Western Australia

- There is no association between loss of vehicle control on the road shoulder and crash type.

C.2.6 Object type

Fatality File

- For hit-object crashes, there is a significant association between type of object hit and crash location. In remote areas, the odds of the object hit being an animal or pedestrian is 4 times that in non-remote rural areas.

Western Australia

- There is no association between type of object hit and hit-object crash location.

Northern Territory

- There is no statistically significant association between type of object hit and crash location due to the small number of hit-object crashes, however the odds ratio is consistent with the Fatality File.

C.2.7 Vehicle defects, vehicle age and driver age

Fatality File

- The frequencies of crashes caused by vehicle defects are too small to test for differences between crash types.
- There is a significant association between vehicle age and driver age for hit-object crashes but not for overturn crashes. In hit-object crashes the odds that the driver is young (under 25 years) are approximately 3 times greater for drivers of vehicles aged 10 years or more than for drivers of newer vehicles.

Victoria

- There is no association between vehicle age and crash type.

Western Australia

- The odds that a vehicle involved in a serious remote overturn crash is at least 10 years old are at least 3 times smaller than the odds for the other crash types.

C.2.8 Seat belt wearing

Fatality File

- For all crash types, the odds of occupant fatality are higher when a seat belt is not worn.
- There is a significant association between whether vehicle occupants involved in a fatal single vehicle crash are fatally injured or not and the use of a seat belt by crash type. Relatively more fatalities occur when occupants are not wearing seat belts in overturn crashes than for hit-object crashes. However, this may just reflect the fact that fatal hit-object crashes have a higher proportion of driver only occupancy than do overturn crashes.
- A similar pattern exists for 'survivable' fatal crashes, and this cannot be simply attributed to hit-object crashes having a higher proportion of driver only occupancy.
- There is a significant association between use of seat belt by vehicle occupant and driver BAC for crash types overturn/non-remote rural, overturn/remote and hit-object/non-remote rural. For each of these crash types, the odds on a vehicle occupant having worn a seat belt when the driver has a low BAC are at least 3 times greater than the odds when the driver has a high BAC.
- There is no association between use of seat belt and purpose of journey.
- There is a significant association between use of seat belt and sex of occupant for crash type overturn/non-remote rural only. The odds on a vehicle occupant having worn a seat belt in an overturn/non-remote rural crash are greater for female occupants than for male occupants.
- There is a significant association between the use of a seat belt by a passenger and crash type with the odds on a passenger having worn a seat belt being greater for hit-object than for overturn crashes. However, there is no association between the use of a seat belt by the driver and crash type.

Queensland

- There is a significant association between the use of a seat belt and crash type for injured occupants involved in a serious single vehicle crash. The odds on a vehicle occupant having worn a seat belt are greatest for the crash type hit-object/remote.
- There is no association between whether a vehicle occupant is seriously injured or not and use of seat belt by crash type.
- There is a significant association between the use of a seat belt and sex of occupant by crash type. It is more likely that an injured female occupant of the vehicle was wearing a seat belt than an injured male occupant for all crash types.

Victoria

- There is no association between the use of a seat belt by a seriously injured occupant and crash type.
- There is a significant association between whether a vehicle occupant is fatally injured or not and the use of a seat belt. For both crash types it is more likely that a vehicle occupant will be fatally injured when a seat belt is not worn than when a seat belt is worn. Relatively fewer fatalities occur when occupants are wearing seat belts for overturn crashes than for hit-object crashes, although this may be a reflection of the higher proportion of hit-object crashes with driver only vehicle occupancy.

- There is a significant association between driver BAC and use of seat belts by crash type for seriously injured occupants. For both crash types the odds of a seriously injured occupant having worn a seat belt are much greater if the driver has a low BAC than a high BAC.
- There is a significant association between the use of a seat belt by a seriously injured occupant and the sex of the occupant for both crash types. The odds on an occupant having worn a seat belt are greater if the occupant is female.
- There is no association between the use of a seat belt and seating position of a seriously injured occupant.

Western Australia
- There is a significant association between the use of a seat belt by seriously injured occupants and crash type. The odds on a seriously injured occupant having worn a seat belt are greatest for hit-object/non-remote rural crashes.
- The odds on a seriously injured occupant being fatally injured to not being fatally injured in a survivable crash, are lower when a seat belt is worn for all crash types.
- There is no association between the use of a seat belt and driver BAC by crash type.
- There is a significant association between the use of a seat belt and the sex of a seriously injured occupant, by crash type. For crash types excluding overturn/remote the odds on a seriously injured occupant having worn a seat belt are at least twice as great for females than for males.

