MONASH University
Accident Research Centre

ANCIS

THE FIRST THREE YEARS

THE AUSTRALIAN NATIONAL
CRASH IN-DEPTH STUDY
2000-2003

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Abstract:

The ANCIS (the Australian National Crash In-depth Study) is a collaborative research program involving the automotive manufacturing industry, State and Federal Government agencies and automobile associations. In-depth data on a representative sample of passenger vehicle crashes is collected currently in Victoria and New South Wales on severe crashes where at least one occupant is hospitalised as a result of the crash. Information collected includes occupant injuries, vehicle damage and crash contributing factors from a retrospective examination of the crash. This first analysis of 180 cases contained in the ANCIS database examines the patterns of crashes and injuries sustained, what caused these injuries, the extent and severity of damage to the vehicle and the characteristics of the crash. These data are rich in terms of the amount of detail contained in each case and are provided to throw new light on the crashworthiness of the vehicles and aspects of their crash involvement. A recent trend analysis of the Federal Fatal File is also included to highlight recent trends in crash involvement from more than 3000 fatal vehicle crashes.

Key Words:

In-depth, crash investigation, injury, injury severity, vehicle safety, airbag, seat belt use, road infrastructure, crash analysis, single vehicle crashes, multiple vehicle crashes, urban, rural

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STUDY TEAM DETAILS

The ANCIS research program is managed and administered by the Monash University Accident Research Centre at Clayton, Victoria. Data collection is undertaken in each jurisdiction by local data collection teams. The study team structure is outlined below.

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- Frankston Hospital, Peninsula Health Care Network
- Dandenong Hospital, Southern Health Care Network
- Monash Medical Centre, Clayton Campus, Southern Health Care Network
- Geelong Hospital, Barwon Health
- The Royal Melbourne Hospital, Melbourne Health, Western Health Care Network
- The Royal Children's Hospital, Women's and Children's Health Care Network (WCH)
- St Vincent's Hospital, St Vincent's Health, Inner and Eastern Health Care Network
- Western Hospital, Western Health Care Network

NSW:

- Liverpool Health Service
- St George Hospital
- Prince of Wales Hospital
- Royal North Shore Hospital
- John Hunter Hospital

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EXECUTIVE SUMMARY

ANCIS (the Australian National Crash In-Depth Study) is a collaborative research project comprising Monash University, the Automobile Manufacturers of Australia, Federal and State Government Transport and Insurance agencies, vehicle parts suppliers and members of the Australian Automobile Association. Its objective is to provide a representative sample of vehicle crashes from around Australia for use in improving vehicle crashworthiness and crash involvement. Participants are admitted to the study while in hospital as a result of injuries sustained in a motor vehicle crash. The vehicle in which they were travelling must be a light duty passenger vehicle manufactured since 1989. A structured interview is conducted with the participant (where able), their medical records are examined to accurately determine their injuries and the crashed vehicle located to be photographed and examined in detail. The police report is obtained to clarify crash events. Where possible, any other vehicles that collided with the case vehicle are also photographed and measured for a more accurate estimate of crash severity. At the conclusion of the data collection process, a multi-disciplinary group uses a best evidence synthesis approach to determine crash circumstances, injury causation and attempts to identify contributing factors to the crash. The case is then entered into a database after being stripped of any personally identifying details.

At this stage, the findings are somewhat limited by the number of cases available (180), the lack of fatal crashes and the small number of participating states in data collection (Victoria and New South Wales only). Negotiations are underway to expand the data collection into other jurisdictions. The DIER in Tasmania is commencing a similar data collection activity in 2004 that will contribute cases to ANCIS. The state coroners of Victoria, NSW and Tasmania have also been approached to become involved in future ANCIS activities.

The data collection activity was predominantly confined to urban crashes (54% urban to 46% rural) from the two most urban states in Australia. It is a high priority to include other states that have a higher number of rural crashes to ensure these data become more representative of Australia generally. It is intended for ANCIS to continue beyond 2003 to expand the number of cases available, thereby further increasing its research value.

ANCIS DATA FINDINGS

The following is a summary of the results presented in this report. Caution needs to be taken in the interpretation of these data, especially in assuming that they represent all serious casualty crashes that occur in Australia at this time.

<u>Injured Occupants</u>

Roughly 75% of all injured occupants were drivers, 17% were front passengers and 1 in 10 were in the rear. Unbelted rates were 11% for drivers, 19% front passengers and 31% rear passengers. Children comprised 5% of the sample, older occupants (above 65 yrs) 15%, young adults (25 yrs or less) 23% and the remaining 57% were other adults. Overweight and obesity was observed in more than one-third of the population. Sixty-three percent of the injured occupants sustained a MAIS of 3 or more, which was slightly, lower in frontals (62%) than side impacts (65%), especially nearside impacts (72%).

<u>Vehicles</u>

More than half the vehicles involved were 4 years old or less, but this is biased by the entry age criteria. Large cars comprised 40% of the crashed vehicle sample, small cars 39%, 4WDs 8%, sports and luxury vehicles 7%, and medium sized cars 6%. Australian-manufactured vehicles made up two-thirds of all crashed vehicles. Two-thirds of the vehicles inspected did not have a driver airbag and three-quarters were without a passenger airbag. Side airbags were not present in more than 90 percent of the crashed vehicles examined.

The mean impact severity was 49 km/h and higher in frontal crashes (58 km/h) than side impacts (38 km/h). Crash severity was typically lower in side impacts, given the minimal amount of structure between the impacting object and the occupant in a near-side crash and that both the impacted vehicles share the impact force in this crash configuration. It was not possible to compute impact severity in rollover crashes.

Crashes

Frontal crashes comprised 48% of the sample, side impacts 36%, rollovers 12%, and rear impacts 4%. The proportion of side impacts in multi-vehicle crashes was much higher in urban areas (51%), while frontals predominated in two-thirds of all rural crashes. Single vehicle crashes were noted in 55% of rural crashes and 45% of urban ones. More than one-third of the crashes occurred in 60 km/h speed zones or less, 35% for 90 or 100 km/h zones, one-quarter in 70 or 80 km/h speed zones, and 2% on 110 km/h freeways.

The majority (60%) of the crashes occurred during daylight hours, 28% at night and 12% either dusk or dawn. A sizeable 84% occurred during fine weather while the rest experienced either rain or fog. Intersections were the predominant site for 61% of urban crashes, while mid-block sections accounted for 70% of rural crashes. Only 4% of urban crashes occurred at roundabouts. Almost one-third of the crashes (31%) occurred on curves or bends.

The crash site details reported here were minimal during the first years of the study but gradually more details have been collected at each site throughout the course of the first three years. In particular, the site examiners now assign associated causal factors for the human, the vehicle and the road at each location. This will enable a more comprehensive analysis of the crash involvement features in future reports.

FATAL FILE ANALYSIS

An analysis of the fatal file, 1988 through to 1999 was also undertaken to highlight recent trends in crash involvement from more than 3000 fatal vehicle crashes across Australia and to compare with ANCIS findings. A number of interesting findings were uncovered by this analysis. Again, some care needs to be exercised in interpreting these data as they represent the most severe outcomes of road crashes and comprise only around 1% of all casualty crashes in Australia.

Drivers and front passengers account for around 90% of fatal crash outcomes across Australia, which is the same as the figures represented in ANCIS. Age groups were similar except for a slightly higher proportion of younger occupants fatally injured and a similar reduced proportion of adults among the fatal file cases. Two-thirds of those fatally injured were males and one-third female, which, again, is a little more male-dominated that in the ANCIS file (54% male and 46% female). Nevertheless, the two samples of occupants are not that disparate from each other.

Fatal crash configurations showed a much higher proportion of side impacts (43%) and rollovers (21%) and a lower proportion of frontal (34%) than in the ANCIS study, representing the higher (and lower) likelihood of a fatality for the more vulnerable crash types. Single-vehicle crashes across Australia accounted for more than half the number of fatalities in the fatal file and roughly 10% higher than those examined in the ANCIS study.

The speed zones in which fatal crashes occurred were quite similar in proportion between the fatal file and ANCIS for 60km/h speed zones and less (36% c.f. 37%) and for 100 km/h speed zones (35% c.f. 35%) but less for 70 and 80 km/h speed zones (14% c.f. 26%) and more for high speed rural zones of 110 km/h (12% c.f.2%). This confirms the bias in the ANCIS data collection away from rural areas and fatal crash outcomes noted earlier.

The predominant injuries associated with a fatal outcome were the head, neck and face (around 43% frequency), chest abdomen and spine (57% frequency) and extremities (about 60% frequency). Life-threatening injuries are somewhat over-represented among the fatal outcomes compared to ANCIS, which is not too surprising, given the extreme crash outcome.

FUTURE DIRECTIONS

As pointed out earlier, these results are limited by the minimal amount of data available and the bias towards urban crashes in Victoria and New South Wales. Steps have been taken to overcome these limitations in future ANCIS data collection activity. These include:

- The continuation of ANCIS data collection with a more broad focus on site and associated causal factors in future activities;
- The inclusion of more states and territories in ANCIS data collection regions to provide a representative crash sample; and
- The inclusion of a representative number of fatal crashes in these regions.

While this initial analysis was somewhat limited in scope, it is indicative of what can be expected from in-depth road crash data. Statistical significance of these results will always be a challenge because of the small number of cases compared to mass data analyses, which are typically collected from police reports across all states and territories. However, they are rich in terms of the level of detail they collect and are therefore more likely to provide detail on causal relationships between human, vehicle and road and environment factors than current databases.

It is argued that these data can provide another level of crash and injury analysis that will enhance our understanding of occupant and road trauma and lead to new countermeasures and intervention programs to address tomorrow’s road safety programs.

1 INTRODUCTION

The Australian National Crash Investigation Study (ANCIS) comprises a random sample of vehicle crashes in Victoria and New South Wales where at least one occupant was hospitalised. This report represents the findings from the first 2½ years of crash investigations, which started in Victoria and has subsequently expanded into New South Wales. As the ANCIS title implies, the objective of the study is to collect data in enough Australian states and territories to provide a sample representative of all Australian crashes. Progressive efforts are underway to achieve this objective.

1.1 Background

The National Road Safety Strategy and Action Plan sets out a number of key challenges and new initiatives for improving road safety in this country. One of the key aspects of any successful road safety program is the collection of high-quality information outlining the causes of serious and fatal road crashes. A multi-disciplinary investigative approach is essential comprising input from experts in engineering, behaviour, medicine, enforcement, and emergency services. In-depth crash investigations is paramount for providing enhanced information about the causes of major trauma and lead to a number of new road safety counter-measures to reduce Harm on our roads.

Mass databases contain valuable information on road crashes across the various states and territories and are used traditionally for establishing road safety priorities. These databases are valuable for determining extent of crashes and injuries but are somewhat limited when it comes to assigning causal information. For this, it is necessary to collect detailed case information on a representative sample of real-world crashes. These in-depth studies provide improved high-quality and accurate data to supplement mass data systems.

There have been a number of in-depth studies undertaken around the world. These include an early UK study (Mackay et al, 1969, 1985), the in-depth fatal injury study in South Australia (McLean and colleagues, 1979a,b,c,d,e), the TRL causal study by Sabey and her colleagues (1975, 1980), The Tri-level study of traffic accident causes in the US (Treat et al., 1979; Treat, 1980), the on-going National Automotive Sampling System in the US (NHTSA, 1979), the in-depth crash investigation program in Germany (Otte et al, 1973 to present; 1997) and the UK Cooperative Crash Investigation Study (Mackay, 1985). However, apart from the US, German and UK in-depth research programs, all of these studies of fatal and serious injuries are at least 20 years old and of questionable relevance to Australia today. Of importance, though, is the worldwide acceptance of the need for such in-depth studies to help determine road safety priorities and countermeasures in the on-going fight to reduce road carnage.

1.2 The ANCIS Partnership

ANCIS is a truly collaborative study by key stakeholders in road safety. It comprises members of the automotive and parts manufacturing industries, the Federal Department of Transport and Regional Services, State transport authorities from Victoria, NSW and Tasmania, the Transport Accident Commission of Victoria and the Motor Accident Authority of NSW, and the motoring authorities RACV, NRMA and the AAA. Partners to the ANCIS program are shown in Table 1.1.

Table 1.1 Partners in the ANCIS project

Partner	Status	Partner	Status
Australian Transport Safety Bureau, Dept of Transport and Regional Services	Member	Royal Automobile Club of Victoria Ltd	Member
Autoliv Australia	Member	Roads & Traffic Authority (NSW)	Member
Ford Motor Company Australia Ltd	Member	Transport Accident Commission (TAC) (Vic)	Member
Holden Ltd	Member	Toyota Motor Corporation	Member
Mitsubishi Motors Australia Ltd	Member	VicRoads	Member
Motor Accidents Authority of NSW	Member	Australian Automobile Association (AAA)	Observer
National Roads and Motorists' Association Ltd (trading as NRMA Motoring & Services)	Member	Federal Chamber of Automotive Industries	Observer

The Monash University Accident Research Centre manages the ANCIS program, undertakes crash investigations in Victoria and maintains the comprehensive "in-depth" database. Collaborators provide the sponsorship to undertake the work and advise on the conduct of the program through regular Project Advisory Committee meetings. Subcontractors undertake data collection in NSW and Tasmania and these cases are combined with Victorian data.

ANCIS is currently funded for three years from July 2000 to June 2003. Plans are for ANCIS to be an on-going research program so that regular data on crashworthiness and crash involvement can be provided. This will facilitate monitoring improvements and emerging problems so that quick and effective safety improvement can be undertaken. At the time of going to press, in-principle support for a further three years has been obtained.

1.3 ANCIS Entry Criteria

Participants are admitted to the study if admitted to hospital as a result of injuries sustained in a motor vehicle crash. Fatalities are only included if they are recruited prior to passing away and die within 30 days of the crash. The vehicle in which they were travelling must have been manufactured since 1989 and must fall into one of the following categories, as defined in the Australian Design Rules Part B Subpart 2: MA (passenger vehicle), MB (forward control passenger vehicle), MC (off-road passenger vehicle) or an MA-derived NA (light goods vehicle). Stolen vehicles are not included, nor are vehicles that have completely burnt out. The site of the crash is only visited when it falls within a two hour drive of the corresponding data collection team's headquarters in Melbourne or Sydney.

1.4 The ANCIS Process

ANCIS utilises a retrospective in-depth examination of a representative sample of crashes in the study areas whereby data are collected soon after the crash and the evidence is forensically 'pieced' together so that the important factors can be established. It is "person-based" where the crash and injured persons are identified through hospitals and coronary services.

Crash details are compiled through detailed inspections of the vehicles involved, the injuries sustained by the victims, a visit to the crash site after the event, and supporting documentation provided by the police, the coroner and the victims or their families. The circumstances surrounding the crash are analysed and causal information derived by detailed examination by experts.

The retrospective method cannot hope to have access to such rich and immediate information available immediately at the scene. Nevertheless, it is capable of piecing together a reasonably detailed account of the crash and injury circumstances for most crashes and can provide a reasonable account of the causal chain of events leading up to the crash. Its main advantage over the at-scene method is the reduced cost associated by greater efficiency in the collection of these data and hence the greater coverage possible using this approach.

1.5 Comprehensive investigation

Police-based crash investigations quite correctly focus on culpability as a central objective. As such, crash and injury factors concerned with vehicle design, human factors, road and traffic engineering, emergency services, trauma management, etc., play a lesser role, thereby limiting the scope, breadth and depth of investigations. Establishment of an in-depth, systematic crash investigation resource helps to provide new knowledge on a range of crash-related dimensions, including:

- Vehicle crashworthiness
- Crash causation
- Highway design influences
- Road user behaviour
- Human factors
- Injury biomechanics
- Effectiveness of countermeasures, current and proposed, and
- Interaction between the above factors

A multi-disciplinary panel of road safety experts is used typically to analyse these data in arriving at the causal factors associated with the injuries sustained and the crash. The use of in-depth data enables a more comprehensive, integrated understanding of the most severe crashes occurring on our roads in both metropolitan and regional areas, from a range of different view points. Hence, new insights into causes and potential solutions are possible.

1.6 Expected Benefits from ANCIS

The last such study was the "*Crashed Vehicle File*" undertaken by the Monash University Accident Research Centre for the Australian Transport Safety Bureau (formerly the Federal Office of Road Safety) between 1989 and 1992. The Crashed Vehicle File comprised details of 500 crashed vehicles and more than 600 injured occupants for post-1982 vehicles where at least one of the vehicle's occupants was either hospitalised or fatally injured. Data from the CVF has proved extremely valuable for a multitude of research studies but is now outdated.

The collection of in-depth crash data has the very real potential to provide substantial benefits in improved road safety for all Australians. The thorough and systematic investigation of a representative sample of fatal and serious injury crashes in this state enables a greater understanding on the cause of severe harmful road crashes and the level of protection offered by today's vehicles. These data provide new knowledge and insights in areas not traditionally covered by Police investigations and elevate our understanding of the road crash problem and its solutions. This information will identify new road safety initiatives for the agencies responsible for providing road safety initiatives in this state. This is vital to ensure that the targets outlined in the recently released National Road Safety Strategy are met. In addition, this project would demonstrate that Australia continues to be a world-leader and innovator in road safety.

The principle benefits from a comprehensive program of in-depth crash investigations, spanning the full range of Australian fatal and serious injury road crashes, include:

i. The level of protection offered by today's vehicles and any emerging problems;

ii. New countermeasure programs and initiatives, covering road infrastructure development, education and behaviour change, vehicle design, trauma management, enforcement and various combinations of these disciplines;

iii. More sharply focussed road safety strategies for future investment in road trauma reduction, in line with current state and national targets;

iv. More comprehensive investigations for Coronial Inquiries;

v. "Time-stamping" Australia's fatal and serious injury crash problem and its characteristics, early in the new decade, thereby enabling comparisons and evaluations to be made at critical times in the future, as well as providing an objective basis for adjusting and strengthening the State's strategic effort over the period 2001 to 2005;

vi. Enhancing the effectiveness of crash investigation and countermeasure development methods by drawing on innovative models.

Although the primary focus of such a process would be on fatal and serious injury crashes, and hence ways of cutting Australia's road toll, many of the findings would naturally apply to other crashes as well. The procedure described here would provide the opportunity to study more thoroughly the serious injury problem, which also represents the major part of the human suffering and economic costs caused by road trauma.

1.7 Analysing ANCIS cases

The strength of the ANCIS program is the very detailed level of data collected that can be analysed using crash, vehicle and road and environment factors not available anywhere else in Australia. This level of detail enables detailed causal relationships to be determined that cannot otherwise be found from mass databases.

Data collected from the ANCIS program is contained in the ANCIS electronic database held at MUARC. This database can be addressed to provide specific analyses on problems and issues as required. While these data are rich in terms of the level of detail available, its greatest limitation is the number of cases available for analysis, which is a particular problem when broken down for various subsets of interest. The representativeness of the sample is also an issue but this can be overcome to some degree by "weighting" each of the cases in terms of its likelihood of its occurrence within the total crash distribution.

The anonymity of the individuals involved is guaranteed in return for their participation in the study; hence the ANCIS database does not contain personal or vehicle identifiers. Analyses, therefore, are generally constrained to overall trends and issues, with a particular focus on any emerging problems in terms of crashes, injuries, and vehicle, road and environmental problems. These data can also be used for specialised purposes such as modelling crashes and injuries and computing cost and benefits for new countermeasures.

1.7.1 Annual Report

Henceforth, ANCIS has a commitment to produce an annual report at the end of the year, outlining findings and highlighting any potential problems, difficulties and trends. The analysis contained in this report also include mass data analyses of fatal and serious injury crashes to illustrate a more widespread picture of road crashes in Australia, as well as to indicate the level of representativeness of the in-depth sample.

Specialised analyses for ANCIS partners and other external sources can also be carried out by MUARC on request. Under the terms of the ANCIS contract, this may require approval by the program sponsors and may involve a cost to the requesting source.

1.8 Conclusion

The ANCIS program has the potential to add new knowledge to the key stakeholders in road safety from the greater depth of information available. As the more obvious solutions to road trauma are addressed through current initiatives, there is a need to look much deeper beyond mass data in the search for new understandings and countermeasures. It is expected that ANCIS will provide this new level of knowledge of use to governments, industry and consumer groups. Crashes are commonly multi-causal and it is important not to focus on a single cause in adopting a "system-wide" approach to crash reduction.

2 ANALYSIS OF ALL ANCIS CASES

2.1 Basic Crash And Case Information

ANCIS commenced hospital-based recruitment in Victoria in March 2000, with the first pilot case in New South Wales (NSW) being conducted in June 2001. This analysis reports on the first 180 'complete' cases, of which 176 were undertaken in Victoria and the remaining four cases from NSW. Each case corresponds to a single occupant of a vehicle. The 180 cases were occupants of 155 different vehicles.

The demographic, crash, and injury characteristics are discussed in turn in the following sections. The aim of this analysis is to provide an overview of the individuals involved, the types of crashes and vehicles, and the type and severity of injuries sustained. The same analysis presented by impact type will be discussed in later sections of the report.

At the time of analysis, drivers represented 73% (n=132) of the sample, front left passengers represented 17% (n=31) of the sample, and as seen in Table 2.1 rear occupants constitute the balance of cases. There was one front centre occupant.

Table 2.1 Number of cases by occupant position

Position	Freq.	%
Driver	132	73.3
Front Left Passenger	31	17.2
Front Centre	1	0.6
Rear Left	9	5.0
Rear Centre	1	0.6
Rear Right	5	2.8
Back Left	1	0.6
Back Centre	Nil	Nil
Back Right	Nil	Nil
Total	180	100

Table 2.2 reveals that proportion of restraint use among the cases was 85%, with close to 90% of drivers being belted. Although the number of cases is small, the proportion of non-restraint use was higher for rear occupants than front seat occupants.

Table 2.2 Occupant position by belt use

Position	Unbelted		Belted used or claimed		Total	
	Freq.	%	Freq.	%	Freq.	%
Driver	15	11.4	117	88.6	132	100
FLP	6	19.4	25	80.6	31	100
Front Centre	1	100	Nil	Nil	1	100
Rear Left	3	33.3	6	66.7	9	100
Rear Centre	Nil	Nil	1	100	1	100
Rear right	2	40.0	3	60.0	5	100
Back left	Nil	Nil	1	100	1	100
Back Centre	Nil	Nil	Nil	Nil	Nil	Nil
Back Right	Nil	Nil	Nil	Nil	Nil	Nil
Total	27	15.0	153	85.0	180	100

2.2 Case Demographic Characteristics

Of the 180 cases recruited to the study, 96 (53.3%) were male and 84 (46.7%) were female. The number and percent distribution of male and females by age group is presented in Table 2.3. Persons aged 15–24 years represented slightly less than one-quarter of all cases (22.8%), followed by persons aged 25–34 years (19%) and 45–54 years (17.2%). There were nine children (5.1%) under 14 years of age, three of which were under six years of age (1.7%). Of note is that males aged 15–34 years of age represent 24.4% of all cases recruited to the ANCIS study, while persons aged 15–34 represented approximately 41% of the sample.

Table 2.3 Number and percent of male and female cases by age group

Age (years)	Male		Female		Total	
	Freq.	%	Freq.	%	Freq.	%
1–5	1	0.6	2	1.1	3	1.7
6–9	1	0.6	2	1.1	3	1.7
10–14	1	0.6	2	1.1	3	1.7
15–24	24	13.3	17	9.4	41	22.8
25–34	20	11.1	14	7.8	34	18.9
35–44	15	8.3	8	4.4	23	12.8
45–54	13	7.2	18	10.0	31	17.2
55–64	9	5.0	6	3.3	15	8.3
65–74	9	5.0	10	5.6	19	10.6
75+	3	1.7	5	2.8	8	4.4
Total	96	53.3	84	46.7	180	100

Summary statistics of the height of male and female cases are presented in Table 2.4. The mean height for males was 176.3cm (SD=9.8cm) with the median male height being 178cm. The mean female height was 162.4cm (SD=10.3cm) and the median female height was 164cm. Other statistics are presented in Table 2.4 to give a picture of the height distribution of males and females.

Table 2.4 Summary statistics of the height of male and female cases

Height (cm)	Male	Female
Mean	176.3	162.4
Median	178	164
Mode	175	165
Std. Deviation	9.8	10.3
Minimum	120	120
Maximum	198	180
25th Percentile	173	158
50th Percentile	178	164
75th Percentile	183	168
Number of cases	92	81
Missing / Unknown	4	3

Table 2.5 presents the height distribution by 5cm categories. As reflected in Table 2.4 above, the majority of males (~70%) were 175cm and taller (5'9'' and above). The height of the majority of females ranged from 155 (5'1'') to 169cm (~5'7'').

Table 2.5 Height distribution for males and females

Height (cm)	Male		Female		Total	
	Freq.	%	Freq.	%	Freq.	%
<=149	1	1.1	4	4.9	5	2.9
150–154	Nil	Nil	7	8.6	7	4.0
155–159	1	1.1	18	22.2	19	11.0
160–164	2	2.2	12	14.8	14	8.1
165–169	15	16.3	21	25.9	36	20.8
170–174	9	9.8	9	11.1	18	10.4
175–179	25	27.2	9	11.1	34	19.7
180–184	23	25.0	1	1.2	24	13.9
185 +	16	17.4	Nil	Nil	16	9.2
Total	92	100	81	100	173	100

Table 2.6 shows summary weight statistics for male and female cases. The mean weight for males was 81.6kg (SD=17.7kg) with the median male weight being 82kg. The mean female weight was 63.1kg (SD=62) and the median female weight was 62kg.

Table 2.6 Summary statistics of the weight of male and female cases

Weight (kg)	Male	Female
Mean	81.6	63.1
Median	82	62
Mode*	80	70
Std. Deviation	17.7	20.1
Minimum	24	12
Maximum	140	150
25th Percentile	70	53.25
50th Percentile	82	62
75th Percentile	94	70
Number of cases	94	84
Missing / Unknown	2	0

* Multiple modes; smallest value shown

The weight distribution of male and female cases is presented in Table 2.7. Approximately 80% of males ranged in age from 61–100kg, while the majority (69%) of female cases were within the 46–75kg range.

Table 2.7 Weight distribution for male and female cases (kg)

Weight (kg)	Male		Female		Total	
	Freq.	%	Freq.	%	Freq.	%
1- 15	Nil	Nil	1	1.2	1	0.6
16 – 30	1	1.1	5	6.0	6	3.4
31 – 45	1	1.1	4	4.8	5	2.8
46 – 60	6	6.4	30	35.7	36	20.2
61 – 75	29	30.9	28	33.3	57	32.0
76 – 85	19	20.2	6	7.1	25	14.0
86 – 100	29	30.9	9	10.7	38	21.3
101 – 115	6	6.4	Nil	Nil	6	3.4
116+	3	3.2	1	1.2	4	2.2
Total	94	100	84	100	178	100

The height and weight of persons can be entered to an equation that produces a 'Body Mass Index' (BMI) and is an index of body composition. The BMI is a ratio of weight (kg) / height (m) squared. Though not without limitations, the BMI provides an indication of those within the healthy range for their height, or alternatively those underweight or overweight (Powers & Howley, 1997). It is generally considered that a BMI of 20–25 represents the healthy weight for height ratio. A BMI of 25–30 is considered overweight, and over 30 is considered obese. It has also been suggested that a BMI of 27.8 for males and 27.3 for females represents the cut-point for obesity (Powers & Howley, 1997).

The mean BMI for males in the sample was 26.4 (SD=4.8, n=92), and ranged from 16.6–42. The mean BMI for females was 24.3 (SD=6.3, n=81), and ranged from 11.8–51.9. While slightly over two-fifths of males were in the healthy weight for height range at the time of the crash, the majority of males in the sample would be considered overweight according to the BMI.

Table 2.8 BMI for male and female cases

BMI	Male		Female	
	Freq.	%	Freq.	%
<20	2	2.2	17	21.0
20 - 25	40	43.5	34	42.0
25 - 30	35	38.0	16	19.8
30+	15	16.3	14	17.3
Total	92	100	81	100

2.3 Crash Characteristics and Vehicle Types

The reader may recall from a previous section, while there are 180 cases in the sample, the 180 cases were occupants of 155 different vehicles. Analysis in this section concerns vehicle and crash characteristics, however the analysis will be conducted for the entire sample of 180 cases. Hence, when analysing the frequency for a vehicle-related variable, if a vehicle had two occupants, the value of the variable for that vehicle will be counted twice in the frequency count. For example, in Table 2.9, 86 occupants were involved in Frontal collisions, however only 74 vehicles were involved in Frontal collisions. In this report analysis is conducted at the "person" or case level for reasons of consistency.

Table 2.9 shows the number and percentage of injury occupants recruited to the ANCIS study, herein referred as 'cases', by impact type. Impact type is defined as the most severe (i.e. using the seventh digit in the Collision Deformation Classification Code) impact and relates to the damage profile upon which CRASH3 calculations were based. A case is classified as a rollover if at any point in the crash sequence the vehicle entered a roll sequence, and this classification is regardless of primary or secondary impacts.

Of the 180 cases recruited to the ANCIS study, approximately 48% were involved in frontal impact collisions, 28% were involved in struck-side (i.e., near-side) collisions, 8.3% were involved in non-struck side impact (i.e., far-side) impacts, and 4.4% were involved in rear impact collisions. There were a total of 20 rollover cases, representing 11% of cases in the study. The impact type of one case was unclassifiable due to the instance of a protruding timber log on a dirt track entering the occupant cabin via the windscreen without further damage to the vehicle.

Table 2.9 Number and percentage of cases (occupants) by the type impact in which they were involved

Impact type	Freq.	%
Frontal	86	47.8
Struck-side	50	27.8
Far-side	15	8.3
Rear	8	4.4
Rollover	20	11.1
Unclassifiable	1	0.6
Total	180	100

The primary collision partner of the 180 cases is presented in Table 2.10. Where the vehicle in which the case individual was an occupant was involved in multiple impacts, the primary collision partner was the collision partner corresponding to the most severe impact. Car-car impacts represent the highest single category, followed by trees (24%) and then signposts / poles (12%). Vehicle impacts represented approximately 50% of primary collision partners, and roadside furniture and fixed objects the remaining 50%.

Table 2.10 Number and percentage of cases by the Primary Collision partner of the vehicle in which each occupant was travelling

Vehicle type	Freq.	%
Car or utility	63	35.0
4 by 4	13	7.2
Truck/bus/Semi	13	7.2
Signpost, pole or post	21	11.7
Tree	44	24.4
Rollover	7	3.9
Other roadside furniture	5	2.8
Other object	3	1.7
Wall	2	1.1
Other vehicle	8	4.4
Motorcycle	1	0.6
Total	180	100

Airbag fitment and deployment status by occupant position is presented in Table 2.11. The term forward airbag indicates an airbag positioned directly in front of the occupant, and in all cases in the study thus far relates only to steering wheel (driver) or facia mounted (front passenger) airbags. Side airbags refer to the following types: seat-mounted (head, thorax, combined); cant-rail mounted/tubular, and side curtains.

Of the 132 drivers, 47 had a frontal airbag fitted (33.6%) of which 32 deployed representing 68% of possible frontal airbag deployments. There were only four drivers that had a side airbag available, three of which deployed. There was a smaller proportion of frontal airbags available to front left passenger cases (~26%) compared to drivers (33.6%). Of the eight front left passengers with a frontal airbag available, 5 deployed. Only three front left passenger cases had a side airbag available (9.7%), one of which deployed. The deployment status of frontal and side airbags is considered in the following sections, broken down by impact direction.

Table 2.11 Airbag fitment and deployment by occupant position

Occupant Position	Airbag status	Forward Airbag (front)		Side Airbag	
		Freq.	%	Freq.	%
Driver	Not fitted	85	64.4	127	96.2
	Fitted & deployed	32	24.2	4	3.0
	Fitted & not deployed	15	11.4	1	0.8
	Total	132	100	132	100
FLP	Not fitted	23	74.2	28	90.3
	Fitted & deployed	5	16.1	1	3.2
	Fitted & not deployed	3	9.7	2	6.5
	Total	31	100	31	100

The summary statistics for delta-V and EBS (where calculated) are shown in Table 2.12 with the cumulative distributions being given in Figure 2.1 and Figure 2.2 respectively. The delta-V was known for 62.5% of possible cases (100 of 160). The mean delta-V was 48km/h (SD=27km/h), the median was 42km/h, and the calculated delta-V ranged from 6km/h–164km/h. The Equivalent Barrier Speed (EBS) was known for 89% of possible cases and closely resembled the mean, median and matched the range of the delta-V. The cumulative distributions are truncated, and it is noteworthy that there was one case with a delta-v of 124 km/h and a further case with a delta-V of 164km/h. Similarly there was one case with an EBS of 125 km with the highest EBS being 164km/h.

Table 2.12 Summary statistics of the delta-V & EBS for all cases

Severity statistic	Delta-V (km/h)	EBS (km/h)
Mean	48.58	46.73
Median	41.75	40.05
Mode*	27	32
Std. Deviation	27.02	25.46
Minimum	6	6
Maximum	164	164
25th Percentile	28.38	29.78
50th Percentile	41.75	40.05
75th Percentile	59.38	58.20
Number in sample	100	142
Unknown / Not possible to calculate	60	18

* Multiple modes exist. The smallest value is shown

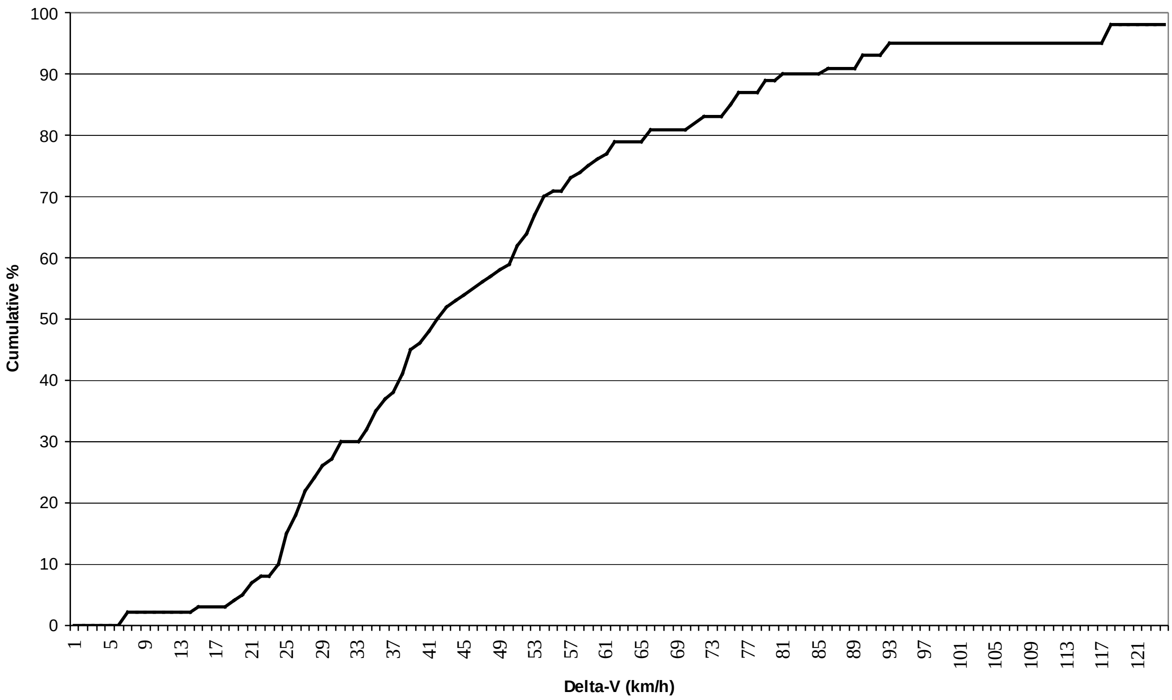

Figure 2.1 Delta-V distribution for all impact types, excluding rollovers

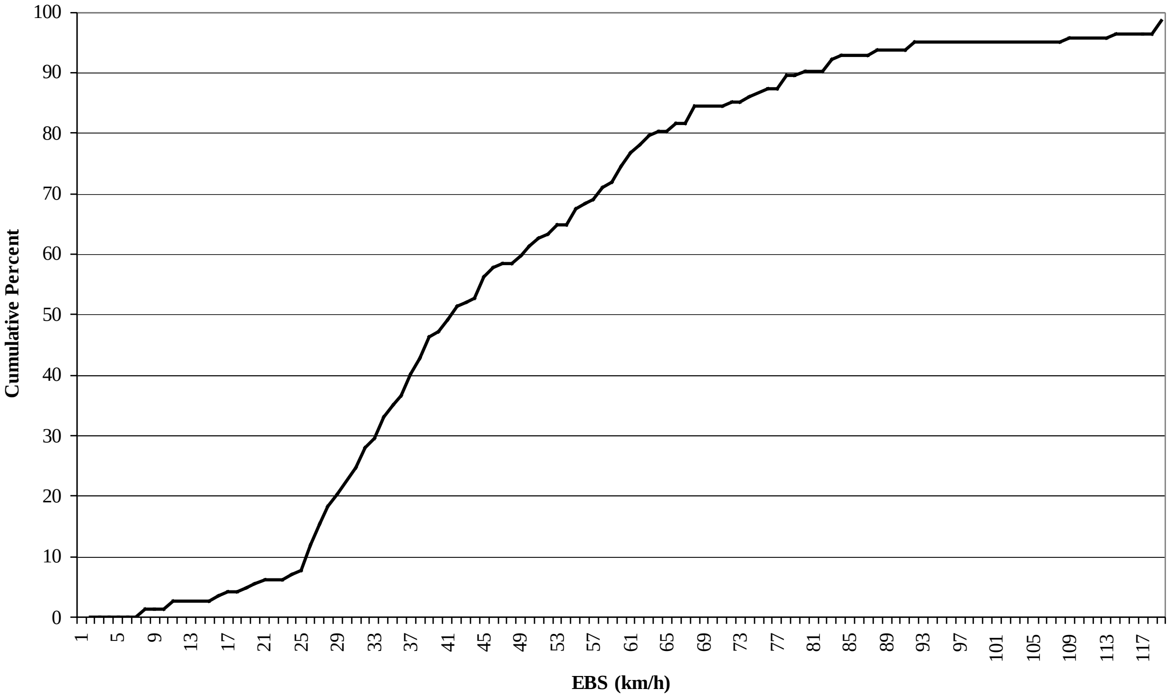

Figure 2.2. Cumulative EBS distribution for all cases

The number and percent of cases by the vehicles (categorized by market group) they were travelling in is shown Table 2.13. Forty percent of the cases were travelling in Small cars and large passenger cars, reflecting the current polarisation of the Australian passenger car fleet. Eight percent of the cases were occupants in four-wheel drive vehicles, while approximately 6% were occupants of medium sized vehicles and 5% were occupants of luxury vehicles.

Table 2.13 Number and percent of cases by the market group of the vehicle in which they were travelling

Market Group	**Freq.**	**%**
Small	71	39.4
Medium	10	5.6
Large	72	40
4WD	14	7.8
Luxury	9	5.0
Sports	1	0.6
Commercial (utility)	3	1.7
Total	180	100

The number and percent of cases by the vehicles (categorized by vehicle manufacturer) they were travelling in is shown in Table 2.14. Two-thirds of cases were occupants in vehicles manufactured by the 'big-four' local manufacturers, with Holden vehicles occupied by 25% of cases, followed by Ford (15%, n= 27) and Toyota (15%, n= 27), and Mitsubishi (10%, n = 19). A smaller number of cases occupied Nissan (7.8%, n=14), Hyundai (6%, n=11), and Subaru vehicles (5.6%, n=10), and a wide variety of other manufacturers were represented in smaller numbers of the sample.

Table 2.14 Number and percent of cases by the make of the vehicle in which they were travelling

Manufacturer	Freq.	%
Holden	48	26.7
Ford	27	15.0
Toyota	27	15.0
Mitsubishi	19	10.6
Nissan	14	7.8
Hyundai	11	6.1
Subaru	10	5.6
Mazda	6	3.3
Daihatsu	4	2.2
BMW	2	1.1
Mercedes	2	1.1
Land Rover	2	1.1
Daewoo	1	0.6
Peugeot	1	0.6
Honda	1	0.6
VW	1	0.6
Audi	1	0.6
Jeep	1	0.6
Kia	1	0.6
Saab	1	0.6
Total	180	100

Table 2.15 presents the number and percent of cases by the year of manufacture of the vehicle they were travelling. While the age of the vehicle at the time of the crash that each case was travelling in is presented in Table 2.16. Table 2.15 shows that over half (62%) of all cases were travelling in vehicles that were manufactured post-1995, and this is also reflected in the vehicle age at the time of the crash.

Table 2.15 Number and percent of cases by the year of manufacture of the vehicle in which they were travelling

Year of manufacture	Freq.	%
1989	1	0.6
1990	4	2.2
1991	5	2.8
1992	14	7.8
1993	11	6.1
1994	13	7.2
1995	21	11.7
1996	14	7.8
1997	22	12.2
1998	23	12.8
1999	21	11.7
2000	26	14.4
2001	5	2.8
Total	180	100

Table 2.16. Number and percent of cases by the age at the time of the crash of the vehicle in which they were travelling

Case vehicle age (years)	Freq.	%
Less than 1 year	10	5.6
1	29	16.1
2	17	9.4
3	23	12.8
4	20	11.1
5	17	9.4
6	16	8.9
7	15	8.3
8	9	5.0
9	19	10.6
10	4	2.2
11	1	0.6
Total	180	100

2.4 Injury Outcomes

As at December 2002, 11 hospitals have been utilised for recruitment. Table 2.17 shows the number of cases recruited since the commencement of the study in 2000. Just on half of the cases (51%, n=92) were recruited from the Alfred Hospital in Melbourne, reflecting its status both as the first hospital utilised for the study, and as a major trauma centre. A total of 26 cases (14.4%) were recruited from Dandenong Hospital, 16 cases (8.9%) from the Royal Melbourne, 10 cases (5.6%) from Monash Medical Centre (Clayton), and eight cases (4.4%) from Frankston Hospital. Six children were recruited from the Royal Children's Hospital in Victoria. The four cases recruited to the study from NSW were recruited at Liverpool Hospital.

Table 2.17 Hospital of admission for cases

Hospital of Admission	Freq.	%
Alfred, VIC	92	51.1
Dandenong, VIC	26	14.4
Royal Melbourne, VIC	16	8.9
Monash Medical Centre, VIC	10	5.6
Frankston, VIC	8	4.4
Royal Children's, VIC	6	3.3
Geelong, VIC	6	3.3
St Vincent's, VIC	5	2.8
Box Hill, VIC	4	2.2
Liverpool, NSW	4	2.2
Western, VIC	2	1.1
Fatally injured (not admitted)	1	0.6
Total	180	100

The Injury Severity Score (ISS) profile for cases in the study is presented in Table 2.18. The mean ISS for the whole sample was 15.1, while the median ISS was 10. The mean ISS for males (*Mean*=16.8, *SD*=14.2) was slightly higher than females (*Mean*=10, *SD*=10.4) while the median values were similar (Males: 11 cf. Female: 10). That males were more seriously injured is also reflected in the finding of the 75th percentile ISS being 26 compared to females of 17. The cumulative ISS distribution for males, females and the overall sample is presented in Figure 2.3.