Northern Territory
- There is a statistically significant association between the use of a seat belt by an injured occupant and crash location but not crash type. The proportion of injured occupants wearing seat belts is lower in non-remote rural crashes than in remote crashes.
- The odds on a seriously injured occupant being fatally injured to not being fatally injured in a survivable crash, are lower when a seat belt is worn for both crash types and both crash locations.
- There is a statistically significant association between the use of seat belt and the sex of the injured occupant for overturn crashes, and for remote crashes. In both cases the odds on a vehicle occupant having worn a seat belt in a crash are greater for female occupants than for male occupants. There is insufficient data for hit-object crashes and for non-remote rural crashes to test for difference in seat belt use between the sexes.

C.2.9 Vehicle occupancy rate

Fatality File
- There is a significant association between the number of vehicle occupants and crash type. The percentage of fatal crashes for which the driver is the only vehicle occupant is approximately twice as large for hit-object crashes than for overturn crashes.

Queensland
- There is no association between the number of injured occupants and crash type.

Victoria
- There is a significant association between the number of vehicle occupants and crash type. The percentage of serious crashes for which the driver is the only vehicle occupant is greater for hit-object than for overturn crashes.

Northern Territory
- There is a statistically significant association between the number of injured occupants and crash location but not crash type. The proportion of crashes in which the driver is the only occupant is 50% greater for non-remote rural crashes than for remote crashes.

C.2.10 Sex of driver

Fatality File
- The proportions of male and female drivers do not differ significantly over crash types.

Queensland

- The proportions of male and female drivers do not differ significantly across crash types.

Northern Territory

- The proportions of male and female drivers do not differ statistically significantly between crash types or between crash locations.

C.2.11 Road type

Fatality File

- There is no association between road type (national highway, state highway or other rural road) on which a fatal crash occurs and crash type.

C.2.12 Injury severity

Fatality File

- There is a significant association between injury severity and crash type for a vehicle occupant involved in a fatal crash. A larger percentage of vehicle occupants are fatally injured in hit-object crashes than in overturn crashes, which may simply be a reflection of the larger percentage of driver only vehicle occupancy for hit-object crashes than for overturn crashes.

C.2.13 Timing of death

Fatality File

- There is no evidence to suggest that the odds on an occupant being fatally injured are any greater for crashes occurring in remote areas than in non-remote rural areas where it would be anticipated that treatment is closer.

C.2.14 Point of impact for hit-object crashes

Fatality File

- Of all fatal hit-object crashes, 59% involve frontal impact. Other impacts occur equally as often to the left and right hand sides.

Victoria

- 80% of serious hit-object crashes and 70% of serious overturns involve an impact to the front of the vehicle.

C.2.15 Time of day by day of week

Fatality File

- There is a significant association between day of week and time of day in which a crash occurs. The odds on a fatal crash occurring in the early morning (midnight to 6am) compared to later in the day, are greater on the weekend than on a week day for all crash types except overturn/remote.

Victoria

- There is a significant association between day of week and time of day in which a crash occurs. The odds on a serious crash occurring in the early morning are 3 times greater on the weekend than during the week.

Western Australia

- There is a significant association between day of week and the time of day in which a crash occurs. The odds on a serious crash having occurred in the early morning as compared to later in the day are twice as great on the weekend than during the week.

Northern Territory

- There is a significant association between day of week and the time of day in which a crash occurs. The odds on a serious crash having occurred in the early morning as compared to later in the day are twice as great on the weekend than during the week.

C.2.16 Injury site

There is a significant association between crash types and injuries to the head, abdomen and pelvic contents and external injuries among fatally injured occupants. There was no significant difference between crash type for chest injuries. Other injury types were too infrequent to permit findings. For fatally injured occupants, the odds on head injury are greatest for overturn crashes, the odds on abdomen and pelvic contents injuries are greatest for hit-object crashes and the odds on external injuries are greatest for overturn/remote crashes.

C.2.17 Summary tables

Table 140 gives a summary of the association detected between a causal factor and crash type for each of the Fatality File and the four states and territories:

- 'All' indicates that there is a statistically significant association ($p < 0.05$) between the two factors for all crash types.
- 'Yes' indicates that there is a statistically significant association between the causal factor(s) and crash type (for all four crash types, or for crash types overturn versus hit-object or remote versus non-remote rural). An asterisk ('*') indicates that the association is inconsistent between two databases.
- 'No' indicates that there is no association between causal factor(s) and crash type.
- 'N/A' indicates that no test of association was carried out.
- 'NE' indicates no evidence due to small expected frequencies.

Table 140 Associations between various causal factors and crash type for data from the Fatality File, Queensland, Victoria, Western Australia and the Northern Territory databases

Causal Factor	Fatality File	Queensland	Victoria	Western Australia	Northern Territory
a) Speeding b) Speeding and road surface type	No Yes	Yes No	N/A N/A	Yes No	Yes* Yes
Alcohol (driver BAC)	No	Yes	Yes	No	Yes*
Asleep/fatigued	NE	No	N/A	N/A	N/A
Vehicle lost control on the shoulder	Yes	N/A	N/A	No	N/A
Object type (hit-object crash)	Yes	N/A	N/A	No	NE
Light conditions	N/A	N/A	Yes	Yes	Yes
Vehicle defects	NE	N/A	N/A	N/A	N/A

Table 140 continued.

Causal Factors	Fatality File	Queensland	Victoria	Western Australia	Northern Territory
Vehicle age	No	N/A	Yes	Yes	N/A
Seat belt wearing					
a) Use of seat belt and fatal injury	All	All	All	N/A	All
b) Use of seat belt and serious injury	N/A	No	N/A	N/A	N/A
c) Use of seat belt in survivable crash and fatal injury	All	All	N/A	All	N/A
d) Use of seat belt and driver BAC	Yes	All	All	No	All
e) Use of seat belt and purpose of journey	No	N/A	N/A	N/A	N/A
f) Use of seat belt and sex of occupant	Yes	All	Yes	Yes	Yes
Vehicle occupancy	Yes	No	Yes	N/A	Yes
Sex of driver	No	No	N/A	N/A	No
Time of day and day of week	Yes	N/A	Yes	Yes	Yes

The remaining factors were investigated for the Fatality File only. The results are shown in Table 141.

Table 141 The level of association between other factors and crash type for the Fatality File only

Causal factors	Level of association
Driver age	Yes
Road type	No
Injury severity	Yes
Timing of death	NE
Injury site	Yes

BIBLIOGRAPHY

ANDERSON, P.R. AND ADENA, M.A. (1989). Car and articulated truck speeds before and after July 1988. Intstat Australia Pty. Ltd., FORS CR88, Federal Office of Road Safety, Canberra, Australia.

ARMOUR, M. (1990). Safety and economic implications of cross section design on Australian rural highways. Ph.D. Thesis.

ARUP TRANSPORTATION PLANNING (1991). Survey of characteristics of seat belt non-wearers. Arup Transportation Planning, FORS CR96, Federal Office of Road Safety, Canberra, Australia.

BENTHAM, G. (1986). Proximity to hospital and mortality from motor vehicle traffic accidents. Social Science and Medicine, 23(10), pp. 1021-6.

BIANCHI, G., AND CHURCH, R. L. (1988). A hybrid fleet model for emergency medical service system design. Social Science and Medicine, 26, pp. 163-71.

BRODSKY, H. (1990). Emergency medical service rescue time in fatal road accidents. Transportation Research Board. Transportation Research Record 1270, pp 89-96.

BRODSKY, H. AND HAKKERT, S. (1983). Highway fatal accidents and accessibility of emergency medical services. Social Science and Medicine, 17, pp. 731-40.

BROGAN, J.D. AND HALL, J.W. (1985). Using accident records to prioritize roadside obstacle improvements in New Mexico. Transportation Research Board, Transportation Research Record 1047, pp. 10-17.

CAMERON McNAMARA PTY. LTD. (1987). Survey of Occupant Restraint. Cameron McNamara Pty. Ltd., FORS CR49, Federal Office of Road Safety, Canberra, Australia.

CHRSTOS, J.P. (1991). An evaluation of static rollover propensity measures. Transportation Research Center of Ohio, Inc. DOT HS 807 747, National Highway Traffic Safety Administration Vehicle Research and Test Center.