Table 2.18 ISS profile for male and female cases

ISS profile	Male	Female	Total
Mean	16.79	13.15	15.09
Median	11.00	10.00	10.00
Mode	5	10	5
Std. Deviation	14.22	10.39	12.68
Minimum	1	1	1
Maximum	75	50	75
25th Percentiles	5.00	5.00	5.00
50th Percentile	11.00	10.00	10.00
75th Percentile	26.00	17.00	21.00
Number in sample	96	84	180

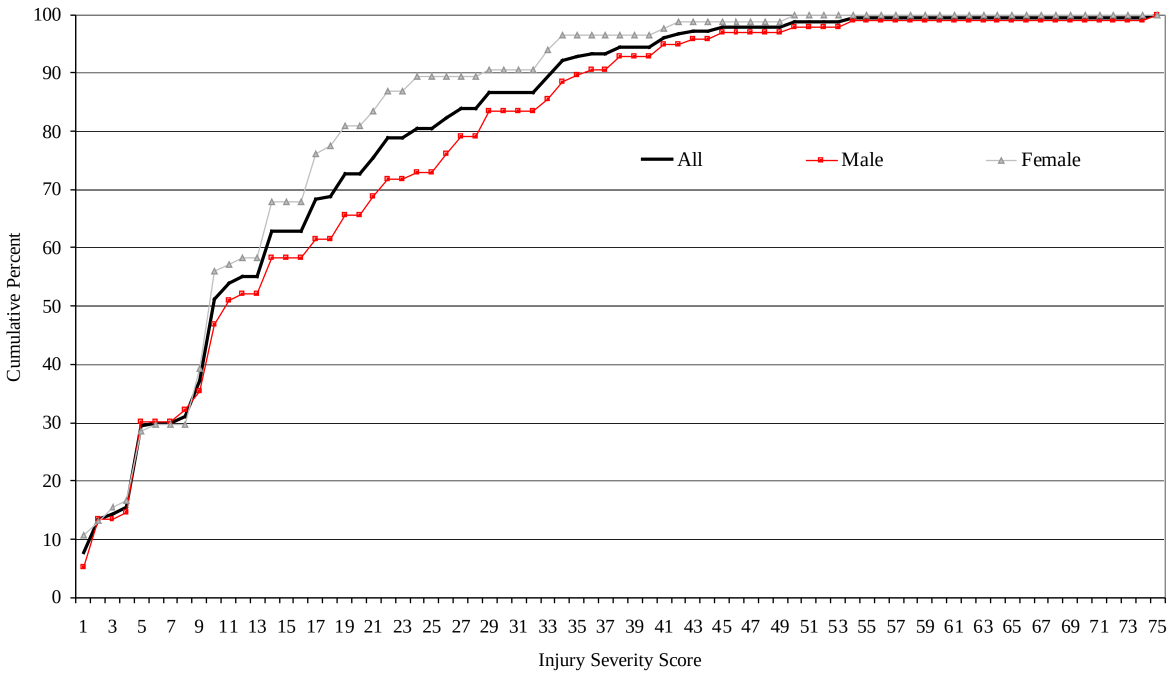

Figure 2.3 Cumulative ISS distribution for males and females in the ANCIS study

Table 2.19 shows injury severity by ISS category by gender. Overall, 62.8% of cases sustained an ISS of less than 15. With respect to gender, 58% of males had an ISS of less than 15 compared to 68% of females. There were a greater proportion of male cases in the higher ISS categories than females. The data presented in Table 2.19 is also presented as a chart in Figure 2.4.

Table 2.19 ISS category by gender for all cases

ISS category	Male		Female		Total	
	Freq.	%	Freq.	%	Freq.	%
1 - 5	29	30.2	24	28.6	53	29.4
6 - 9	5	5.2	9	10.7	14	7.8
10 - 14	22	22.9	24	28.6	46	25.6
15 - 24	14	14.6	18	21.4	32	17.8
25 - 34	15	15.6	6	7.1	21	11.7
35 - 44	7	7.3	2	2.4	9	5.0
45 - 54	3	3.1	1	1.2	4	2.2
55-64	Nil	Nil	Nil	Nil	Nil	Nil
65-74	Nil	Nil	Nil	Nil	Nil	Nil
75	1	1.0	Nil	Nil	1	0.6
Total	96	100	84	100	180	100

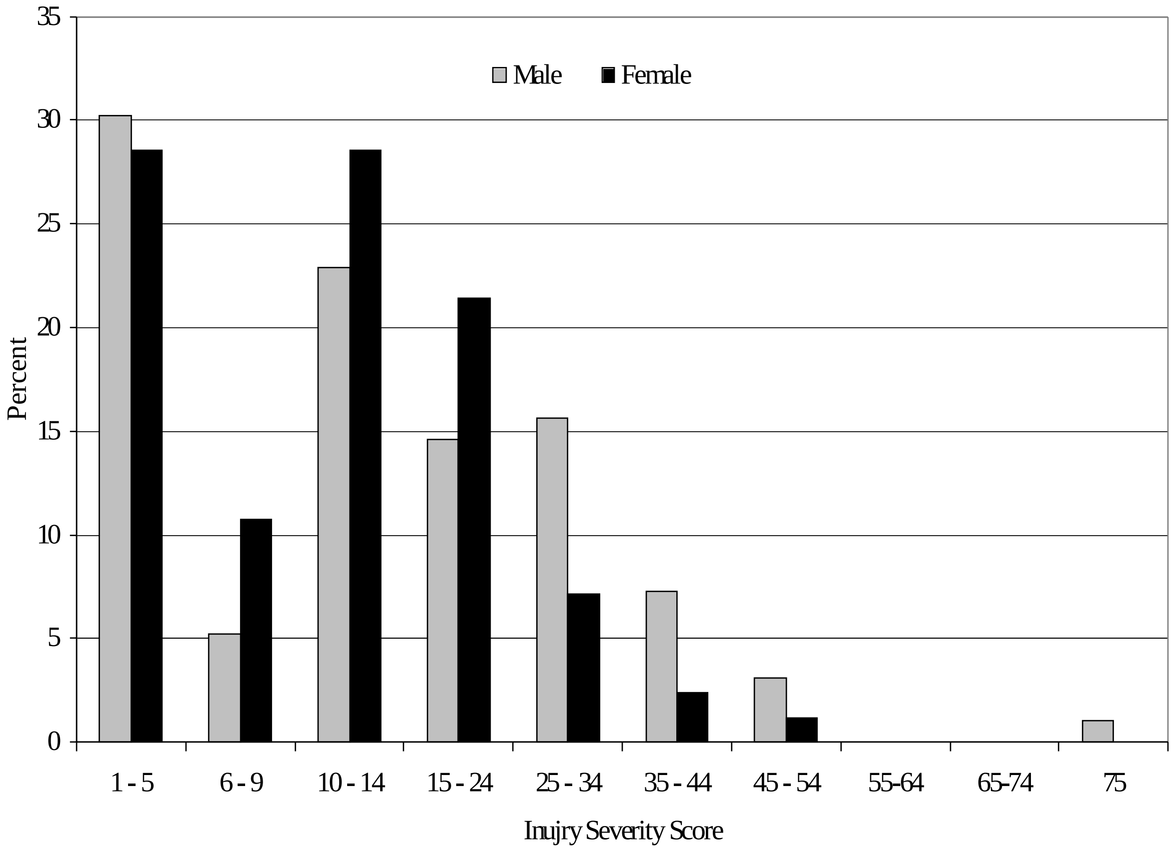

Figure 2.4 ISS distribution for males and females

The Maximum Abbreviated Injury Scale (MAIS) for male and female cases is presented in Table 2.20. The high injury severity of the sample is reflected in the maximum injury scale of each case, with slightly more than 60% of occupants sustaining an AIS 3+ injury. Nearly 20% of the sample sustained an MAIS score of 4 (severe), although the proportion of females with an MAIS4 score was slightly less than males. In addition, eight males and four females sustained an MAIS score equal to 5 (critical). This data is presented graphically in Figure 2.5 below.

Table 2.20 Maximum Abbreviated Injury Scale (MAIS) severity for male and female cases

MAIS	Male		Female		Total	
	Freq.	%	Freq.	%	Freq.	%
Minor (1)	13	13.5	13	15.5	26	14.4
Moderate (2)	21	21.9	20	23.8	41	22.8
Serious (3)	33	34.4	35	41.7	68	37.8
Severe (4)	20	20.8	12	14.3	32	17.8
Critical (5)	8	8.3	4	4.8	12	6.7
Maximum (6)	1	1.0	Nil	Nil	1	0.6
Total	96	100	84	100	180	100

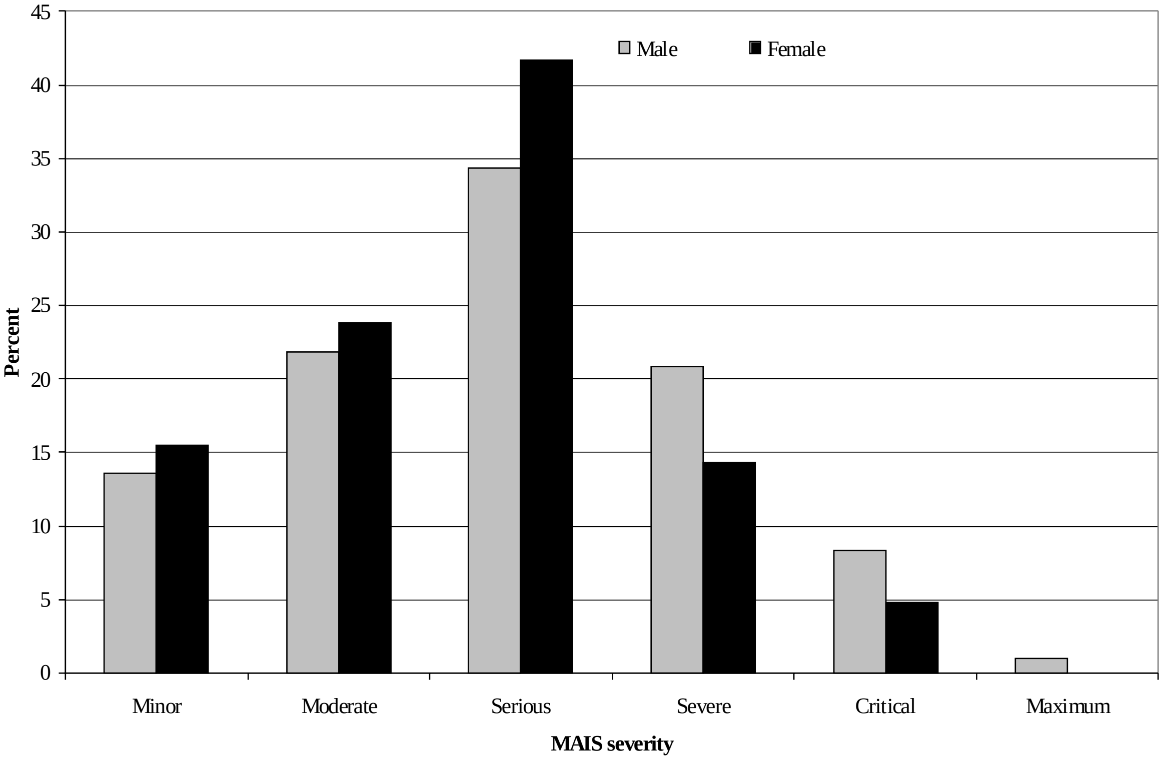

Figure 2.5 Maximum Abbreviated Injury Scale

Table 2.21 presents the number and percent of cases with AIS 1+ and AIS3+ injuries by AIS body region. The most commonly injured body regions were the upper and lower extremities with 67% of occupants sustaining an upper extremity injury or lower extremity (64.4%). Approximately 65% of cases sustained a chest injury, approximately 40% sustained an injury to the abdomen / pelvis, while two-fifths of cases sustained an injury to the head.

Table 2.21 Number and percent of cases with AIS 1 + and AIS 3+ injuries by AIS body region

AIS Body region	ALL AIS		AIS 3+	
	Number of Cases	% of all cases	Number of Cases	% of all cases
Head	75	41.7	31	17.2
Face	100	55.6	2	1.1
Neck	30	16.7	4	2.2
Chest	116	64.4	61	33.9
Abdomen / Pelvis	76	42.2	23	12.8
Spine	33	18.3	9	5.0
Upper Extremity	121	67.2	19	10.6
Lower Extremity	116	64.4	37	20.6
External	2	1.1	Nil	Nil

Table 2.21 also presents the proportion of cases sustaining AIS 3+ injuries. One third (33.9%) of cases sustained at least a 'serious' injury of the chest, while one fifth of the sample sustained at least an AIS 3+ injury of the lower extremity. Critically, given the nature of injury outcomes, nearly 20% of the sample sustained an AIS 3+ injury of the head.

The injury contact sources associated with AIS 1 + and AIS 3+ injuries are presented in Table 2.22. For AIS 1+ injuries, the seat belt, instrument panel, door panel, and the steering assembly were the most commonly attributed injury contact points. For example, 19% of the sample sustained an injury that was attributed to seat belt contact, while this proportion decreased to 13% of the sample when considering AIS3+ injuries. Thirty-four persons (19%) sustained an AIS 1+ injury that was attributed to deceleration forces, and 15% of cases sustained an airbag-related contact injury. The data presented in Table 2.22 is designed to give a broad overview of contact source implicated with injuries. This data is of greater relevance for countermeasure design and implementation when examining each impact type.

Table 2.22 Number of persons sustaining AIS 1+ and AIS 3+ injuries by contact source

Injury contact source	All AIS		AIS 3+	
	Number persons	Percentage	Number persons	Percentage
Seat Belt	85	47.2	24	13.3
Instrument panel	79	43.9	24	13.3
Door panel	62	34.4	30	16.7
Other + Unknown	61	33.9	3	1.7
Steering assembly	54	30.0	20	11.1
Floor & toe pan	39	21.7	7	3.9
Deceleration / Inertial forces	34	18.9	6	3.3
Airbag (+cover + gases)	27	15.0	2	1.1
B-pillar	21	11.7	12	6.7
Windscreen / Header rail	20	11.1	6	3.3
Window + frame	15	8.3	2	1.1
Seats & head rest	15	8.3	4	2.2
Other vehicle or exterior object	13	7.2	9	5.0
Roof surface	10	5.6	6	3.3
Roof side rail	6	3.3	2	1.1
Console	6	3.3	1	0.6
Other occupant	5	2.8	3	1.7
Exterior of other vehicle	3	1.7	2	1.1
A-pillar	2	1.1	2	1.1
Fire in vehicle	2	1.1	Nil	Nil
Rear screen	1	0.6	Nil	Nil
Exterior of vehicle	1	0.6	1	0.6
Child Seat / Restraint	1	0.6	1	0.6

3 FRONTAL IMPACT CASES

3.1 Basic Crash and Case Information

There were 86 cases where the most severe impact was classified as a frontal impact, excluding vehicle rollovers. These 86 cases were occupants of 74 different vehicles. As in the previous section, all analysis in this section is completed with respect to the 86 individual cases, not the 74 vehicles, even when vehicle characteristics are being analysed. As such, frontal impact cases represent approximately 48% of ANCIS cases to date. Table 3.1 shows the number and percent of cases involved in frontal impact crashes by occupant seating position. Of the 86 cases, 66 (76.7%) were drivers, nine (10.5%) were front left passengers, one was a front centre passenger and ten (11.6%) were rear passengers.

Table 3.1 Number and percent of cases involved in frontal impact crashes by seat position

Position	Freq.	%
Driver	66	76.7
FLP	9	10.5
Front Centre	1	1.2
Rear Left	4	4.7
Rear Centre	1	1.2
Rear right	5	5.8
Total	86	100

Table 3.2 displays restraint use by occupant position for frontal cases. Of the occupants, 85% were restrained or claimed restraint use, while the remaining 15% were unbelted or there was no physical evidence to support belt use. The proportion of driver and front left passenger belt use was at a similar level at 89.4% and 88.9% respectively. Restraint use by rear passengers was significantly less, with only 6 of the 10 (60%) cases belted or claiming belt use. The single front centre passenger was unbelted.

Table 3.2 Occupant position by belt use for frontal impact cases

Occupant Position	Unbelted		Belted used or claimed		Total	
	Freq.	%	Freq.	%	Freq.	%
Driver	7	10.6	59	89.4	66	100
FLP	1	11	8	88.9	9	100
Front Centre	1	100	Nil	Nil	1	100
Rear Left	2	50.0	2	50.0	4	100
Rear Centre	Nil	Nil	1	100	1	100
Rear right	2	40.0	3	60	5	100
Total	13	15.1	73	84.9	86	100

3.2 Case Demographic Characteristics

The age and sex distribution of the frontal cases is shown in Table 3.3. Of the 86 frontal cases, 44 (51.2%) were male and 42 (48.8%) were female. The majority of occupants (88.4%) were in the age range 15-74, and within this age range, the distribution was fairly even. Of the age/sex groups, the male age range of 25-34 comprised the highest number of cases, forming 14% of all frontal case occupants and 27.3% of male frontal crash involved cases. The most common female age range was 45-54, accounting for 11.6% of all cases and 23.8% of female frontal cases.

Table 3.3 Number and percent of male and female frontal impact cases by age group

Age (years)	Male		Female		Total	
	Freq.	%	Freq.	%	Freq.	%
1–5	Nil	Nil	1	1.2	1	1.2
6–9	1	1.2	2	2.3	3	3.5
10–14	Nil	Nil	1	1.2	1	1.2
15–24	6	7.0	7	8.1	13	15.1
25–34	12	14.0	6	7.0	18	20.9
35–44	7	8.1	3	3.5	10	11.6
45–54	6	7.0	10	11.6	16	18.6
55–64	4	4.7	3	3.5	7	8.1
64–74	6	7.0	6	7.0	12	14
75+	2	2.3	3	3.5	5	5.8
Total	44	51.2	42	48.8	86	100

The summary statistics of the height and weight of male and female occupants in frontal cases is displayed in Table 3.4. The mean height for males was 176.4cm (SD=7.2cm) and the median was 175cm. The mean female height was 162.5cm (SD=10.5cm) and the median was 163cm. The male height ranged from 156 to 180 cm and the female height ranged from 120 –178 cm.

Table 3.4. Summary statistics of the height of male and female frontal impact cases

Height (cm)	Male	Female
Mean	176.43	162.49
Median	175.00	163.00
Mode	175	158
Std. Deviation	7.21	10.46
Minimum	156	120
Maximum	190	178
25th Percentile	173.75	158.00
50th Percentile	175.00	163.00
75th Percentile	182.25	168.00
Number of cases	42	39
Unknown	2	3

Table 3.5 displays the height distribution for frontal case occupants by 5cm categories. There was only a single male case (2.4%) with a height less than 165cm with the majority of male occupant heights (59.5%) being in the range 175-184cm. All female cases had heights less than 179cm, and there were only 2 cases (5.1%) of heights 149cm and less. The majority of female heights (64%) were in the range 155-169cm.

Table 3.5 Height distribution for male and female frontal impact cases

Height (cm)	Male		Female		Total	
	Freq.	%	Freq.	%	Freq.	%
<=149	Nil	Nil	2	5.1	2	2.5
150–154	Nil	Nil	3	7.7	3	3.7
155–159	1	2.4	10	25.6	11	13.6
160–164	Nil	Nil	6	15.4	6	7.4
165–169	6	14.3	9	23.1	15	18.5
170–174	5	11.9	3	7.7	8	9.9
175–179	14	33.3	6	15.4	20	24.7
180–184	11	26.2	Nil	Nil	11	13.6
185 +	5	11.9	Nil	Nil	5	6.2
Total	42	100	39	100	81	100

Table 3.6 shows summary weight statistics for male and female occupants in frontal cases. The mean weight for males was 81.9kg (SD=4.6kg) with the median male weight being 94kg. The mean female weight was 49.8kg (SD=17.8) and the median female weight was 52kg.

Table 3.6 Summary statistics of the weight of male and female frontal impact cases

Weight (kg)	Male	Female
Mean	81.93	63.66
Median	83.00	61.00
Mode*	86	60
Std. Deviation	16.95	21.76
Minimum	35	12
Maximum	122	100
25th Percentile	70.00	52.75
50th Percentile	83.00	61.00
75th Percentile	94.00	81.25
Number of cases	43	42
Missing / Unknown	1	0

* Multiple modes; smallest value shown

The weight distribution of male and female frontal case occupants is presented in Table 3.7. The majority of males were in the weight range 61-100kg (83.7%). The majority of females (54.8%) weighed between 46 and 75kg, and there were also 19% of females in the 86-100kg range.

Table 3.7 Weight distribution for male and female frontal impact cases

Weight (kg)	Male		Female		Total	
	Freq.	Col %	Freq.	Col %	Freq.	Col %
1- 15	Nil	Nil	1	2.4	1	1.2
16 - 30	Nil	Nil	3	7.1	3	3.5
31 - 45	1	2.3	3	7.1	4	4.7
46 - 60	1	2.3	14	33.3	15	17.6
61 - 75	15	34.9	9	21.4	24	28.2
76 - 85	8	18.6	4	9.5	12	14.1
86 - 100	13	30.2	8	19.0	21	24.7
101 - 115	4	9.3	Nil	Nil	4	4.7
116+	1	2.3	Nil	Nil	1	1.2
Total	43	100	42	100	85	100

3.3 Crash Characteristics and Vehicle Information

Table 3.8 shows the frequency of primary collision partner types in the frontal impact cases. Approximately 60% of frontal crash-involved cases involved another vehicle while 41.8% were single vehicles crashes. The most common collision partners were: cars or car-based utilities (33.7%), trees (23.3%), signposts, poles or posts (14.0%) and 4WD vehicles (10.5%). There were a smaller number of cases involving impacts with other objects, and these are listed in Table 3.8.

Table 3.8 Primary collision partners associated with frontal impact cases

Collision Partner	Freq.	%
Car or car-based utility	29	33.7
4 by 4	9	10.5
Truck/bus/Semi	5	5.8
Signpost, pole or post	12	14.0
Tree	20	23.3
Other roadside furniture	2	2.3
Other object	3	3.5
Other vehicle	6	7.0
Total	86	100

Airbag fitment and deployment status by occupant position for frontal impacts is presented in Table 3.9. Of the 66 drivers, 28.8% (n=19) had a front airbag fitted of which all deployed. Of the front left passengers, one third had frontal airbags, all of which deployed as a result of the collision. No rear occupants had a forward-facing airbag fitted. All frontal airbags present in frontal impact case vehicles deployed.