DART, O.K. AND McKENZIE, L.S. (1982). Study of ran-off-roadway fatal accidents in Louisiana. Transportation Research Board, Transportation Research Record 847, pp. 7-14.

DEWAR, R.E. (1991). The driver: improving performance to improve safety. ITE Journal, July, pp. 33-7.

EVANS, L. (1990). The fraction of traffic fatalities attributable to alcohol. Accident Analysis and Prevention, 22(6), pp. 587-601.

EVANS, W.N., NEVILLE, D. AND GRAHAM, J.D. (1991). General deterrence of drunk driving,: evaluation of recent American policies. Risk Analysis, 11(2), pp. 279-89.

FILDES, B.N., FLETCHER, M.R. AND CORRIGAN, J. McM. (1987). Speed perception 1: Drivers' judgements of safety and speed on urban and rural straight roads. Royal Automobile Club of Victoria Ltd., FORS CR54, Federal Office of Road Safety, Canberra, Australia.

FILDES, B.N., LANE, J.C., LENARD, J. AND VULCAN, A.P. (1991). Passenger cars and occupant injury. Monash University Accident Research Centre, CR95, Federal Office of Road Safety, Canberra, Australia.

FINDLEY, L.J., UNVERZAGT, M.E. AND SURATT, P.M. (1988). Automobile accidents involving patients with obstructive sleep apnoea. American Review of Respiratory Diseases, 138, pp. 337-40.

FITZGERALD, R.W. (1989). Rural truck speed differentials. The 1986/87 national study. R. W. Fitzgerald and Associates, FORS CR82, Federal Office of Road Safety, Canberra, Australia.

FREILICH, D.A. AND SPIEGEL, A.D. (1990). Aeromedical emergency trauma services and mortality reduction in rural areas. New York State Journal of Medicine, 90(7), pp. 358-65.

FROM THE CENTERS FOR DISEASE CONTROL, (1991). Alcohol-related traffic fatalities among youth and young adults - United States, 1982-1989. JAMA, 265(15), pp. 1930.

GALLAHER, M.M., SEWELL, C.M., FLINT, S., HERNDON, J.L., GRAFF, H., FENNER, J. AND HULL, H.F. (1989). Effects of the 65-mph speed limit on rural interstate fatalities in New Mexico. JAMA, 262(16), pp. 2243-5.

GRIME, G. (1987). Handbook of road safety research. Butterworth & Co. (Publishers) Ltd.