Table 3.9 Airbag fitment and deployment by occupant position for frontal impact cases

Position	Airbag status	Forward Airbag (front)		Side Airbag	
		Freq.	%	Freq.	%
Driver	Not fitted	47	71.2	65	98.5
	Fitted & deployed	19	28.8	Nil	Nil
	Fitted & not deployed	Nil	Nil	1	1.5
	Total	66	100	66	100
FLP	Not fitted	6	66.7	9	100
	Fitted & deployed	3	33.3	Nil	Nil
	Fitted & not deployed	Nil	Nil	Nil	Nil
	Total	9	100	Nil	Nil

The summary statistics for delta-V and EBS (where able to be calculated) are shown in Table 3.10. The delta-V was calculated for 68.6% of frontal impact cases. The mean delta-V was 57.8km/h (SD=28km/h), the median was 53.4km/h, and values calculated ranged from 19–164km/h. EBS was found for 90.7% of frontal impacts. The mean and median EBS were, respectively, 55.0 and 50.7km/h. The maximum EBS was 164km/h and the minimum was 23km/h. The cumulative delta-v distribution is shown in Figure 3.1 and the cumulative EBS distribution is shown in Figure 3.2, with both distributions truncated at 117 km/h (95th percentile).

Table 3.10 Summary statistics of the delta-V & EBS for frontal impact cases

Severity statistic	Delta-V	EBS
Mean	57.84	54.96
Median	53.40	50.70
Mode	53	33
Std. Deviation	28.16	26.03
Minimum	19	23
Maximum	164	164
25th Percentile	37.80	34.15
50th Percentile	53.40	50.70
75th Percentile	74.40	67.22
Number of cases	59	78
Unable to be calculated	27	8

* Multiple modes exist. The smallest value is shown

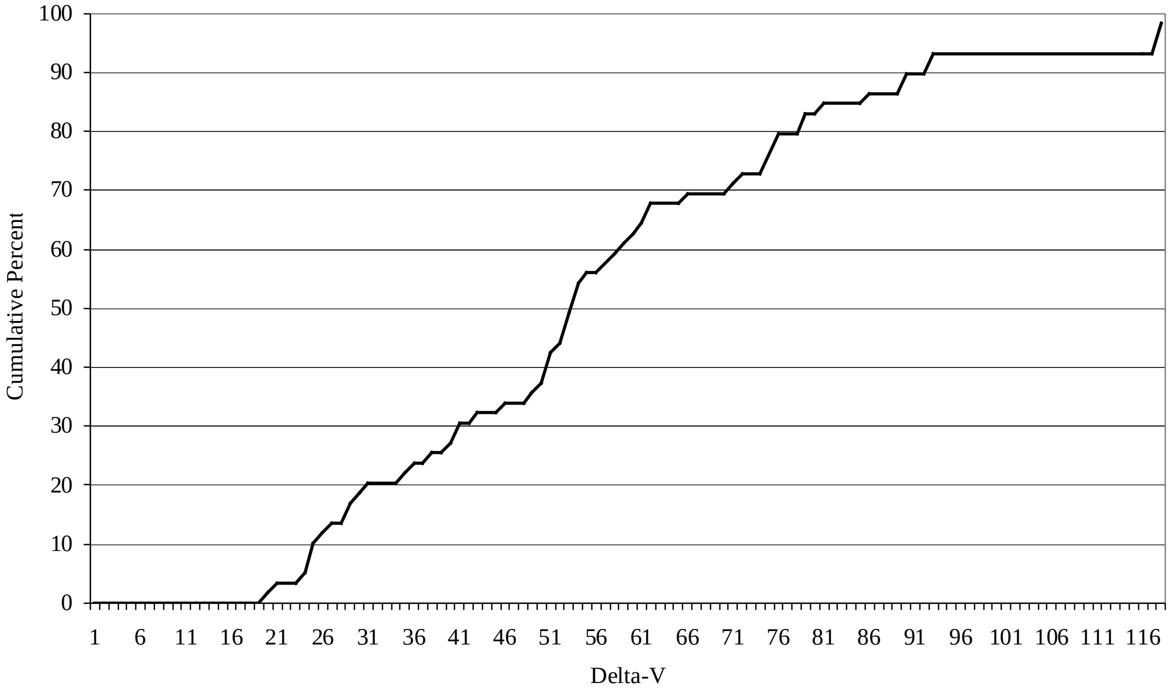

Figure 3.1 Cumulative delta-v distribution for frontal impact cases

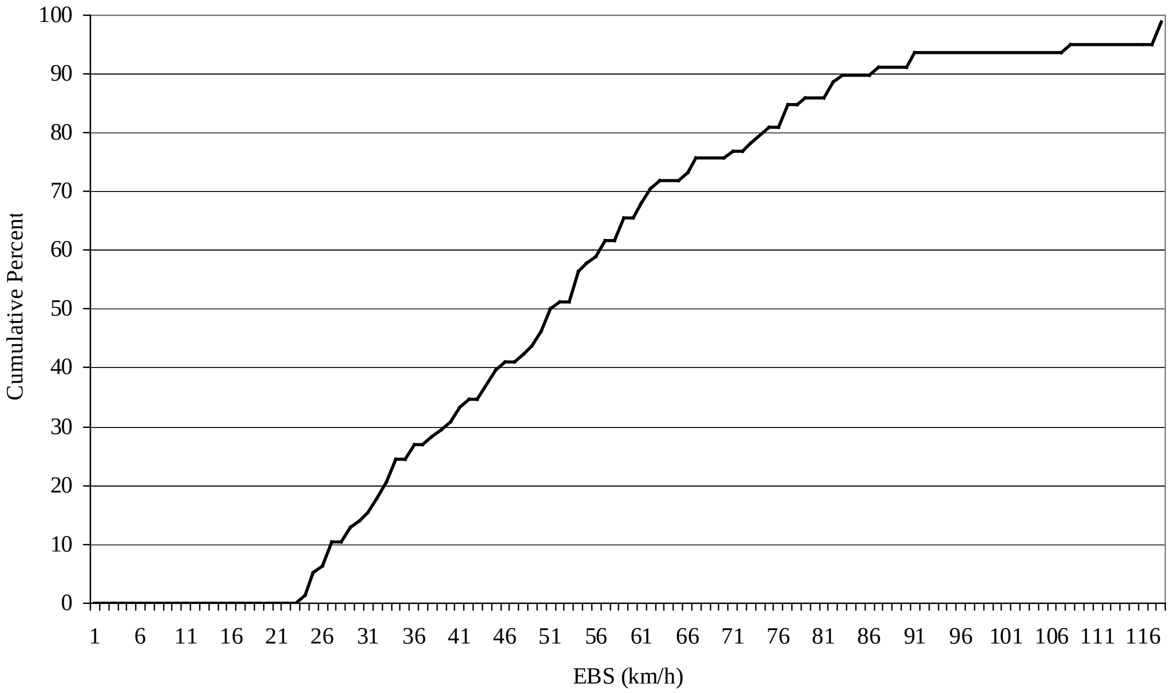

Figure 3.2 Cumulative EBS distribution for frontal impact cases

The number and percent of frontal crash-involved case vehicles by market group is shown in Table 3.11. Small and large cars were equally represented, each representing 42% of the frontal impact case vehicles. There were six medium sized vehicles (7%), while 4WD, luxury and commercial vehicles were represented in fewer numbers.

Table 3.11 Number and percent of cases involved in frontal impacts by the market group of the vehicle in which they were travelling

Market Group	Freq.	%
Small	36	41.9
Medium	6	7.0
Large	36	41.9
4WD	3	3.5
Luxury	3	3.5
Commercial (utility)	2	2.3
Total	86	100

The number and percent of frontal impact cases by vehicle manufacturer is presented in Table 3.12. Holden vehicles comprised 27.9% of case vehicles, followed by Ford vehicles (16.3%), Toyota (15.1%) and Mitsubishi (15%) vehicles. The remainder of case vehicles consisted of small frequencies from a large range of other manufacturers.

Table 3.12 Number and percent of cases involved in frontal impacts by the manufacturer of the vehicle in which they were travelling

Manufacturer	Freq.	%
Holden	24	27.9
Ford	14	16.3
Toyota	13	15.1
Mitsubishi	13	15.1
Nissan	5	5.8
Hyundai	5	5.8
Mazda	4	4.7
Subaru	3	3.5
Peugeot	1	1.2
Daihatsu	1	1.2
VW	1	1.2
Jeep	1	1.2
Kia	1	1.2
Total	86	100

Table 3.13 presents the number and percent of cases involved in frontal impacts by the year of manufacture of the vehicles in which they were travelling. It can be observed that the year of manufacturer of the case vehicles was spread between 1989 and 2001. The majority of cases were occupants of vehicles that were manufactured from 1995- 2000 (74.4%).

Table 3.13 Number and percent of cases involved in frontal impacts by the year of manufacturer of the vehicle in which they were travelling

Year of manufacture	Freq.	%
1989	1	1.2
1990	3	3.5
1991	Nil	Nil
1992	6	7.0
1993	6	7.0
1994	4	4.7
1995	10	11.6
1996	11	12.8
1997	13	15.1
1998	12	14.0
1999	6	7.0
2000	12	14.0
2001	2	2.3
Total	86	100

The number and percentage of cases by the age at the time of the crash of the vehicle in which they were travelling is displayed in Table 3.14. The majority of cases were occupants of vehicles less than 5 years old at the time of the crash (67.4%). Only three (3.5%) cases were travelling in vehicles were less than one year old.

Table 3.14 Number and percent of cases involved in frontal impacts by the age at the time of the crash of the vehicle in which they were travelling

Case Vehicle Age (years)	Freq.	%
Less than 1 year	3	3.5
1	13	15.1
2	6	7.0
3	12	14.0
4	13	15.1
5	11	12.8
6	7	8.1
7	8	9.3
8	1	1.2
9	8	9.3
10	3	3.5
11	1	1.2
Total	86	100

3.4 Frontal Impact Case Injury Outcomes

Table 3.15 shows the hospital of admission for the frontal impact cases. Nearly half of the participants (45.3%) were admitted to the Alfred Hospital, 12.8% to Dandenong Hospital, 9.3% to the Royal Melbourne Hospital and 8.1% to Frankston Hospital. The remainder of frontal impact cases were recruited from a number of other hospitals.

Table 3.15 Hospital of admission for frontal impact cases

Hospital of admission	Freq.	%
Alfred, VIC	39	45.3
Dandenong, VIC	11	12.8
Royal Melbourne, VIC	8	9.3
Frankston, VIC	7	8.1
Box Hill, VIC	4	4.7
St Vincent's, VIC	4	4.7
Geelong, VIC	4	4.7
Royal Children's, VIC	3	3.5
Liverpool, NSW	3	3.5
Monash MC, VIC	2	2.3
Western, VIC	1	1.2
Total	86	100

The ISS profile for frontal impact cases is presented in Table 3.16. The mean ISS was 13.9 and the median was 10. The mean and median ISS for males of 14.7 and 11 respectively, was higher than for females whose mean ISS was 13 and a median of 10. That males were more seriously injured as a group than females is also reflected in the finding of the 75th percentile ISS was 21 compared to 17.25 for females. The cumulative ISS distribution for male and female frontal cases is shown in Figure 3.3.

Table 3.16 ISS profile for male and female frontal impact cases

ISS profile	Male	Female	Total
Mean	14.68	13.00	13.86
Median	11.00	10.00	10.00
Mode	5	5	5
Std. Deviation	10.85	9.31	10.11
Minimum	1	1	1
Maximum	41	34	41
25th Percentiles	5.00	5.00	5.00
50th Percentile	11.00	10.00	10.00
75th Percentile	21.00	17.25	19.00
Number of cases	44	42	86

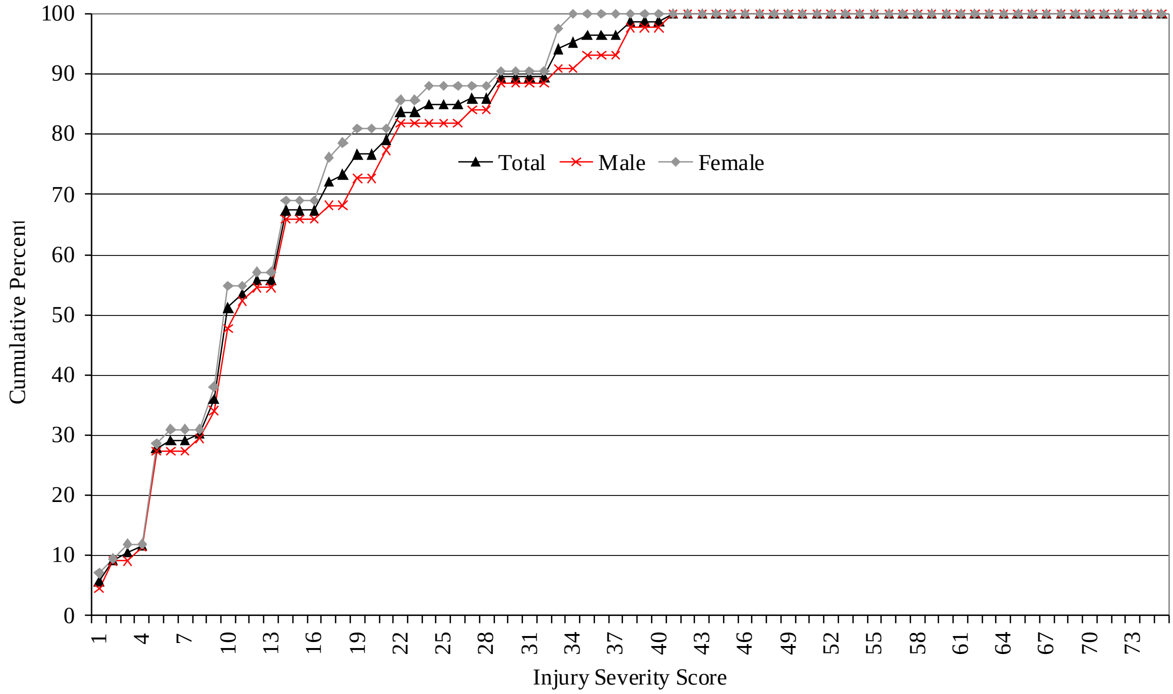

Figure 3.3 Cumulative ISS distribution for male and female frontal impact cases

Table 3.17 shows injury severity by ISS category for males and females frontal impact cases. The vast majority of male and female cases sustained an ISS of less than 15, with no case sustaining an ISS of greater than 45. The ISS category with most cases was 10-14 range with 27 (31.4%) while there were also 24 cases (27.9%) with ISS of 1 to5.

Table 3.17 ISS category by gender for frontal impact cases

ISS	Male		Female		Total	
	Freq.	%	Freq.	%	Freq.	%
1 – 5	12	27.3	12	28.6	24	27.9
6 – 9	3	6.8	4	9.5	7	8.1
10 - 14	14	31.8	13	31.0	27	31.4
15 - 24	7	15.9	8	19.0	15	17.4
25 - 34	4	9.1	5	11.9	9	10.5
35 - 44	4	9.1	Nil	Nil	4	4.7
45 - 54	Nil	Nil	Nil	Nil	Nil	Nil
55-64	Nil	Nil	Nil	Nil	Nil	Nil
65-74	Nil	Nil	Nil	Nil	Nil	Nil
75	Nil	Nil	Nil	Nil	Nil	Nil
Total	44	100	42	100	86	100

The Maximum Abbreviated Injury Scale (MAIS) for male and female occupants in frontal impact cases is presented in Table 3.18. Approximately 80% of frontal impact cases sustained an MAIS score of 3 (serious) or less. Of the 86 cases, 38 (44%) sustained an MAIS score of 4 (severe). The maximum abbreviated injury scale severity distributions for males and females were similar, however the proportion of males with MAIS4 (severe) and MAIS5 (critical) scores (13.6% and 6.8%) was slightly higher than those of females (12.8% and 5.8%).

Table 3.18 Maximum Abbreviated Injury Scale severity for male and female frontal impact cases

MAIS	Male		Female		Total	
	Freq.	%	Freq.	%	Freq.	%
Minor (1)	4	9.1	5	11.9	9	10.5
Moderate (2)	12	27.3	11	26.2	23	26.7
Serious (3)	19	43.2	19	45.2	38	44.2
Severe (4)	6	13.6	5	11.9	11	12.8
Critical (5)	3	6.8	2	4.8	5	5.8
Maximum (6)	Nil	Nil	Nil	Nil	Nil	Nil
Total	44	100	42	100	86	100

Table 3.19 presents the number and percent of occupants in frontal impact cases with AIS 1+ and AIS 3+ injuries by body region. The most common AIS1+ injuries were sustained to the lower extremity (76.7%), upper extremity (74.4%), chest (65.1%) and face (61.1%). For AIS 3+ injuries, the most commonly injury body regions were the chest (27.9% of cases), lower extremity (26.72%) and upper extremity (16.3%).

Table 3.19 Number and percent of frontal impact cases with AIS 1 + and AIS 3+ injuries by body region

AIS Body region	ALL AIS		AIS 3+	
	Number of Cases	% of all frontal cases	Number of Cases	% of all frontal cases
Head	24	27.9	7	8.1
Face	53	61.6	1	1.2
Neck	19	22.1	2	2.3
Chest	56	65.1	24	27.9
Abdomen / Pelvis	42	48.8	12	14.0
Spine	11	12.8	Nil	Nil
Upper Extremity	64	74.4	14	16.3
Lower Extremity	66	76.7	23	26.7
External	Nil	Nil	Nil	Nil

The injury contact sources associated with AIS 1 + and AIS 3+ injuries for frontal impacts are presented in Table 3.20. For AIS 1+ injuries the instrument panel (67.4%), the seat belt (66.3%), the steering assembly (44.2%) and the floor and toe pan (29.1%) were the most common sources of injury. One-third of AIS 1+ injury contact sources were unable to be confidently attributed to a single source. With respect to AIS 3+ injuries, the contact sources were most frequently the instrument panel (22.1%), the seat belt (19.8%), the steering assembly (16.3%) and the floor and toe pan (5.8%). Two (2.3%) of the AIS 3+ injury sources were unknown or from an unlisted source. The airbag was the source of only 14 (16.3%) AIS 1+ injuries, and no AIS 3+ injuries.

Table 3.20 Number of frontal impact cases sustaining AIS 1+ and AIS 3+ injuries by contact source

Contact source	All AIS		AIS 3+	
	Number persons	Percentage	Number persons	Percentage
Windscreen / Header rail	13	15.1	4	4.7
Steering assembly	38	44.2	14	16.3
Instrument panel	58	67.4	19	22.1
Console	2	2.3	1	1.2
Window + frame	3	3.5	1	1.2
A-pillar	1	1.2	1	1.2
Roof side rail	1	1.2	Nil	Nil
Roof surface	1	1.2	1	1.2
Door panel	17	19.8	3	3.5
Floor & toe pan	25	29.1	5	5.8
Seats & head rest	8	9.3	2	2.3
Seat Belt	57	66.3	17	19.8
Airbag (+cover + gases)	14	16.3	Nil	Nil
Other occupant	3	3.5	2	2.3
Other + Unknown	29	33.7	2	2.3
Deceleration /inertial forces	17	19.8	3	3.5
Exterior of other vehicle	1	1.2	1	1.2
Child Seat / Restraint	1	1.2	1	1.2

4 SIDE IMPACT: STRUCK-SIDE / NEAR SIDE CASES

4.1 Basic Crash and Case Information

Table 4.1 shows the number and percent of cases involving a struck-side occupant in a side impact crash. Recall from Section 2 that when a vehicle was involved in multiple impacts, the impact is classified as a side impact when the side impact is the most severe (calculated using the CDC codes for each impact) of all the impacts and no rollover occurred. Whether the side impact was a struck side impact or a non-struck side impact is determined according to the case occupants seating position in the car. There were 50 ANCIS cases classified as struck side crashes, equating to 28% of the sample. These 50 cases were occupants of 43 different vehicles. As in previous sections, all analysis in this section is completed with respect to the 50 individual cases, not the 43 vehicles, even when vehicle characteristics are being analysed. Of these 50 cases, 34 cases (68%) were drivers, 12 (24%) were front left passengers, and four (8%) were rear passengers.

Table 4.1 Number and percent of cases involved in struck-side impact crashes by occupant position

Position	Freq.	%
Driver	34	68.0
FLP	12	24.0
Front Centre	Nil	Nil
Rear Left	3	6.0
Rear Centre	Nil	Nil
Rear right	Nil	Nil
Back left	1	2.0
Back centre	Nil	Nil
Back right	Nil	Nil
Total	50	100

Table 4.2 displays restraint use for occupant position in struck side cases. Among the fifty occupants, 86% were belted or claimed restraint use, while the remaining 14% were either unbelted or there was no physical evidence to support belt use. The proportion of unbelted drivers was 11.8% while 25% of front left passengers were unbelted. The four rear occupants were belted.

Table 4.2 Occupant position by belt use for struck-side impact cases

Position	Unbelted		Belted used or claimed		Total	
	Freq.	%	Freq.	%	Freq.	%
Driver	4	11.8	30	88.2	34	100
Font left passenger	3	25.0	9	75.0	12	100
Front Centre	Nil	Nil	Nil	Nil	Nil	Nil
Rear Left	Nil	Nil	3	100	3	100
Rear Centre	Nil	Nil	Nil	Nil	Nil	Nil
Rear right	Nil	Nil	Nil	Nil	Nil	Nil
Back left	Nil	Nil	1	100	1	100
Back centre	Nil	Nil	Nil	Nil	Nil	Nil
Back right	Nil	Nil	Nil	Nil	1	100
Total	7	14.0	43	86.0	50	100

4.2 Case Demographic Characteristics

The age and sex distribution of the struck side cases is shown in Table 4.3. Of the 50 struck side cases, 28 (51.2%) were male and 22 (48.8%) were female. The majority of occupants (88.4%) were in the age range 15-74, and within this the age range 15-34 was most represented accounting for 46% of cases. Of the age/sex groups, the male age range 15-24 was the most frequently represented, comprising 18% of all struck side case occupants and 32.1% of male struck side cases. The most highly represented female age group was 45-54 years, accounting for 12% of all cases and 27.3% of female stuck side cases.

Table 4.3 Number and percent of male and female struck-side cases by age group

Age (years)	Male		Female		Total	
	Freq.	%	Freq.	%	Freq.	%
1–5	1	2.0	1	2.0	2	4.0
6–9	Nil	Nil	Nil	Nil	Nil	Nil
10–14	1	2.0	Nil	Nil	1	2.0
15–24	9	18.0	4	8.0	13	26.0
25–34	5	10.0	5	10.0	10	20.0
35–44	5	10.0	2	4.0	7	14.0
45–54	2	4.0	6	12.0	8	16.0
55–64	2	4.0	2	4.0	4	8.0
64–74	2	4.0	2	4.0	4	8.0
75+	1	2.0	Nil	Nil	1	2.0
Total	28	56.0	22	44.0	50	100

The summary statistics of the height of male and female occupants in struck side cases is displayed in Table 4.4. The mean height for males was 175.2cm (SD=13.9cm) and the median was 178cm. The mean female height was 162.7cm (SD=12.3cm) and the median was 165cm. The male height ranged from 120 to 198 cm and the female height ranged from 120 to 180 cm.

Table 4.4. Summary statistics of the height of male and female of struck-side cases

Height (cm)	Male	Female
Mean	175.15	162.68
Median	178.00	165.00
Mode	165	165
Std. Deviation	13.93	12.34
Minimum	120	120
Maximum	198	180
25th Percentile	170	157.25
50th Percentile	178	165
75th Percentile	182	170.25
Number of cases	27	22
Unknown	1	0

Table 4.5 displays the height distribution for side impact case occupants by 5cm categories. There were only two male occupants (7.4%) with heights less than 165cm and the distribution of male heights above 165cm was relatively even. The majority of female heights (72.7%) were between 155 and 174cm.

Table 4.5 Height distribution for male and female struck-side impact cases

Height (cm)	Male		Female		Total	
	Freq.	%	Freq.	%	Freq.	%
<=149	1	3.7	1	4.5	2	4.1
150–154	Nil	Nil	2	9.1	2	4.1
155–159	Nil	Nil	4	18.2	4	8.2
160–164	1	3.7	3	13.6	4	8.2
165–169	4	14.8	4	18.2	8	16.3
170–174	4	14.8	5	22.7	9	18.4
175–179	6	22.2	2	9.1	8	16.3
180–184	6	22.2	1	4.5	7	14.3
185 +	5	18.5	Nil	Nil	5	10.2
Total	27	100	22	100	49	100

Table 4.6 shows summary weight statistics for male and female occupants in struck side impact cases. The mean weight for males was 76.8kg (SD=16.8kg) with the median male weight being 80kg. The mean female weight was 63.7kg (SD=22.4kg) and the median female weight was 62kg.

Table 4.6 Summary statistics of the weight of male and female struck-side impact cases

Weight (kg)	Male	Female
Mean	76.82	63.68
Median	80.00	62.00
Mode*	80	53
Std. Deviation	16.80	22.37
Minimum	24	22
Maximum	102	150
25th Percentile	67.00	53.00
50th Percentile	80.00	62.00
75th Percentile	85.75	68.50
Number of cases	28	22
Unknown	0	0

* Multiple modes exist. The smallest value is shown

The weight distribution of male and female struck side impact cases is presented in Table 4.7. The majority of males were in the weight range 46 –85kg while the majority of females (86.4%) weighed between 31 and 60kg.

Table 4.7 Weight distribution (kg) for male and female struck-side cases

Weight (kg)	Male		Female		Total	
	Freq.	Col %	Freq.	Col %	Freq.	Col %
16 - 30	1	3.6	1	4.5	2	4.0
31 - 45	Nil	Nil	Nil	Nil	Nil	Nil
46 - 60	3	10.7	9	40.9	12	24.0
61 - 75	8	28.6	10	45.5	18	36.0
76 - 85	9	32.1	1	4.5	10	20.0
86 - 100	6	21.4	Nil	Nil	6	12.0
101 - 115	1	3.6	Nil	Nil	1	2.0
116+	Nil	Nil	1	4.5	1	2.0
Total	28	100	22	100	50	100

4.3 Crash Characteristics and Vehicle Information

Table 4.8 shows the frequency of cases involved in struck-side collisions by the primary collision partner types for the vehicles in which they were travelling. Cases were most commonly involved in collisions with car and car-based utilities, making up 40% of all struck side collisions. Stationary objects were the collision partners for 40% of cases involved in struck-side collisions, with trees accounting for 26% of cases, while signpost, poles and lamps forming 12% of struck side impact collision partners.

Table 4.8 Number and percentage of struck-side impact cases by the Primary Collision partner of the vehicle in which they were travelling

Collision partner	Frequency	Percent
Car or car-based utility	20	40
4 by 4	2	4.0
Truck/bus/Semi	5	10
Signpost, pole or post	6	12
Tree	13	26
Wall	1	2.0
Other vehicle	2	4.0
Motorcycle	1	2.0
Total	50	100

Airbag fitment and deployment status by occupant position for struck side cases are presented in Table 4.9. Of the 34 drivers, 19 had a front airbag fitted (55.9%; 10 deployed) and four had a side airbag (12%; all deployed). Of the 12 front left passengers, one had a side airbag fitted and which deployed. No airbags were fitted for rear passengers. Notably, where fitted, all side impact airbags deployed.

Table 4.9 Airbag fitment and deployment by occupant position for struck-side impact cases

Position	Airbag status	Forward Airbag (front)		Side Airbag	
		Freq.	%	Freq.	%
Driver	Not fitted	15	44.1	30	88.2
	Fitted & deployed	9	26.5	4	11.8
	Fitted & not deployed	10	29.4	Nil	Nil
	Total	34	100	34	100
FLP	Not fitted	11	91.7	11	91.7
	Fitted & deployed	Nil	Nil	1	8.3
	Fitted & not deployed	1	8.3	Nil	Nil
	Total	12	100	12	100

The summary statistics for delta-V and EBS for struck side cases (where able to be calculated) are shown in Table 4.10. The delta-V was calculated in 58% of struck side cases. The mean delta-V was 31.5km/h (SD=9.8km/h), the median was 33.6km/h, and values found ranged from 6–47km/h. EBS was found for 84% of struck side impacts. The mean and median EBS were, respectively, 31.8 and 31.9km/h, and ranged from 6-km/h to 66-km/h. The cumulative delta-v distribution is shown in Figure 4.1 and the cumulative EBS distribution is shown in Figure 4.2 for struck side impact.

Table 4.10 Summary statistics of the delta-V & EBS for struck-side impact cases

Severity statistic	Delta-V	EBS
Mean	31.47	31.77
Median	33.60	31.90
Mode	25	25
Std. Deviation	9.75	11.41
Variance	95.02	130.30
Minimum	6	6
Maximum	47	66
25th Percentile	24.90	24.80
50th Percentile	33.60	31.90
75th Percentile	38.75	37.65
95th Percentile	45.50	49.46
Number of cases	29	42
Unable to calculate	21	8

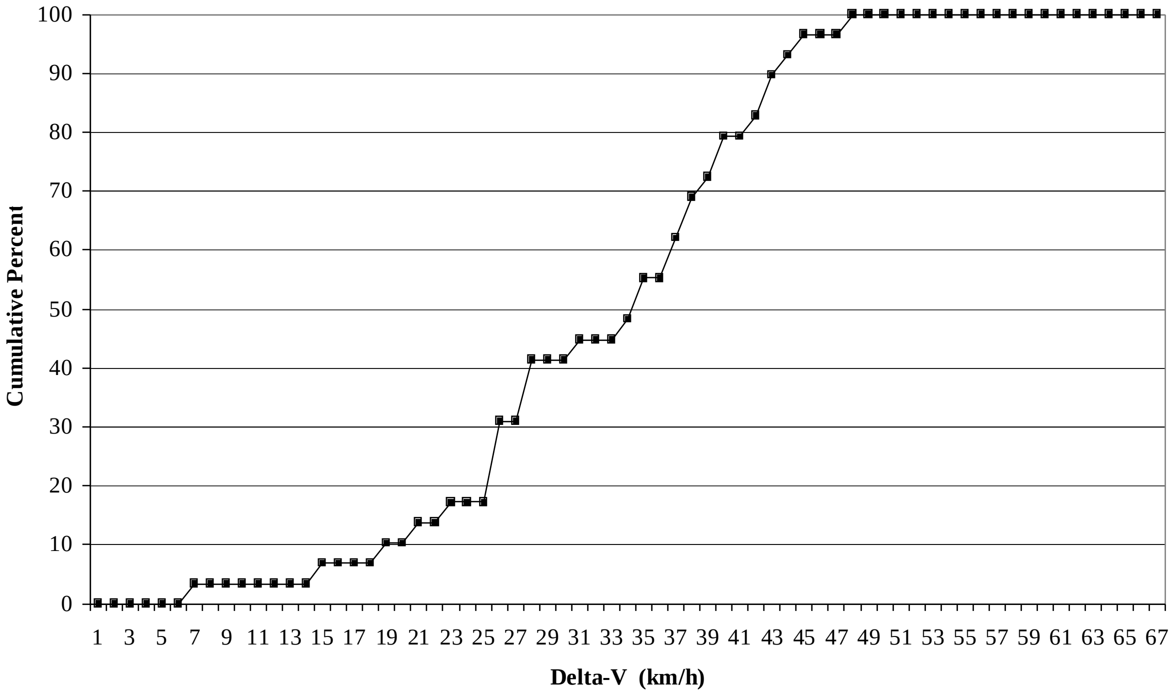

Figure 4.1 Delta-V distribution for struck-side impact occupants

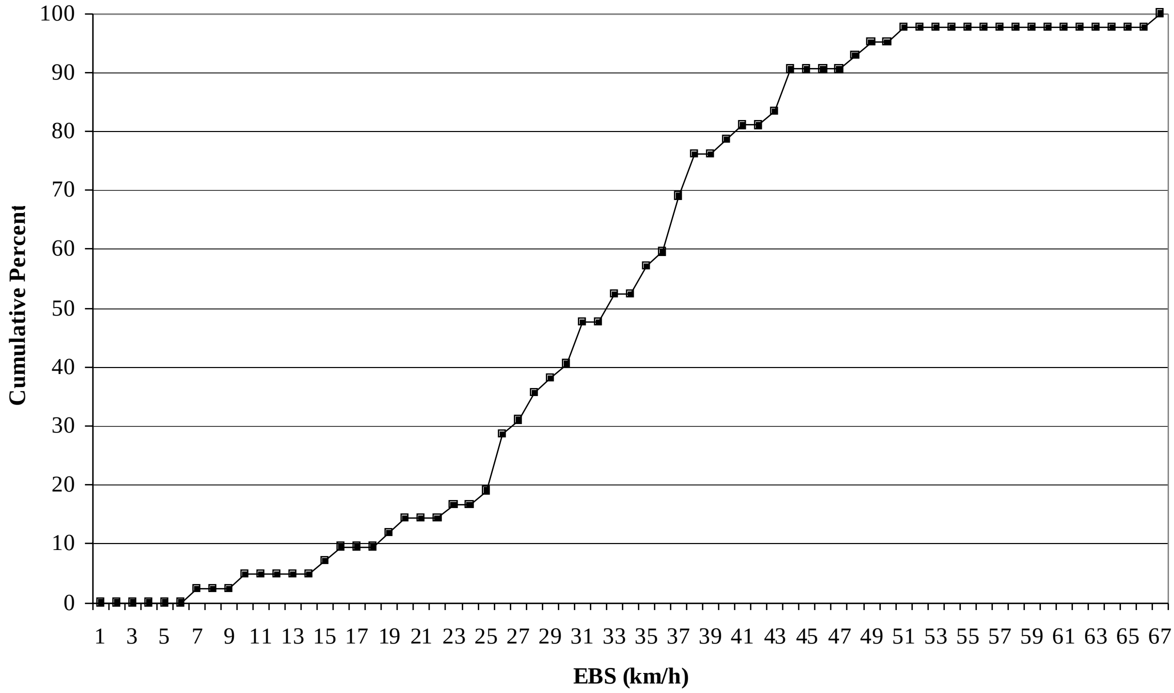

Figure 4.2 Cumulative EBS distribution for struck-side impact occupants

The number and percent of struck side case vehicles by market group is shown in Table 4.11. Small and large vehicles were approximately equally represented, consisting of 40% and 38%, respectively, of the struck side case vehicles. There were five luxury vehicles (10%), and three 4WD vehicles (6%), and a single vehicle of each the sports and commercial group.

Table 4.11 Number and percent of struck-side impact cases by the market group of the vehicles in which they were travelling

Market Group	Freq.	%
Small	20	40
Medium	1	2.0
Large	19	38
4WD	3	6.0
Luxury	5	10
Sports	1	2.0
Commercial (utility)	1	2.0
Total	50	100

The number and percent of struck side cases by the manufacturer of the vehicle in which they were travelling is presented in Table 4.12. Thirty percent of cases involved in of struck side case vehicles, followed by Toyota vehicles (16%) and Fords (14%). The remainder of vehicles consisted of small frequencies from a range of other manufacturers.

Table 4.12 Number and percent of struck-side impact cases by the manufacturer of vehicles in which they were travelling

Manufacturer	Freq.	%
Holden	15	30
Toyota	8	16
Ford	7	14
Nissan	4	8.0
Subaru	4	8.0
Mitsubishi	3	6.0
BMW	2	4.0
Hyundai	2	4.0
Mercedes	1	2.0
Honda	1	2.0
Land Rover	1	2.0
Mazda	1	2.0
Audi	1	2.0
Total	50	100

Table 4.13 presents the distribution of cases involved in struck side impacts by the year of manufacture of the vehicles in which they were travelling. It can be observed that the distribution according to the year of manufacturer was spread between 1990 and 2001. The majority (56%) of struck side cases were occupants of vehicles that were manufactured from 1997 to 2000.

Table 4.13 Number and percent of struck-side impact cases by the year of manufacture of vehicles in which they were travelling

Year of manufacture	Freq.	%
1990	1	2.0
1991	2	4.0
1992	4	8.0
1993	2	4.0
1994	5	10
1995	6	12
1996	1	2.0
1997	6	12
1998	6	12
1999	9	18
2000	7	14
2001	1	2.0
Total	50	100

The distribution of cases involved in struck side impacts by the age of the vehicles in which they were travelling is displayed in Table 4.14. The majority (58%) of struck side cases were travelling in vehicles that were less than 4 years old at the time of the crash. Only three (6%) cases were occupants of vehicles were less than one year old.

Table 4.14 Number and percent of struck-side impact cases by the age of the vehicles in which they were travelling at the time of the crash

Case vehicle age (years)	Freq.	%
Less than 1 year	3	6.0
1	7	14
2	9	18
3	5	10
4	5	10
5	3	6.0
6	4	8.0
7	3	6.0
8	6	12
9	4	8.0
10	1	2.0
Total	50	100

4.4 Injury Outcomes

Table 4.15 shows the hospital of admission for the cases. Over half of the participants (52%) were admitted to the Alfred Hospital, 16% to Dandenong Hospital, 10% to the Royal Melbourne Hospital and 10% to Royal Melbourne Hospital.

Table 4.15. Hospital of admission for struck-side impact cases

Hospital of admission	Freq.	%
Alfred, VIC	26	52
Dandenong, VIC	8	16
Monash MC, VIC	4	8.0
Frankston, VIC	1	2.0
Royal Melbourne, VIC	5	10
Royal Children's, VIC	2	4.0
Western, VIC	1	2.0
Liverpool, NSW	1	2.0
Fatally injured (not admitted)	1	2.0
Total	50	100

The ISS profile for struck side cases is presented in Table 4.16. The mean ISS for this sample was 18.8 and the median was 14. The mean and median ISS for males, 23.2 and 21.5 respectively, was significantly higher than females, 13.2 and 10. That males experienced more severe injuries is also reflected in the finding of the 75th percentile being an ISS of 34 compared to 17 for females. The cumulative ISS distribution for male and female struck side cases is shown in Figure 4.3.

Table 4.16. ISS profile for male and female struck-side impact cases

ISS profile	Male	Female	Total
Mean	23.21	13.23	18.82
Median	21.50	10.00	14.00
Mode	5	10	10
Std. Deviation	18.43	8.06	15.49
Minimum	1	4	1
Maximum	75	41	75
25th Percentiles	6.25	9.00	9.00
50th Percentile	21.50	10.00	14.00
75th Percentile	34.00	17.00	26.25
Number of cases	28	22	50

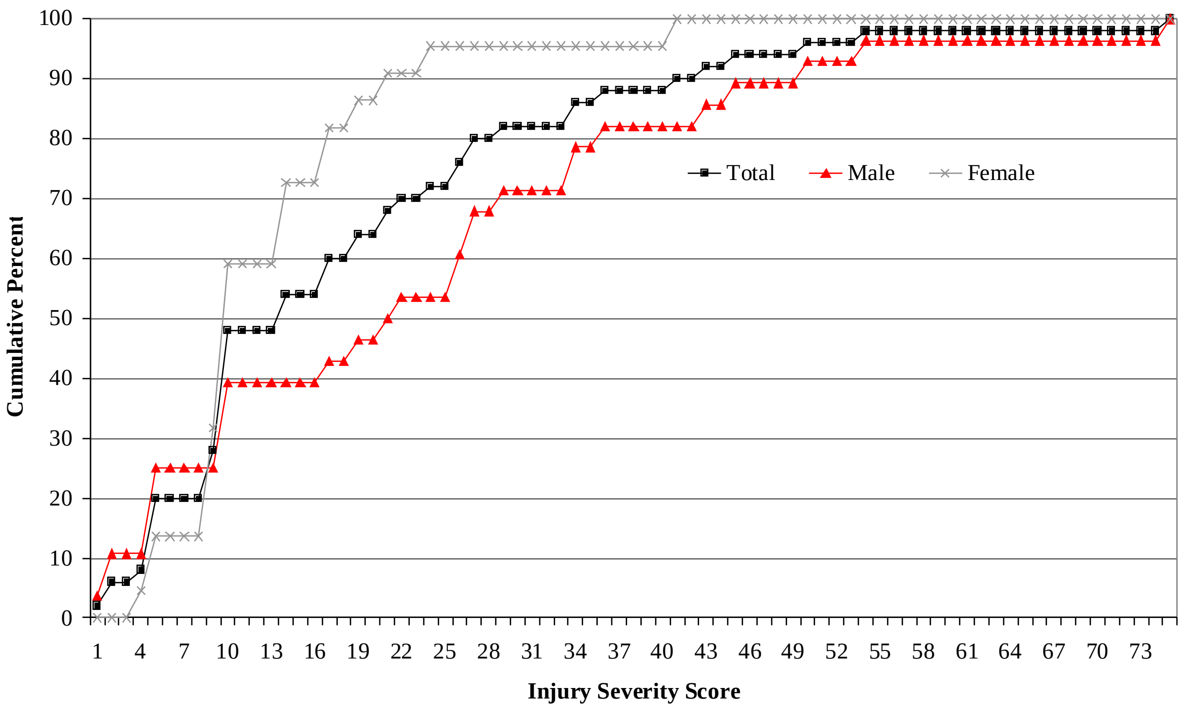

Figure 4.3 Cumulative ISS distribution for males and female struck-side impact occupants

Table 4.17 shows injury severity by ISS category for males, females and all occupants for the struck side cases. The highest male ISS was a single 75 (fatality), the next highest male category being 45-54 with 3 cases (10.7%) and the highest female ISS category being 25-34 with 5 cases, 9.1% of female cases. The ISS category with most cases was the 10-14 range with 13 cases (26%); and there were also 10 cases (20%) with ISS of 1 to 5.

Table 4.17 ISS category by gender for struck-side impact cases

ISS	Male		Female		Total	
	Freq.	%	Freq.	%	Freq.	%
1 - 5	7	25.0	3	13.6	10	20
6 - 9	Nil	Nil	4	18.2	4	8.0
10 - 14	4	14.3	9	40.9	13	26
15 - 24	4	14.3	5	22.7	9	18
25 - 34	7	25.0	Nil	Nil	7	14
35 - 44	2	7.1	1	4.5	3	6.0
45 - 54	3	10.7	Nil	Nil	3	6.0
55-64	Nil	Nil	Nil	Nil	Nil	Nil
65-74	Nil	Nil	Nil	Nil	Nil	Nil
75	1	3.6	Nil	Nil	1	2.0
Total	28	100	22	100	50	100

The Maximum Abbreviated Injury Scale (MAIS) for male and female occupants in struck side impact cases is presented in Table 4.18. Two-thirds of the sample sustained an MAIS score of three (serious) or less. The most common maximum injury severity sustained was a serious injury (38%). The most common maximum injury severity for males was a score of three (28.6%), followed by four (25%). Half of the female cases sustained a serious (MAIS3) maximum injury severity score, 31.8% sustained moderate (MAIS2) score and 18.2% sustained a severe (MAIS4) score. Approximately half of the male cases sustained an MAIS4+ score (severe or greater) compared with 18.2% of females.

Table 4.18 Maximum Abbreviated Injury Scale severity for male and female for struck-side impact cases

MAIS	Male		Female		Total	
	Freq.	%	Freq.	%	Freq.	%
Minor (1)	3	10.7	Nil	Nil	3	6.0
Moderate (2)	4	14.3	7	31.8	11	22.0
Serious (3)	8	28.6	11	50.0	19	38.0
Severe (4)	7	25.0	4	18.2	11	22.0
Critical (5)	5	17.9	Nil	Nil	5	10.0
Maximum (6)	1	3.6	Nil	Nil	1	2.0
Total	28	100	22	100	50	100

Table 4.19 presents the number and percent of occupants in struck side impact cases with AIS 1+ and AIS 3+ injuries by body region. The most common AIS1+ injuries were sustained to the chest (72%), lower extremity (66%), upper extremity (64%) and the head (48%). For AIS 3+ injuries, the chest (50%), lower extremity (24%) and the head (24%) were the most frequently injured body regions.

Table 4.19 Number and percent of for struck-side impact cases with AIS 1 + and AIS 3+ injuries by AIS body region

AIS Body region	ALL AIS		AIS 3+	
	Number of Cases	% of all struck-side cases	Number of Cases	% of all struck-side cases
Head	24	48	12	24
Face	23	46	1	2
Neck	3	6	Nil	Nil
Chest	36	72	25	50
Abdomen / Pelvis	22	44	8	16
Spine	8	16	3	6
Upper Extremity	32	64	1	2
Lower Extremity	33	66	12	24
External	2	4	Nil	Nil

The injury contact sources associated with AIS 1 + and AIS 3+ injuries for struck side cases are presented in Table 4.20. For AIS 1+ injuries, the door panel (66%), B-pillar (30%), the instrument panel (24%) and the floor (20%) were the most common attributed sources of injury. Slightly less than one-third of AIS 1+ injuries could not be attributed a definitive contact point. For AIS 3+ injuries the source was most commonly the door panel (48%), the B-pillar (16%), and the seat belt (8%). One (2%) of the AIS 3+ injury sources was unknown.