HAWORTH, N.L. (1989). Driver fatigue and stimulants. Monash University Accident Research Centre, FORS MR5, Federal Office of Road Safety, Canberra, Australia.
HAWORTH, N.L., TRIGGS, T.J. AND GREY, E.M. (1988). Driver fatigue: concepts, measurement and crash countermeasures. Human Factors Group, FORS CR72, Federal Office of Road Safety, Canberra, Australia.
HEIMAN, L. (1988). Vehicle occupant protection in Australia. FORS CR10, Federal Office of Road Safety, Canberra, Australia.
HENDERSON, M. (1991). Airbags: safety delayed. The Medical Journal of Australia, 155(4), pp. 215-7.
HEWITT, J. (1992). Personal Communication.
HOLUBOWYCZ, O.T. (1989). Sex differences in drink driving. NHMRC Road Accident Research Unit, University of Adelaide, FORS MR3, Federal Office of Road Safety, Canberra, Australia.
HORNE, J. (1992). Stay awake, stay alive. New Scientist, 4th. January, 1992, pp. 20-4.
HYLAND, M.J., LOWENFELS, A.B., FALVO, C.E. AND CHEN, E. (1990). Death takes a ride: Alcohol-associated single vehicle fatalities revisited. New York State Journal of Medicine, 90(7), pp. 349-51.
KING, K.L. (1986). Rural traffic crashes in Queensland, 1984. Geoff McDonald & Associates Pty. Ltd., FORS CR45, Federal Office of Road Safety, Canberra, Australia.
LUND, A.K. AND WOLFE, A.C. (1991). Changes in the incidence of alcohol- impaired driving in the United States, 1973-1986. Journal of Studies on Alcohol, 52(4), pp. 293-301.
McADIE, M. (1991). Why does going to sleep in front of the television cause people to die on the roads? A discussion paper. Personal Communication.
MIRATE, D.J. (1990). Letter to the Editor. JAMA, 263(14), pp. 1916.
MITLER, M.M., CARSKADON, M.A., CZEISLER, C.A., DEMENT, W.C., DINGES, D.F. AND GRAEBER, R.C. (1988). Catastrophes, sleep and public policy: consensus report. Sleep, 11(l), pp. 100-9.
NATIONAL HIGHWAY TRAFFIC SAFETY ADMINISTRATION (1992). Rollover prevention. Federal Register, 57(2), pp. 242-52.
NAUGHTON, M. AND PIERCE, R. (1991). Sleep apnoea's contribution to the road toll. (Editorial), Australia and New Zealand Journal of Medicine, 21, pp. 833-4.
NELSON, D.C. AND STRUEBER, J.V. (1991). The effect of open-back vehicles on casualty rates: the case of Papua New Guinea. Accident Analysis and Prevention, 23(2/3), pp. 109-17.
OVE ARUP AND PARTNERS (1988). Survey of occupant restraint: stage 2. Ove Arup and Partners, FORS CR76, Federal Office of Road Safety, Canberra, Australia.
PAK-POY AND KNEEBONE (1988). Road safety benefits from rural road improvements. Pak-Poy and Kneebone Pty. Ltd., FORS CR71, Federal Office of Road Safety, Canberra, Australia.
POPKIN, C.L. (1991). Drinking and driving by young females. Accident Analysis and Prevention, 23(l), pp. 37-44.
RAY, M.H., TROXEL, L.A. AND CARNEY III, J.F. (1990). Characteristics of fixed- roadside-object side-impact accidents. Journal of Transportation Engineering, 117(3), pp. 281-97.
RENWICK, M.Y., OLSEN, G.G. and TYRRELL, M.S. (1982). Road fatalities in rural New South Wales; weighing the causes. Medical Journal of Australia, 1982(l), pp. 291-4.
RYAN, G.A., CLARK, P.D. AND LAZARUS, S.S. (1973). A review of emergency medical service in relation to road safety. Australian Department of Transport. Report NR/24.
RYAN, G.A., WRIGHT, J.N., HINRICHS, R.W. AND McLEAN, A.J. (1988). An in-depth study of rural road crashes in South Australia. NHMRC Road Accident Research Unit, University of Adelaide, FORS CR78, RSB 13/88. South Australian Department of Transport, Adelaide, Australia.
SWEATMAN, P.F., OGDEN, K.J., HAWORTH, N., VULCAN, A.P. AND PEARSON, R.A. (1990). NSW heavy vehicle crash study Final technical report. Road User Research Pty Ltd., Monash University Accident Research Centre, FORS CR92, RSB CR5/90. Federal Office of Road Safety, Canberra, Australia.
STEVENSON, A. AND WILLIAMSON, J. (1988). Attitude survey of truck drivers and operators. Siromath Pty. Ltd., FORS CR62, Federal Office of Road Safety, Canberra, Australia.
UNITED STATES DEPARTMENT OF TRANSPORT. (1990). Effect of car size on fatality and injury risk in single-vehicle crashes. National Highway Traffic Safety Administration, Washington, D.C., USA.

WENNEKER, W.W., MURRAY. D.H. AND LEDWICH, T. (1990). Improved trauma care at a rural hospital after establishing a level II trauma center. The American Journal of Surgery, 160(6), pp. 655-7.
WHITE, W.T. (1986). Does periodic vehicle inspection prevent accidents? Accident Analysis and Prevention, 18(l), pp. 51-62.
WINKLER, C.B., CAMPBELL, K.L. AND MINK, C.E. (1991). Center of gravity height: a round robin measurement program. The University of Michigan Transportation Research Institute, A Technical Report to the Motor Vehicle Manufacturers Association, MVMA Project No. 0167A.
WORLD HEALTH ORGANISATION. (1989). New approaches to improve road safety; report of a WHO study group. WHO Technical Report Series 781, WHO Geneva, Albany, New York.
ZADOR, P.L. (1991). Alcohol-related relative risk of fatal driver injuries in relation to driver age and sex. Journal of Studies on Alcohol, 52(4), pp. 302- 10.
ZADOR, P., STEIN, H., HALL, J. AND WRIGHT, P. (1987). Relationships between vertical and horizontal roadway alignments and the incidence of fatal rollover crashes in New Mexico and Georgia. Transportation Research Board, Transportation Research Record 1111, pp. 27-42.