Table 4.20 Number of for struck-side impact cases with AIS 1+ and AIS 3+ injuries by contact source

Contact Source	All AIS		AIS 3+	
	Number persons	Percentage	Number persons	Percentage
Windscreen / Header rail	3	6	1	2
Steering assembly	6	12	3	6
Instrument panel	12	24	3	6
Console	1	2	Nil	Nil
Window + frame	9	18	Nil	Nil
A-pillar	1	2	1	2
B-pillar	15	30	8	16
Roof side rail	1	2	Nil	Nil
Roof surface	2	4	1	2
Door panel	33	66	24	48
Floor & toe pan	10	20	1	2
Rear screen	1	2	Nil	Nil
Seat Belt	9	18	4	8
Airbag (+cover + gases)	7	14	2	4
Other occupant	1	2	1	2
Other + Unknown	16	32	1	2
Deceleration / Inertial forces	5	10	Nil	Nil
Exterior of other vehicle	1	2	1	2
Other vehicle or exterior object	4	8	3	6
Fire in vehicle	2	4	Nil	Nil

5 SIDE IMPACT: NON-STRUCK SIDE / FAR SIDE CASES

5.1 Basic Crash and Case Information

A total of 15 non-struck side cases have been investigated, of which two-thirds (n=10) were drivers and one third were front left passengers (n=5), as shown in Table 5.1. These 15 cases were occupants of 11 different vehicles.

Table 5.1 Number and percent of cases involved in non-struck side impact crashes by occupant position

Position	Freq.	%
Driver	10	66.7
FLP	5	33.3
Total	15	100

Table 5.2 shows seat belt use by occupant position. The proportion of occupants that were belted was the same for drivers and front left seat passengers. 80% of occupants used or claimed use of a seat belt and the remaining 20% were unbelted or there was no physical evidence to support belt use.

Table 5.2 Occupant position by belt use for non-struck side impact cases

Position	Unbelted		Belted used or claimed		Total	
	Freq.	%	Freq.	%	Freq.	%
Driver	2	20	8	80	10	100
Front left passenger	1	20	4	80	5	100
Total	3	20	12	80	15	100

5.2 Demographic Characteristics of Non-Struck Side Cases

The distribution of male and female cases by age group is shown in Table 5.3. Of the non-struck side cases, 8 (53.3%) were female and 7 (46.7%) were male. Persons aged 15–24 years were the most numerous, making up over half the cases (53.3%), of which three quarters were male. There were two cases in the age groups 64 –74 and 75+ years, and a single case in each of the 25-34, 35-44 and 45-54 year old groups.

Table 5.3 Number and percent of male and female non-struck side cases by age group

Age (years)	Male		Female		Total	
	Freq.	%	Freq.	%	Freq.	%
1–5	Nil	Nil	Nil	Nil	Nil	Nil
6–9	Nil	Nil	Nil	Nil	Nil	Nil
10–14	Nil	Nil	Nil	Nil	Nil	Nil
15–24	6	40	2	13.3	8	53.3
25–34	Nil	Nil	1	6.7	1	6.7
35–44	Nil	Nil	1	6.7	1	6.7
45–54	Nil	Nil	1	6.7	1	6.7
55–64	Nil	Nil	Nil	Nil	Nil	Nil
64–74	1	6.7	1	6.7	2	13.3
75+	Nil	Nil	2	13.3	2	13.3
Total	7	46.7	8	53.3	15	100

Statistics of the height of male and female non-struck side cases are presented in Table 5.4. The mean height for males was 175.2cm (SD=9.8cm) with the median male height being 179cm. The mean female height was 162.4cm (SD=10.3cm) and the median female height was 162.5cm.

Table 5.4 Summary statistics of the height of male and female non-struck side cases

Height (cm)	Male	Female
Mean	175.17	162.38
Median	179.00	162.50
Mode	160	165
Std. Deviation	10.23	7.96
Minimum	160	152
Maximum	185	178
25^{th} Percentile	163.75	156.00
50^{th} Percentile	179.00	162.50
75^{th} Percentile	183.50	165.00
Number of cases	6	8
Unknown	1	0

Table 5.5 presents the height distribution by 5cm categories. The majority of males (66%) were 175cm and taller. The height of the majority of females ranged from 155–169cm.

Table 5.5 Height distribution for male and female non-struck side impact cases

Height (cm)	Male		Female		Total	
	Freq.	%	Freq.	%	Freq.	%
<=149	Nil	Nil	Nil	Nil	Nil	Nil
150–154	Nil	Nil	1	12.5	1	7.1
155–159	Nil	Nil	2	25.0	2	14.3
160–164	1	16.7	1	12.5	2	14.3
165–169	1	16.7	3	37.5	4	28.6
170–174	Nil	Nil	Nil	Nil	Nil	Nil
175–179	1	16.7	1	12.5	2	14.3
180–184	2	33.3	Nil	Nil	2	14.3
185 +	1	16.7	Nil	Nil	1	7.1
Total	6	100	8	100	14	100

Table 5.6 shows summary weight statistics for male and female non-struck side cases. The mean weight for males was 71.2kg (SD=12.8kg) with the median male weight being 70kg. The mean female weight was 65.6kg (SD=8kg) and the median female weight was 64kg.

Table 5.6 Summary statistics of the weight of male and female non-struck side cases

Weight (kg)	Male	Female
Mean	71.17	65.63
Median	70.00	64.00
Mode*	60	63
Std. Deviation	12.81	8.00
Minimum	60	55
Maximum	95	82
25th Percentile	60.00	60.75
50th Percentile	70.00	64.00
75th Percentile	77.75	69.25
Number of cases	6	8
Unknown	1	0

* Multiple modes; smallest value shown

The weight distribution of male and female cases is presented in Table 5.7. Approximately 83% of males were in the weight range from 46–75kg, the majority (69%) of females were 46–75kg. Approximately three-fifths of females were in the weight range 61-75kg.

Table 5.7 Weight distribution for male and female non-struck side cases

Weight (kg)	Male		Female		Total	
	Freq.	Col %	Freq.	Col %	Freq.	Col %
46 - 60	2	33.3	2	25.0	4	28.6
61 - 75	3	50.0	5	62.5	8	57.1
76 - 85	Nil	Nil	1	12.5	1	7.1
86 - 100	1	16.7	Nil	Nil	1	7.1
Total	6	100	8	100	14	100

5.3 Crash Characteristics and Vehicle Information

Table 5.8 shows the frequency of cases involved in non-struck side collisions by the primary collision partner types for the vehicles in which they were travelling. Recall that when the vehicle was involved in multiple impacts with different objects, the primary collision partner was the one corresponding to the most severe impact. Non-struck side cases were most commonly occupants in cars or car-based utilities, making up slightly over half (53.3%) of all non-struck side cases. Stationary objects were the collision partners for just under half (46.7%) of cases involved in non-struck side collisions. Trees accounted for 26.7% and signpost, poles and lamps 13.3% of all the non-struck side cases.

Table 5.8 Number and percent of non-struck side impact cases by the primary collision partners for the vehicles in which they were travelling

Collision Partner	Freq.	%
Car or car-based utility	8	53.3
Signpost, pole or post	2	13.3
Tree	4	26.7
Wall	1	6.7
Total	15	100

Airbag fitment and deployment status by occupant position is presented in Table 5.9. Of the 10 drivers, three had a front airbag fitted (30%), two of which deployed, representing two thirds of possible frontal airbag deployments. No drivers in the sample had a side airbag. Of the five front left passengers, three had frontal airbags available, of which two deployed. Two out of five front left passenger cases had a side airbag available (40%), with none deploying.

Table 5.9 Airbag fitment and deployment by occupant position

Position	Airbag status	Forward Airbag (front)		Side Airbag	
		Freq.	%	Freq.	%
Driver	Not fitted	7	70	10	100
	Fitted & deployed	2	20	Nil	Nil
	Fitted & not deployed	1	10	Nil	Nil
	Total	10	100	Nil	Nil
FLP	Not fitted	2	40	3	60
	Fitted & deployed	2	40	Nil	Nil
	Fitted & not deployed	1	20	2	40
	Total	5	100	5	100

The summary statistics for Delta-V and EBS (where able to be calculated) are shown in Table 5.10. The Delta-V was calculated for 60% of non-struck side cases (9 out of 15). The calculated Delta-V mean was 45.2km/h (SD=34.5km/h), the median was 34.9km/h, and it ranged from 6km/h to 125km/h. EBS was calculated for 93% of possible cases (14 of 15).

Table 5.10 Summary stats of the delta-V & EBS for non-struck side cases

Severity statistic	Delta-V	EBS
Mean	45.21	39.57
Median	34.90	31.15
Mode*	6	6
Std. Deviation	34.53	30.78
Minimum	6	6
Maximum	125	125
25th Percentile	25.05	24.05
50th Percentile	34.90	31.15
75th Percentile	60.90	43.55
Number of cases	9	14
Unable to calculate	6	1

* Multiple modes exist. The smallest value is shown.

The distribution of non-struck side cases by the market group of the vehicles in which they were travelling is shown in Table 5.11. Non-struck side cases that were occupants of small cars represented 46.7% of the non-struck side sample, while occupants of large cars accounted for 33.3% of the sample. There were two cases of non-struck side cases that were occupants of medium size and one case that was an occupant of a 4WD.

Table 5.11 Number and percent of cases involved in non-struck side collisions by the market group of the vehicles in which they were travelling

Market Group	Freq.	%
Small	7	46.7
Medium	2	13.3
Large	5	33.3
4WD	1	6.7
Total	15	100

The number and percent of non-struck side cases by the manufacturer of the vehicle in which they were travelling is presented in Table 5.12. One third of non-struck side cases were occupants of Holden vehicles, the remainder of cases were occupants of vehicles that consisted of small frequencies from a range of other manufacturers.

Table 5.12 Number and percent of non-struck side cases by the manufacturer of the vehicle in which they were travelling

Manufacturer	Freq.	%
Ford	1	6.7
Holden	5	33.3
Toyota	1	6.7
Mercedes	1	6.7
Nissan	2	13.3
Subaru	2	13.3
Hyundai	2	13.3
Mazda	1	6.7
Total	15	100

Table 5.13 presents the distribution of non-struck side cases by the year of manufacture of the vehicles in which they were travelling. Two thirds of the cases were occupants of vehicles that were manufactured in 1997 or later.

Table 5.13 Number and Percent of non-struck cases by the year of manufacture of the vehicle in which they were travelling

Year of manufacture	Freq.	%
1991	1	6.7
1992	Nil	Nil
1993	1	6.7
1994	2	13.3
1995	1	6.7
1996	Nil	Nil
1997	2	13.3
1998	3	20.0
1999	2	13.3
2000	3	20.0
Total	15	100

The distribution of non-struck side cases by the age at the time of the crash of the vehicles in which they were travelling is displayed in Table 5.14. The majority of cases were occupants of vehicles that were aged three years or less.

Table 5.14 Number and Percent of non-struck side cases by the age at the time of the crash of the vehicle in which they were travelling

Case vehicle age (years)	Freq.	%
Less than 1 year	2	13.3
1	2	13.3
2	1	6.7
3	4	26.7
4	1	6.7
5	Nil	Nil
6	1	6.7
7	2	13.3
8	1	6.7
9	1	6.7
Total	15	100

5.4 Non-Struck Side Case Injury Outcomes

Table 5.15 shows the hospital of admission for the cases. 40% of participants (9 of 15) had been admitted to the Alfred Hospital and 26.7% had been admitted to Dandenong Hospital. There were 2 admissions to the Monash Medical Centre and one admission to each of the Royal Melbourne, Royal Children's and St Vincent's hospitals.

Table 5.15 Hospital of admission for non-struck side cases

Hospital of admission	Freq.	%
Alfred, VIC	6	40
Dandenong, VIC	4	26.7
Monash MC, VIC	2	13.3
Royal Melbourne, VIC	1	6.7
Royal Children's, VIC	1	6.7
Geelong, VIC	1	6.7
Total	15	100

The ISS profile for the non-struck side cases is presented Table 5.16. The mean ISS for this sample was 13 and the median was 3. The mean and median ISS for males, 15.1 and 11 respectively, was higher than females, 11 and 2.5. That males experienced more severe injuries is also reflected in the finding of the 75th percentile being an ISS of 33 compared to females of 18.75.

Table 5.16 ISS profile for male and female non-struck side cases

ISS profile	Male	Female	Total
Mean	15.14	11.13	13.00
Median	11.00	2.50	3.00
Mode	1	1	1
Std. Deviation	16.23	17.28	16.33
Minimum	1	1	1
Maximum	41	50	50
25th Percentiles	1.00	1.00	1.00
50th Percentile	11.00	2.50	3.00
75th Percentile	33.00	18.75	22.00
Number of cases	7	8	15

Table 5.17 shows injury severity by ISS category for males, females and all occupants for the non-struck side cases. Overall, 66.7% of cases had an ISS of less than 15. With respect to gender, 57.2% of males had an ISS of less than 15, while 75% of females had an ISS of less than 15. There were a greater proportion of male cases in the higher ISS categories than females, although the participant with highest ISS was female.

Table 5.17 ISS category by gender for non-struck side cases

ISS	Male		Female		Total	
	Freq.	%	Freq.	%	Freq.	%
1–5	3	42.9	5	62.5	8	53.3
6–9	Nil	Nil	1	12.5	1	6.7
10–14	1	14.3	Nil	Nil	1	6.7
15–24	1	14.3	1	12.5	2	13.3
25–34	1	14.3	Nil	Nil	1	6.7
35–44	1	14.3	Nil	Nil	1	6.7
45–54	Nil	Nil	1	12.5	1	6.7
55-64	Nil	Nil	Nil	Nil	Nil	Nil
65-74	Nil	Nil	Nil	Nil	Nil	Nil
75	Nil	Nil	Nil	Nil	Nil	Nil
Total	7	100	8	100	15	100

The Maximum Abbreviated Injury Scale (MAIS) for male and female occupants in non-struck side cases is presented in Table 5.18. Forty percent of the sample sustained MAIS3 (serious) scores or greater. While 42.9% of males sustained an MAIS4 (severe) score, and one female (12.5%) sustained an MAIS5 (critical) score.

Table 5.18 Maximum Abbreviated Injury Scale severity for male and female non-struck side impact cases

MAIS	Male		Female		Total	
	Freq.	%	Freq.	%	Freq.	%
Minor (1)	3	42.9	5	62.5	8	53.5
Moderate (2)	Nil	Nil	1	12.5	1	6.7
Serious (3)	1	14.3	1	12.5	2	13.3
Severe (4)	3	42.9	Nil	Nil	3	20.0

Critical (5)	Nil	Nil	1	12.5	1	6.7
Maximum (6)	Nil	Nil	Nil	Nil	Nil	Nil
Total	7	100	8	100	15	100

Table 5.19 presents the number and percent of occupants in non-struck side cases with AIS 1+ and AIS 3+ injuries by body region. The most commonly injured regions were the lower extremities (53.3% of cases), chest (53.3% of cases) and head (46.7% of cases). The head and chest were the body regions that sustained the greatest proportion of AIS 3+ injuries by cases, each at 26.7%.

Table 5.19 Number and percent of non-struck side impact cases with AIS 1+ and AIS 3+ injuries by body region

AIS Body region	ALL AIS		AIS 3+	
	Number of Cases	% of all non-struck side cases	Number of Cases	% of all non-struck side cases
Head	7	46.7	4	26.7
Face	6	40	Nil	Nil
Neck	2	13.3	1	6.7
Chest	8	53.3	4	26.7
Abdomen / Pelvis	4	26.7	2	13.3
Spine	5	33.3	1	6.7
Upper Extremity	5	33.3	1	6.7
Lower Extremity	8	53.3	1	6.7
External	Nil	Nil	Nil	Nil

The injury contact sources associated with AIS 1 + and AIS 3+ injuries for non-struck side crashes are presented in Table 5.20. For AIS 1+ injuries the instrument panel (40%), the seat belt (33.3%), the airbag (33.3%) and deceleration forces (26.7%) were the most prevalent injury sources. The influence of the seatbelt is likely to have been mostly the lap portion of the three-point belt, as the sash is virtually ineffective in non-struck side crashes. Four-fifths of AIS 1+ injury sources were unknown. For AIS 3+ injuries the source was most commonly the instrument panel (13.3%) and the B-pillar (13.3%).

Table 5.20 Number of non-struck side impact cases sustaining AIS 1+ and AIS 3+ injuries by contact source

Contact Source	All AIS (n=15)		AIS 3+ (n=15)	
	Number persons	Percentage	Number persons	Percentage
Windscreen / Header rail	1	6.7	1	6.7
Steering assembly	4	26.7	1	6.7
Instrument panel	6	40	2	13.3
Console	2	13.3	Nil	Nil
Window + frame	1	6.7	1	6.7
B-pillar	3	20	2	13.3
Door panel	1	6.7	1	6.7
Seats & head rest	2	13.3	1	6.7
Seat Belt	5	33.3	Nil	Nil
Airbag +cover + gases	5	33.3	Nil	Nil
Other occupant	1	6.7	Nil	Nil
Other + Unknown	6	40	Nil	Nil
Deceleration / Inertial forces	4	26.7	1	6.7

6 REAR IMPACT CASES

6.1 Basic Crash and Case Information

Of the 180 cases investigated thus far, there were a total of eight rear impacts. All these rear impact cases were occupants of eight different vehicles. When a vehicle in which the case individual was an occupant was involved in multiple impacts, the impact was classified as rear when the severity of the rear impact was greater than all the other impacts and no rollover occurred. The severity of each impact is determined by examining the CDC code each impact. Of the occupants in rear impact cases six were drivers (75%), one was a front left seat passenger and one was a rear left passenger. Table 6.1 shows the number of rear impact cases by occupant position.

Table 6.1 Number and percent of rear impact cases by occupant position

Position	Freq.	%
Driver	6	75.0
FLP	1	12.5
Front Centre	Nil	Nil
Rear Left	1	12.5
Rear Centre	Nil	Nil
Rear right	Nil	Nil
Total	8	100

Seat belt use is shown in Table 6.2. Only one occupant, a driver, was unbelted among the rear impact cases. The remaining five drivers, the front left passenger and rear left passenger were all belted or claimed belt use. Table 6.2 shows the occupant position by belt use.

Table 6.2 Occupant position by belt use for rear impact cases

Position	Unbelted		Belted used or claimed		Total	
	Freq.	%	Freq.	%	Freq.	%
Driver	1	16.7	5	83.3	6	100
Front left	Nil	Nil	1	100	1	100
Front Centre	Nil	Nil	Nil	Nil	Nil	Nil
Rear Left	Nil	Nil	1	100	1	100
Rear Centre	Nil	Nil	Nil	Nil	Nil	Nil
Rear right	Nil	Nil	Nil	Nil	Nil	Nil
Total	1	12.5	7	87.5	8	100

6.2 Demographic Characteristics of Rear Impact Cases

The distribution of age and sex of the occupants in rear impact cases is shown in Table 6.3. It can be seen that five of the eight cases were female (62.5%) and three were male (37.5%). There was a reasonably even spread of ages in the sample, with two cases in each of the 15-24, 35-44 and 55-64 age groups. The 10-14 year old range was the youngest group represented in the data, and the 55-64 year old range was the oldest group represented.

Table 6.3 Number and percent of male and female rear impact cases by age group

Age (years)	Male		Female		Total	
	Freq.	%	Freq.	%	Freq.	%
1–5	Nil	Nil	Nil	Nil	Nil	Nil
6–9	Nil	Nil	Nil	Nil	Nil	Nil
10–14	Nil	Nil	1	12.5	1	12.5
15–24	Nil	Nil	2	25.0	2	25.0
25–34	1	12.5	Nil	Nil	1	12.5
35–44	1	12.5	1	12.5	2	25.0
45–54	Nil	Nil	Nil	Nil	Nil	Nil
55–64	1	12.5	1	12.5	2	25.0
64–74	Nil	Nil	Nil	Nil	Nil	Nil
75+	Nil	Nil	Nil	Nil	Nil	Nil
Total	3	37.5	5	62.5	8	100

Table 6.5 shows the summary statistics of the height of male and female occupants in rear impact cases. The mean male height was 182.7cm (SD=4cm) and median was 185cm. The mean female height was 159.2cm (SD=10.9) and the median was 159cm.

Table 6.4 Summary statistics of the height of male and female rear impact cases

Height (cm)	Male	Female
Mean	182.67	159.20
Median	185.00	159.00
Mode*	185	146
Std. Deviation	4.04	10.94
Minimum	178	119.70
Maximum	185	146
25th Percentile	178.00	174
50th Percentile	185.00	149.00
75th Percentile	185.00	159.00
Number of cases	3	5
Unknown	0	0

* Multiple modes exist. The smallest value is shown

Table 6.5 presents the height distributions by 5cm categories for occupants in the rear impact cases. All the males were 175cm or taller, and 2 of the 3 males were 185cm or taller. There was an even spread of female heights in the sample, ranging up to the 170- 174cm category.

Table 6.5 Height distribution for males and female rear impact cases

Height (cm)	Male		Female		Total	
	Freq.	%	Freq.	%	Freq.	%
<=149	Nil	Nil	1	20.0	1	12.5
150–154	Nil	Nil	1	20.0	1	12.5
155–159	Nil	Nil	1	20.0	1	12.5
160–164	Nil	Nil	Nil	Nil	Nil	Nil
165–169	Nil	Nil	1	20.0	1	12.5
170–174	Nil	Nil	1	20.0	1	12.5
175–179	1	33.3	Nil	Nil	1	12.5
180–184	Nil	Nil	Nil	Nil	Nil	Nil
185 +	2	66.7	Nil	Nil	2	25.0
Total	3	100	5	100	8	100

Table 6.6 shows summary weight statistics for male and female occupants in rear impact cases. The mean weight for males was 91.3kg (SD=4.6kg) with the median male weight being 94kg. The mean female weight was 49.8kg (SD=17.8) and the median female weight was 52kg.

Table 6.6 Summary statistics of the weight of male and female rear impact cases

Weight (kg)	Male	Female
Mean	91.33	49.80
Median	94.00	52.00
Mode*	94	25
Std. Deviation	4.62	17.84
Minimum	86	318.20
Maximum	94	25
25th Percentile	86.00	70
50th Percentile	94.00	32.50
75th Percentile	94.00	52.00
Number of cases	3	5
Missing Cases	0	0

* Multiple modes; smallest value shown

The weight distribution of male and female rear impact cases is presented in Table 6.7. All males were in the weight range 86-100 kg. All females weighed less than 76kg, with two of the five female occupants in the 61-75kg weight range.

Table 6.7 Weight distribution for male and female rear impact cases

Weight (kg)	Male		Female		Total	
	Freq.	Col %	Freq.	Col %	Freq.	Col %
16 - 30	Nil	Nil	1	20	1	12.5
31 - 45	Nil	Nil	1	20	1	12.5
46 - 60	Nil	Nil	1	20	1	12.5
61 - 75	Nil	Nil	2	40	2	25
76 - 85	Nil	Nil	Nil	Nil	Nil	Nil
86 - 100	3	100	Nil	Nil	3	37.5
Total	3	100	5	100	8	100

6.3 Crash Characteristics and Vehicle Information

Table 6.8 shows the frequency of primary collision partner types in the rear impact cases. Cars or car-based utilities (37.5%) and trucks or buses (37.5%) were the most common collision partners. There was one rear impact where the partner vehicle was a 4WD and one where the rear impact was with a signpost, pole or post.

Table 6.8 Primary collision partners associated with rear impact cases

Collision Partner	Freq.	%
Car or car-based utility	3	37.5
4 by 4	1	12.5
Truck/bus/Semi	3	37.5
Signpost, pole or post	1	12.5
Total	8	100

Airbag fitment and deployment status by occupant position for rear impact cases is presented in Table 6.9. Of the 6 drivers, two had a front airbag fitted (33.3%), of which one deployed. It is unusual for an airbag to deploy in a rear impact. However in this case the airbag deployed because when the vehicle I which the case individual was driving was struck from behind, it was pushed into a car in front of it, which caused the airbag to activate. There were no other front or side air bags present in this sample.

Table 6.9 Airbag fitment and deployment by occupant position for rear impact cases

Position	Airbag status	Forward Airbag (front)		Side Airbag	
		Freq.	%	Freq.	%
Driver	Not fitted	4	66.7	6	100
	Fitted & deployed	1	16.7	Nil	Nil
	Fitted & not deployed	1	16.7	Nil	Nil
	Total	6	100	6	100
FLP	Not fitted	1	100	1	100
	Fitted & deployed	Nil	Nil	Nil	Nil
	Fitted & not deployed	Nil	Nil	Nil	Nil
	Total	1	100	1	100

The summary statistics for delta-V and EBS (where calculated) are shown in Table 6.10. The delta-V was known in 3 out of 8 (37.5%) rear impact cases. The mean delta-V was 41.8km/h (SD=12.4km/h), the median was 46.4km/h, and values found ranged from 28–51km/h. EBS was found for all rear impact cases. The mean and median EBS, 57.4 km/h and 56.4km/h, were significantly different to those of delta-V. This was probably due to differences in the samples, as delta V was not be calculated for all cases. The maximum EBS was 112km/h and the minimum was 17km/h.

Table 6.10 Summary stats of delta-V & EBS for rear impact cases

Severity statistic	Delta-V	EBS
Mean	41.83	57.43
Median	46.40	56.40
Mode&	28	17
Std. Deviation	12.40	27.34
Variance	153.70	747.60
Minimum	28	17
Maximum	51	112
25th Percentile	27.80	40.20
50th Percentile	46.40	56.40
75th Percentile	51.30	65.57
Number of cases	3	8
Unknown	5	0

The number and percent of rear impact case vehicles by market group is shown in Table 6.11. The only represented groups were the small and large car groups. Five of the eight (62.5%) case vehicles were classified in the large market group with the remaining three case vehicles (37.5%) being classified as small.

Table 6.11 Number and percent of rear impact case vehicles by market group

Market Group	Freq.	%
Small	3	37.5
Large	5	62.5
Total	8	100

The number and percent of rear impact cases by vehicle manufacturer is presented in Table 6.12. Of the eight cases, three were occupants of Ford vehicles; two were occupants of a Mitsubishi vehicle, while there was a single case in a Holden, Toyota, and Nissan vehicle.

Table 6.12 Number and percent of rear impact case vehicles by manufacturer

Manufacturer	Freq.	%
Ford	3	37.5
Holden	1	12.5
Toyota	1	12.5
Mitsubishi	2	25.0
Nissan	1	12.5
Total	8	100.0

Table 6.13 presents the year of manufacture for rear impact case vehicles. It can be observed that the year of manufacturer of the case vehicles was spread from 1991 to 2001. There were two case vehicles (25%) manufactured in 1995. The oldest manufacture date was 1991 and the latest was 2001.

Table 6.13 Year of manufacture of rear impact case vehicles

Year of manufacture	Freq.	%
1991	1	12.5
1992	Nil	Nil
1993	1	12.5
1994	Nil	Nil
1995	2	25.0
1996	1	12.5
1997	Nil	Nil
1998	1	12.5
1999	Nil	Nil
2000	1	12.5
2001	1	12.5
Total	8	100

The ages of the rear impact case vehicles at the time of the crash are displayed in Table 6.14. There were 2 out of 8 cases (25%) where the case vehicle was under a year old, no case vehicles between one and three years of age and approximately one case per year of age in the 3 to 9 year age.

Table 6.14 Rear impact case vehicle age at the time of the crash

Case vehicle age (years)	Freq.	%
Less than 1 year	2	25.0
1	Nil	Nil
2	Nil	Nil
3	1	12.5
4	1	12.5
5	1	12.5
6	1	12.5
7	Nil	Nil
8	1	12.5
9	1	12.5
Total	8	100

6.4 Rear Impact Injury Case Outcomes

Table 6.15 shows the hospital of admission for the rear impact cases. Half of the participants (4 of 8) had been admitted to the Alfred Hospital and a quarter (2 of 8) had been admitted to each of the Monash Medical Centre and the Dandenong Hospital.

Table 6.15 Hospital of admission for rear impact cases

Hospital of Admission	Freq.	%
Alfred, VIC	4	50
Dandenong, VIC	2	25
Monash MC, VIC	2	25
Total	8	100

The ISS profile for rear impact cases is presented in Table 6.16. The mean ISS for this sample was 9.9 and the median was 10.5. The mean and median ISS for males, 11.7 and 14 respectively, was higher than for females at 8.8 and 10 respectively. That males experienced more severe injuries is also reflected in the finding of the 75th percentile being an ISS of 19 compared to 14 for females.

Table 6.16 ISS profile for male and female rear impact cases

ISS profile	Male	Female	Total
Mean	11.67	8.80	9.88
Median	14.00	10.00	10.50
Mode*	2	1	1
Std. Deviation	8.74	6.10	6.73
Minimum	2	1	1
Maximum	19	17	19
25th Percentiles	2.00	3.00	2.75
50th Percentile	14.00	10.00	10.50
75th Percentile	19.00	14.00	16.25
Number of cases	3	5	8

* Multiple modes exist. The smallest value is shown

Table 6.17 shows injury severity by ISS category for males, females and all occupants for the rear impact cases. All ISS were less than 24. Of the males, there was one case in each of the ISS ranges 1-5, 10-14 and 15-24. Of the females, there were two cases in each of the 1-5 and 10-14 ISS ranges, and one case in the 15-24 ISS range.

Table 6.17 ISS category by gender for rear impact cases

ISS	Male		Female		Total	
	Freq.	%	Freq.	%	Freq.	%
1 - 5	1	33.3	2	40	3	37.5
6 - 9	Nil	Nil	Nil	Nil	Nil	Nil
10 - 14	1	33.3	2	40	3	37.5
15 - 24	1	33.3	1	20	2	25
25 - 34	Nil	Nil	Nil	Nil	Nil	Nil
35 - 44	Nil	Nil	Nil	Nil	Nil	Nil
45 - 54	Nil	Nil	Nil	Nil	Nil	Nil
55-64	Nil	Nil	Nil	Nil	Nil	Nil
65-74	Nil	Nil	Nil	Nil	Nil	Nil
75	Nil	Nil	Nil	Nil	Nil	Nil
Total	3	100	5	100	8	100

The Maximum Abbreviated Injury Scale (MAIS) for male and female occupants in rear impact cases is presented in Table 6.18. Approximately 90% of the sample sustained MAIS3 (serious) scores or less. The most common maximum injury severity sustained was a score of three (serious). Only one occupant sustained an MAIS score of 4 (severe) or greater. Two of the three males sustained serious injuries and the other only sustained minor injuries (AIS1). Of the females, two out of five sustained maximum injury severity of three (serious), and of the remaining female participants there was one case each of minor, moderate (MAIS2) and severe maximum injury severity scores.

Table 6.18 Maximum Abbreviated Injury Scale severity for male and female rear impact cases

MAIS	Male		Female		Total	
	Freq.	%	Freq.	%	Freq.	%
Minor (1)	1	33.3	1	20	2	25
Moderate (2)	Nil	Nil	1	20	1	12.5
Serious (3)	2	66.7	2	40	4	50
Severe (4)	Nil	Nil	1	20	1	12.5
Critical (5)	Nil	Nil	Nil	Nil	Nil	Nil
Maximum (6)	Nil	Nil	Nil	Nil	Nil	Nil
Total	3	100	5	100	8	100

Table 6.19 presents the number and percent of occupants in rear impact cases with AIS 1+ and AIS 3+ injuries by body region. The most frequently AIS 1+ injuries were sustained to the upper extremity (62.5% of occupants) and chest (62.5%). The chest (37.5%) was also the most frequently injured body region for AIS 3+ injuries.

Table 6.19 Number (%) of rear impact cases with AIS 1 + and AIS 3+ injuries by body region

AIS Body region	ALL AIS		AIS 3+	
	Number of Cases	% of all rear cases	Number of Cases	% of all rear cases
Head	4	50	Nil	Nil
Face	4	50	Nil	Nil
Neck	3	37.5	1	12.5
Chest	5	62.5	3	37.5
Abdomen / Pelvis	3	37.5	1	12.5
Spine	3	37.5	1	12.5
Upper Extremity	5	62.5	Nil	Nil
Lower Extremity	2	25	Nil	Nil
External	Nil	Nil	Nil	Nil

The injury contact sources associated with AIS 1 + and AIS 3+ injuries for rear impacts are presented in Table 6.20. For AIS 1+ injuries, the seat belt (75%), seats and headrests (62.5%) and deceleration forces (50%) were the common sources of injury. More than one third of AIS 1+ injury sources were either unknown source. For AIS 3+ injuries, the source was most commonly the seat belts (25%).

Table 6.20 Number of rear impact cases sustaining AIS 1+ and AIS 3+ injuries by contact source

Contact Source	All AIS (n=8)		AIS 3+ (n=8)	
	Number persons	Percentage	Number persons	Percentage
Steering assembly	2	25	Nil	Nil
Floor & toe pan	1	12.5	Nil	Nil
Seats & head rest	5	62.5	1	12.5
Seat Belt	6	75	2	25
Airbag +cover + gases	1	12.5	Nil	Nil
Other + Unknown	3	37.5	Nil	Nil
Deceleration / Inertial forces	4	50	1	12.5
Other vehicle or exterior object	1	12.5	1	12.5

7 ROLLOVER CASES

The rollover cases considered in this section were occupants of vehicles that in any part of the crash sequence experienced a rollover. Therefore, included in this analysis are rollover cases without any impact (pure rollover: n=7, 35%), rollover prior to another impact (n=5, 25%), rollover post-impact (n=5, 25%), and three rollovers where pre/post event status could not be accurately ascertained. The twenty cases in which an occupant was involved in a rollover crash were distributed across 18 different vehicles. As before, all the analysis in this section is completed with respect to the 20 individual cases, not the 18 vehicles, even when vehicle characteristics are being analysed. At the outset it must be noted that the small number of cases means that conclusions that may be drawn from the data will be somewhat limited; this is especially true when there is a large number of potential categories for a data point, for example, age group. Having said that, the injury data is most revealing as each injury sustained is coded.

7.1 Basic Crash and Case Information

As indicated in Table 7.1, drivers represented 75% of all rollover cases, equating to 15 persons. There were a smaller number of front left passengers (n=4; 20%), and one rear left occupant. Table 7.2 shows that number of occupants by position and restraint use. A total of three cases were unbelted: 1 driver; 1 front left passenger, and one rear seat occupant. Restraint use was 93% for drivers and 75% for front left passengers.

Table 7.1 Number of rollover cases by occupant position

Position	**Freq.**	**%**
Driver	15	75
FLP	4	20
Front Centre	Nil	Nil
Rear Left	1	5
Rear Centre	Nil	Nil
Rear right	Nil	Nil
Total	20	100

Table 7.2 Occupant position by belt use for rollover cases

Position	**Unbelted**		**Belted used or claimed**		**Total**	
	Freq.	**%**	**Freq.**	**%**	**Freq.**	**%**
Driver	1	6.7	14	93.3	15	100
FLP	1	25.0	3	75	4	100
Front Centre	Nil	Nil	Nil	Nil	Nil	Nil
Rear Left	1	100	Nil	Nil	1	100
Rear Centre	Nil	Nil	Nil	Nil	Nil	Nil
Rear right	Nil	Nil	Nil	Nil	Nil	Nil
Total	3	15.0	17	85	20	100

7.2 Demographic Characteristics of Rollover Cases

As noted in the opening comments to this section, the small number of cases and the large number of categories for some analyses limits the conclusions that may be drawn. This is particularly true of the analysis of age group by gender presented in Table 7.3. Males represented 65% of cases, equating to 13 persons. The mean age of males was 43 years of age (SD=12.8 years) and ranged from 23 – 60 years. The mean age of the seven female rollover cases was 37.8 years (SD=17.1 years) and ranged from 21 – 71 years of age. An interesting observation is that 25% (n=5) of rollover cases were males aged 45 – 54 years, perhaps reflecting vehicle use behaviour.

Table 7.3 Number and percent of male and female rollover cases by age group

Age (years)	Male		Female		Total	
	Freq.	%	Freq.	%	Freq.	%
15 – 24	2	10	2	10	4	20
25 – 34	2	10	2	10	4	20
35 – 44	2	10	1	5	3	15
45 – 54	5	25	1	5	6	30
55 – 64	2	10	Nil	Nil	2	10
64 – 74	Nil	Nil	1	5	1	5
Total	13	65	7	35	20	100

Information of the height of male and female cases is presented in Table 7.4 and Table 7.5. The mean height of males was 176.4cm (SD=7cm) and was 164cm for females (SD=4.9cm). The height of males ranged from 166cm – 185cm, while the female height range was 155cm – 168cm. Table 7.5 shows the number and percent of cases by height and gender, however due to the small number of cases it can only reflect the observation of Table 7.4 that males cases were, as a group, taller than female cases.

Table 7.4 Summary statistics of the height of male and female rollover cases

Height (cm)	Male	Female
Mean	176.46	163.86
Median	178.00	165.00
Std. Deviation	7.00	4.95
Minimum	166	155
Maximum	185	168
25th Percentile	168.00	160.00
50th Percentile	178.00	165.00
75th Percentile	183.00	168.00
Number of cases	13	7
Missing Cases	0	0

Table 7.5 Height distribution for males and females involved in rollovers

Height	Male		Female		Total	
	Freq.	%	Freq.	%	Freq.	%
155 – 159	Nil	Nil	1	14.3	1	5
160 – 164	Nil	Nil	2	28.6	2	10
165 – 169	4	30.8	4	57.1	8	40
170 – 174	Nil	Nil	Nil	Nil	Nil	Nil
175 – 179	3	23.1	Nil	Nil	3	15
180 – 184	4	30.8	Nil	Nil	4	20
185 +	2	15.4	Nil	Nil	2	10
Total	13	100	7	100	20	100

Data relating to the weight of male and female rollover cases is presented in Table 7.6 and Table 7.7. As would be expected given the height and weight of the cases, males (Mean: 92) were heavier as a group than female cases (Mean: 64.7). The weight distribution in Table 7.7 reflects the weight difference between male and females who experienced a vehicle rollover.

Table 7.6 Summary statistics of the weight of male and female rollover cases

Weight (kg)	Male	Female
Mean	92.08	64.71
Median	90.00	60.00
Std. Deviation	20.92	12.88
Minimum	68	54
Maximum	140	91
25^{th} Percentile	75.50	55.00
50^{th} Percentile	90.00	60.00
75^{th} Percentile	105.00	70.00
Number of cases	13	7
Missing Cases	0	0

Table 7.7 Weight distribution for male and female rollover cases (kg)

Weight (kg)	Male		Female		Total	
	Freq.	Col %	Freq.	Col %	Freq.	Col %
46 – 60	Nil	Nil	4	57.1	4	20.0
61 – 75	3	23.1	2	28.6	5	25.0
76 – 85	2	15.4	Nil	Nil	2	10.0
86 – 100	5	38.5	1	14.3	6	30.0
101 – 115	1	7.7	Nil	Nil	1	5.0
116+	2	15.4	Nil	Nil	2	10.0
Total	13	100	7	100	20	100

7.3 Crash Characteristics and Vehicle Information

As noted above, seven of the twenty cases were involved in rollovers in which there was no pre or post impact. Table 7.8 shows the types of objects implicated in pre and post rollover impacts.

Table 7.8 Distribution of rollover cases by the Primary collision partner(s) associated with rollover event

Collision Partner	Freq.	%
Rollover – no other impact	7	35
Tree	6	30
Car or car-based utility	3	15
Other roadside furniture	3	15
4 by 4	1	5
Total	20	100

Table 7.9 shows that the majority of rollover cases were in a vehicle where there was no frontal airbag fitted, and there were no cases where a side airbag was fitted. Of the 4 driver cases where a frontal airbag was fitted, only one deployed.

Table 7.9 Airbag fitment and deployment by occupant position for rollover cases

Position	Airbag status	Forward Airbag (front)		Side Airbag	
		Freq.	%	Freq.	%
Driver	Not fitted	11	73.3	15	100
	Fitted & deployed	1	6.7	Nil	Nil
	Fitted & not deployed	3	20.0	Nil	Nil
	Total	15	100	15	100
FLP	Not fitted	3	75	4	100
	Fitted & deployed	Nil	Nil	Nil	Nil
	Fitted & not deployed	1	25	Nil	Nil
	Total	4	100	4	100

The distribution of rollover cases by the market group of the vehicles they were travelling in is presented in Table 7.10. The most interesting observation is the apparent over-representation of rollover cases that were travelling in 4WD vehicles. Thirty percent (6 cases) of cases involved in rollover crashes were occupants of 4WD vehicles, whereas in the ANCIS sample occupants of 4WDs only represented 7.8% of cases overall.

Table 7.10 Number and percent of cases involved in rollovers by the market group of the vehicle in which they were travelling

Market Group	Freq.	%
Small	5	25
Medium	1	5
Large	7	35
4WD	6	30
Luxury	1	5
Total	20	100

Table 7.11 shows the number and percent of cases involved in rollover crashes by the manufacturer of the vehicle in which they were travelling. There were 10 different vehicle brands for the 20 cases. Table 7.11 indicates that there were three rollover cases that were occupants of a Daihatsu vehicle, representing 15% of rollover cases. Each of these three cases of occupants of a Daihatsu being involved in a rollover were occupants of separate vehicles. Examination of Table 3.14 reveals that there were four Daihatsu vehicles in the ANCIS sample (2.8%), pointing to an apparent over-representation of these vehicles in rollover crashes. Given that the number of cases is small, this early observation requires further inquiry.

Table 7.11 Number and percent of cases involved in rollovers by the manufacturer of the vehicle in which they were travelling

Manufacturer	Freq.	%
Toyota	4	20
Daihatsu	3	15
Holden	3	15
Ford	2	10
Hyundai	2	10
Nissan	2	10
Mitsubishi	1	5
Daewoo	1	5
Subaru	1	5
Saab	1	5
Total	20	100

The number and percent of rollover cases by year of manufacture and the age of the vehicles in which they were travelling are shown in Table 7.12 and Table 7.13 respectively. Thirty-five percent of cases were travelling in vehicles that were one year of age. This may point to an issue of vehicle use and experience that is worthy of further detailed consideration.

Table 7.12 Number and percent of cases involved in rollover crashes by the year of manufacture of the vehicles in which they were travelling

Year of manufacture	Freq.	%
1991	1	5
1992	3	15
1993	1	5
1994	2	10
1995	2	10
1996	1	5
1997	1	5
1998	1	5
1999	4	20
2000	3	15
2001	1	5
Total	20	100

Table 7.13 Number and percent of rollover cases by the age at the time of the crash of the vehicle in which they were travelling.

Case vehicle age (years)	Freq.	%
1	7	35
2	1	5
3	1	5
4	Nil	Nil
5	2	10
6	3	15
7	2	10
8	Nil	Nil
9	4	20
Total	20	100

7.4 Rollover Injury Case Outcomes

The hospital of admission, and hence recruitment, is shown in Table 7.14. Sixteen of the twenty cases (80%) were admitted to the Alfred Hospital, two cases were recruited from the Royal Melbourne Hospital, and one case from both Dandenong Hospital and St Vincent's Hospital.

Table 7.14 Hospital of admission for rollover cases

Hospital of Admission	Freq.	%
Alfred, VIC	16	80
Royal Melbourne, VIC	2	10
Dandenong, VIC	1	5.0
St Vincent's, VIC	1	5.0
Total	20	100

The injury severity scale distribution for male and female rollover cases is presented in Table 7.15 and Table 7.16. The mean ISS for males was 13, and ranged from 2 – 34. Females sustained more severe injuries than did their male counterparts with a mean ISS of 19.3, with a range of 1 – 42. The percentile ISS groups and ISS categories in Table 7.16 also indicate that females consistently sustained injuries of greater severity than males.

Table 7.15 ISS profile for male and female rollover cases

ISS profile	Male	Female	Total
Mean	13.08	19.29	15.25
Median	9.00	19.00	10.50
Mode	5	1	5
Std. Deviation	11.09	15.33	12.69
Minimum	2	1	1
Maximum	34	42	42
25th Percentiles	5.00	1.00	5.00
50th Percentile	9.00	19.00	10.50
75th Percentile	25.00	34.00	25.50
Number of cases	13	7	20

Table 7.16 ISS category by gender for rollover cases

ISS	Male		Female		Total	
	Freq.	%	Freq.	%	Freq.	%
1 - 5	5	38.5	2	28.6	7	35
6 - 9	2	15.4	Nil	Nil	2	10
10 - 14	2	15.4	Nil	Nil	2	10
15 - 24	1	7.7	3	42.9	4	20
25 - 34	3	23.1	1	14.3	4	20
35 - 44	Nil	Nil	1	14.3	1	5
45 - 54	Nil	Nil	Nil	Nil	Nil	Nil
55-64	Nil	Nil	Nil	Nil	Nil	Nil
65-74	Nil	Nil	Nil	Nil	Nil	Nil
75	Nil	Nil	Nil	Nil	Nil	Nil
Total	13	100	7	100	20	100

Table 7.17 presents the Maximum Abbreviated Injury Scale (MAIS). The MAIS is the most severe injury sustained by a case. The majority of male and female cases sustained an MAIS of two (moderate) and higher, with one female sustaining an AIS 5 injury (critical).

Table 7.17 Maximum Abbreviated Injury Scale severity for male and female rollover cases

MAIS	Male		Female		Total	
	Freq.	%	Freq.	%	Freq.	%
Minor (1)	2	15.4	2	28.6	4	20
Moderate (2)	4	30.8	Nil	Nil	4	20
Serious (3)	3	23.1	2	28.6	5	25
Severe (4)	4	30.8	2	28.6	6	30
Critical (5)	Nil	Nil	1	14.3	1	5
Maximum (6)	Nil	Nil	Nil	Nil	Nil	Nil
Total	13	100	7	100	20	100

Table 7.18 shows the number of cases injured by body region and broad severity level. Of the 20 cases, 8 (40%) sustained an AIS2+ injury of the head and 7 sustained an AIS2+ spine injury (35%), indicating the high injury risk associated with rollover events.

Table 7.18 Number and percent of rollover cases with AIS 1 + & AIS 3+ injuries by body region

AIS Body region	ALL AIS		AIS 3+	
	Number of Cases	% of all rollover cases	Number of Cases	% of all rollover cases
Head	16	80	8	40
Face	14	70	Nil	Nil
Neck	3	15	Nil	Nil
Chest	11	55	5	25
Abdomen / Pelvis	4	20	Nil	Nil
Spine	6	30	4	20
Upper Ex.	15	75	3	15
Lower Ex.	7	35	1	5
External	Nil	Nil	Nil	Nil

Table 7.19 shows the injury contact sources for all injuries and AIS 3+ injuries for rollover cases. The most common sources implicated in injuries are door panel (55%), seat belt (40%), roof surface (35%) and other vehicle or exterior object (35%). For more serious injuries (AIS3+), five cases (25%) had injuries that were attributed to objects exterior to the vehicle (for example: ground) pointing to ejection as a major issue in injury outcomes.

Table 7.19 Number of rollover cases sustaining AIS 1+ and AIS 3+ injuries by contact source

Injury Contact Source	All AIS (n=20)		AIS 3+ (n=20)	
	Number persons	Percentage	Number persons	Percentage
Windscreen / Header rail	3	15	Nil	Nil
Steering assembly	4	20	2	10
Instrument panel	3	15	Nil	Nil
Console	1	5	Nil	Nil
Window + frame	2	10	Nil	Nil
B-pillar	3	15	2	10
Roof side rail	4	20	2	10
Roof surface	7	35	4	20
Door panel	11	55	2	10
Floor & toe pan	3	15	1	5
Seat Belt	8	40	1	5
Exterior of vehicle	1	5	1	5
Other + Unknown	7	35	Nil	Nil
Deceleration / Inertial forces	4	20	1	5
Exterior of other vehicle	1	5	Nil	Nil
Other vehicle or exterior object	7	35	5	25

8 CRASH SITE INFORMATION

Information from the site of each crash was collected, wherever possible, within the two to three weeks following the crash. It must be noted at the outset that information relating to the crash site is limited to a small number of variables due to the original aims of the study being an injury outcome study. In recognition of the diverse interests of the sponsors of the ANCIS project, the crash site inspection has been expanded significantly. It is expected that the enhanced crash site information will be gathered for all cases recruited to the study from March 2003 onwards.

The following data is available for the current analysis:

- Speed limit
- Road class: intersection; mid-block; roundabout etc…
- Road topography: level; uphill slope; downhill slope etc…
- Location: rural; urban, & mixed
- Lighting conditions at the time of the crash
- Street lighting
- Carriageway separation
- Road curvature
- Road surface: sealed etc…
- Traffic control device
- Weather

Other data relevant to the overall picture of the scene are:

- Definition of Classifying Accidents (DCA) code, describing the movements of vehicles involved in the crash (see Appendix, p. 119);
- Number of vehicles involved
- Collision partner
- Impact type

The site case data will be presented split on single vehicle and multi-vehicle crashes, and crashes occurring in rural and urban environments. For this report, the eight cases whose crashes occurred in mixed environments, for example provincial towns, will be excluded from all analyses. While excluding these cases is not ideal, the small number of cases precludes making any definitive conclusions about the role played by crash site factors. In the revised form to be introduced in 2003, the definition of overall regional environment will be expressed with greater clarity than is currently the case. In addition, the site of one crash was unable to be examined due to it being on private property. Weather conditions at the time of the crash are not presented in this report due to data acquisition and coding difficulties that are in the process of being overcome. Site information is therefore available for 171 cases.

Cases involved in crashes that occurred in rural areas represented 46% (79) of all cases, with 54% having occurred in urban areas. Cases involved in single-vehicle crashes represented the majority (55%) of cases in which the crash occurred in a rural area, while cases involved in multi-vehicle crashes formed 64% of cases involved in crashes occurring in urban areas.

For the purpose of analysis, cases involved in single vehicle and multi-vehicle crashes will be analysed separately in the sections 8.1 and 8.2 respectively. Within each section, the rural / urban split will form the dominant comparison type.

8.1 Single Vehicle Crashes

Of the 76 cases that were occupants of vehicles involved in single vehicle crashes, 56% (43) were involved in crashes that occurred in rural regions, while the remaining 46% (33) occurred in urban regions. Characteristics of the crash, temporal, road, and environmental conditions are examined in the following sub-sections.

8.1.1 Primary vehicle movement in single vehicle crashes

The vehicle movement associated with each crash (case) in rural and urban environments is presented in Table 8.1. Vehicle movements are classified according to the 'Definition for Classifying Accidents (DCA) chart used by VicRoads.

Run-off-road crashes on straight road segments comprised 53.5% of cases involved in crashes in rural areas. While 63.6% of cases involved in urban single vehicle crashes were involved in run off road crashes. Cases involved in off-path-on-curve crashes were the second most common crash type in both rural and urban areas, representing approximately one-third of rural and urban cases. There were a smaller number cases involved in manoeuvring and 'on-path' crashes.

Table 8.1 Number and percent of cases by the DCA vehicle movements associated with the case vehicle in single vehicle crashes

Vehicle Movement	Rural		Urban		Total	
	Freq.	%	Freq.	%	Freq.	%
Manoeuvring	2	4.7	1	3.0	3	3.9
On path	2	4.7	1	3.0	3	3.9
Off path, straight	23	53.5	21	63.6	44	57.9
Off path, curve	16	37.2	10	30.3	26	34.2
Total	43	100	33	100	76	100

The impact types for cases involved in single vehicle crashes in rural and urban areas are presented in Table 8.2. Cases involved in frontal impact crashes represent approximately half of all cases as well as half of all rural and urban cases. The major difference between the impact types of cases between rural and urban areas is the high proportion of rollover cases (25.6%) involved in crashes in rural areas and the greater proportion of urban cases being involved in struck-side impacts (30%).

Table 8.2 Number and percent of cases by impact types for single vehicle cases in rural and urban areas

Primary Impact Type	Rural		Urban		Total	
	Freq.	%	Freq.	%	Freq.	%
Frontal	20	46.5	16	48.5	36	47.4
Struck side	8	18.6	10	30.3	18	23.7
Far side	3	7.0	4	12.1	7	9.2
Rear	Nil	Nil	1	3.0	1	1.3
Rollover	11	25.6	2	6.1	13	17.1
Unclassifiable	1	2.3	Nil	Nil	1	1.3
Total	43	100	33	100	76	100

The predominant collision partner for cases involved in single vehicle crashes were signs / poles / posts and trees. Table 8.3 indicates that cases involved in collisions with trees alone account for 57% of all cases involved in single vehicle crashes in the sample, and this percent increases to 70% when considering rural crashes. All five cases involved in single vehicle rollover crashes that did not involve a pre-impact with another vehicle were involved in crashes that occurred in rural areas.

Table 8.3 Collision partner for single vehicle crashes in rural and urban areas

Collision partner	Rural		Urban		Total	
	Freq.	%	Freq.	%	Freq.	%
Signpost, pole or post	5	11.6	13	39.4	18	23.7
Tree	30	69.8	13	39.4	43	56.6
Rollover	5	11.6	Nil	Nil	5	6.6
Other roadside furniture	1	2.3	2	6.1	3	3.9
Other object	2	4.7	1	3.0	2	2.6
Wall	Nil	Nil	2	6.1	2	2.6
Lamp-post	Nil	Nil	2	6.1	2	2.6
Total	43	100	33	100	76	100

The speed zones in which the crashes occurred in are presented in Table 8.4. The vast majority (65%, n=28) of cases involved in rural crashes were involved in crashes that occurred on roads with a 100 km/h speed zone. While only one case involved in a crash on a road with a 100 km/h speed zone was involved in an urban crash (3%). Conversely, 40% of cases involved in urban crashes were involved in crashes that occurred on roads with a posted limit of 60km/h compared to only 2 (4.7%) cases involved in crashes on a road with the same speed limit but in a rural area.

Table 8.4 Number and Percent of cases involved in single vehicle crashes by the Speed zone and region in which the crash occurred

Speed Zone	Rural		Urban		Total	
	Freq.	%	Freq.	%	Freq.	%
50	Nil	0	7	21.2	7	9.2
60	2	4.7	13	39.4	15	19.7
70	3	7.0	2	6.1	5	6.6
80	5	11.6	9	27.3	14	18.4
90	1	2.3	Nil	Nil	1	1.3
100	28	65.1	1	3.0	29	38.2
110	1	2.3	Nil	Nil	1	1.3
Unknown	3	7.0	Nil	Nil	4	5.2
Total	43	100	33	100	76	100

8.1.2 Temporal and environmental factors in rural and urban cases

This section examines the temporal and environmental factors associated with each case. The day of the week in which the case experienced the crash is presented in Table 8.5. Of the 76 cases involved in single vehicle crashes, approximately 45% overall occurred on Saturday and Sunday. A greater proportion of urban cases occurred on a Friday night than in rural regions.

Table 8.5 Number and percent of cases involved in single vehicle rural and urban crashes by day of week

Day of week	Rural		Urban		Total	
	Freq.	%	Freq.	%	Freq.	%
Monday	3	7.0	2	6.1	5	6.6
Tuesday	5	11.6	2	6.1	7	9.2
Wednesday	5	11.6	5	15.2	10	13.2
Thursday	6	14.0	5	15.2	11	14.5
Friday	4	9.3	6	18.2	10	13.2
Saturday	12	27.9	6	18.2	18	23.7
Sunday	8	18.6	7	21.2	15	19.7
Total	43	100	33	100	76	100

The number and percent of cases involved in single vehicle rural and urban crashes by lighting conditions is presented in Table 8.6. Overall, 46% of cases were involved in crashes that occurred in the daylight and exactly half were involved in crashes that occurred at night. A smaller percentage of cases where involved in crashes that occurred at dawn and dusk. When examining the differences between rural and urban crashes the time of day in which the majority of crashes occurred was reversed. More specifically, 56% of cases involved in rural crashes were involved in crashes that occurred in daytime hours, while 64% were involved in urban crashes that occurred at night.

Table 8.6 Number and percent of cases involved in single vehicle rural and urban crashes by lighting conditions

Light	Rural		Urban		Total	
	Freq.	%	Freq.	%	Freq.	%
Daylight	24	55.8	11	33.3	35	46.1
Dark	17	39.5	21	63.6	38	50.0
Dawn	Nil	Nil	1	3.0	1	1.3
Dusk	2	4.7	Nil	Nil	2	2.6
Total	43	100	33	100	76	100

As noted above and indicated in Table 8.7, 38 cases had a crash at night. The availability of street lighting for these cases is indicated in Table 8.7. The contrast between the availability of street lighting of crashes occurring in rural and urban areas is stark. In the instance of cases having crashed in a rural area, street lighting was unavailable for close to 90% of cases. Conversely, half of the cases in urban areas had functional streetlights at the crash location. There were, however, a large number of cases involved in urban crashes where the status of street lighting was unknown at the time of analysis.

Table 8.7 Number and percent of cases involved in single vehicle rural and urban crashes by availability of street lighting

Street lighting	Rural		Urban		Total	
	Freq.	%	Freq.	%	Freq.	%
None	15	88.2	1	4.8	16	42.1
Available and on	Nil	Nil	11	52.4	11	28.9
Available and not on	1	5.9	1	4.8	2	5.3
Unknown	1	5.9	8	38.1	9	23.7
Total	17	100	21	100	38	100

The weather conditions at the time of the crash for each case are presented in Table 8.8. It is evident that there are a large number of cases where the weather conditions at the time of the crash is unknown.

Table 8.8 Number and percent of cases involved in single vehicle rural and urban crashes by weather conditions

Weather	Rural		Urban		Total	
	Freq.	%	Freq.	%	Freq.	%
Fine	18	41.9	8	24.2	26	34.2
Raining	5	11.6	5	15.2	10	13.2
Dust / smoke	1	2.3	Nil	Nil	1	1.3
Unknown	20	46.5	20	60.6	40	52.6
Total	43	100	33	100	76	100

8.1.3 Physical road environment in rural and urban cases

As part of the scene inspection, basic information relating to the road type, layout and surface is collected. Table 8.9 indicates that all cases involved in urban crashes and approximately 80% of cases involved in rural crashes were involved in crashes on sealed roads, a proportion of which had gravel shoulders. There were no urban cases that occurred on unsealed roads, while one-third of rural cases occurred on unsealed roads.

Table 8.9 Number and percent of cases involved in single vehicle rural and urban crashes by road surface

Road surface	Rural		Urban		Total	
	Freq.	%	Freq.	%	Freq.	%
Sealed	20	46.5	27	81.8	47	61.8
Unsealed	9	20.9	Nil	Nil	9	11.8
Sealed with gravel shoulder	14	32.6	6	18.2	20	26.3
Total	43	100	33	100	76	100

The distribution of cases by the road layout of crashes is presented in Table 8.10. Of the 43 cases involved in rural crashes, 38 (89%) were involved in crashes that occurred at mid-blocks (i.e., not at any form of intersection), with a smaller number occurring at intersections. A similar pattern is apparent in urban crashes with 88% (29) of cases involved in crashes occurring at mid-blocks. A small number, though large proportion, of cases involved in urban crashes were involved in crashes that occurred at 3-leg intersections, while this was not the case in rural cases.

Table 8.10 Number and percent of cases involved in single vehicle rural and urban crashes by road classification

Road type	Rural		Urban		Total	
	Freq.	%	Freq.	%	Freq.	%
3-leg intersection	Nil	Nil	3	9.1	3	3.9
Multi-leg intersection	2	4.7	Nil	Nil	2	2.6
Roundabout	1	2.3	1	3.0	2	2.6
Mid-block	38	88.4	29	87.9	67	88.2
Unknown	2	4.7	Nil	Nil	2	2.6
Total	43	100	33	100	76	100

With respect to median separation, only 11.6% of rural cases were involved in crashes on carriageways divided by a median barrier. The equivalent figure for urban cases was 33% (see Table 8.11).

Table 8.11 Number and percent of cases involved in single vehicle rural and urban crashes by median separation status

Median Separation	Rural		Urban		Total	
	Freq.	**%**	**Freq.**	**%**	**Freq.**	**%**
None	36	83.7	22	66.7	58	76.3
Divided by median / barrier	5	11.6	11	33.3	16	21.1
Unknown	2	4.7	Nil	Nil	2	2.6
Total	43	100	33	100	76	100

The road alignment associated with each case in rural and urban areas is presented in Table 8.12. Approximately 50% of rural cases were involved in crashes that occurred on straight sections, while the equivalent figure for urban cases was 64%.

Table 8.12 Number and percent of cases involved in single vehicle rural and urban crashes by road alignment type

Alignment	Rural		Urban		Total	
	Freq.	**%**	**Freq.**	**%**	**Freq.**	**%**
Straight	22	51.2	21	63.6	43	56.6
Curve	21	48.8	12	36.4	33	43.4
Total	43	100	33	100	76	100

8.2 Multiple Vehicle Crashes

There were 95 cases recruited to the study whose crash involved more than one vehicle. The characteristics of the crash, road layout and surface, and temporal factors are presented in the following sections.

8.2.1 Primary vehicle movement in multiple vehicle crashes

Table 8.13 shows the primary vehicle movement for multiple vehicle crashes. The top three vehicle movements associated with case was found to be: adjacent-direction type crashes (intersections); opposing direction impacts (head-on crashes), and ‘same direction’ crash types. Cases involved in adjacent intersection crashes represented 44% of all urban cases, while cases involved in opposing direction crashes was the dominant rural crash type. In contrast to single vehicle crashes there very few cases of run-off-road crashes in either rural or urban locations.

Table 8.13 Number and percent of cases involved in multiple vehicle crashes by DCA vehicle movements

Vehicle Movement	Rural		Urban		Total	
	Freq.	%	Freq.	%	Freq.	%
Adjacent	5	13.9	26	44.1	31	32.6
Opposing	14	38.9	14	23.7	28	29.5
Same direction	10	27.8	13	22.0	23	24.2
Manoeuvring	4	11.1	1	1.7	5	5.3
Overtaking	2	5.6	Nil	Nil	2	2.1
On path	Nil	Nil	2	3.4	2	2.1
Off path, straight	Nil	Nil	3	5.1	3	3.2
Off path, curve	1	2.8	Nil	Nil	1	1.1
Total	36	100	59	100	95	100

The impact types for cases involved in multiple vehicle crashes in rural and urban areas are presented in Table 8.2. Cases involved in frontal impact crashes represent approximately half of cases overall, followed by struck-side cases. Two-thirds of rural cases were involved in frontal impacts while only one-third of urban crash-involved cases were involved in frontal crashes. As seen in Table 8.15, cases involved in struck-side impacts represented a greater proportion of urban cases than was the case for cases involved in crashes in urban areas.

Table 8.14 Number and percent of cases involved in multiple vehicle crashes in rural and urban areas by impact type

Primary Impact Type	Rural		Urban		Total	
	Freq.	%	Freq.	%	Freq.	%
Frontal	24	66.7	21	35.6	45	47.4
Struck side	5	13.9	25	42.4	30	31.6
Far side	3	8.3	5	8.5	8	8.4
Rear	3	8.3	4	6.8	7	7.4
Rollover	1	2.8	4	6.8	5	5.3
Total	36	100	59	100	95	100

The primary collision partner (upon which Crash-3 was based) for each case is presented in Table 8.15. Occupants of passenger cars made up 53% of all rural cases and 71% of cases involved in urban crashes. The most fundamental difference between rural and urban crashes is the involvement of 4WD vehicles as collision partners. Whilst the overall numbers are small, it remains the case that 16.7% of cases involved in rural crashes involved a 4WD compared to 6.8% of urban cases.

Table 8.15 Number and percent of cases involved in multiple vehicle crashes in rural and urban areas by collision partner

Collision Partner	Rural		Urban		Total	
	Freq.	%	Freq.	%	Freq.	%
Car or car-based utility	19	52.8	42	71.2	61	64.2
4 by 4	6	16.7	4	6.8	10	10.5
Camper Van	Nil	Nil	2	3.4	2	2.1
Truck/bus/Semi	4	11.1	6	10.2	10	10.5
Tree	Nil	Nil	1	1.7	1	1.1
Rollover	Nil	Nil	1	1.7	1	1.1
Other roadside furniture	1	2.8	1	1.7	2	2.1
Other object	1	2.8	Nil	Nil	1	1.1
Other vehicle	4	11.1	2	3.4	6	6.3
Motorcycle	1	2.8	Nil	Nil	1	1.1
Total	36	100	59	100	95	100

The speed zones in which the crashes occurred in are presented in Table 8.16. Eight percent of rural cases were involved in crashes that occurred on roads with a 100 km/h posted limit, compared to only three urban cases (5.1%). Conversely, over half of urban cases were involved in crashes that occurred on roads with a posted limit of 60km/h compared to no cases involved in multiple vehicle rural crashes. There were also a greater proportion of urban cases involved in crashes that occurred on 80 km/h roads than was the case for rural cases.

Table 8.16 Number and percent of cases involved in rural and urban multiple vehicle crashes by speed zone

Speed Limit	Rural		Urban		Total	
	Freq.	%	Freq.	%	Freq.	%
50	Nil	Nil	3	5.1	3	3.2
60	Nil	Nil	32	54.2	32	33.7
70	Nil	Nil	5	8.5	5	5.3
80	4	11.1	16	27.1	20	21.1
90	1	2.8	Nil	Nil	1	1.1
100	29	80.6	3	5.1	32	33.7
110	2	5.6	Nil	Nil	2	2.1
Total	36	100	59	100	95	100

8.2.2 Temporal and environmental factors in rural and urban cases

This section examines the temporal and environmental factors associated with each multiple vehicle case. The day of the week in which the case experienced the crash is presented in Table 8.17. In contrast to single vehicle crashes, the highest crash day was Friday for rural crash-involved cases, and Wednesday for urban crash-involved cases.

Table 8.17 Number and percent of cases involved in multiple vehicle rural and urban crashes by day of week

Day of week	Rural		Urban		Total	
	Freq.	%	Freq.	%	Freq.	%
Monday	6	16.7	8	13.6	14	14.7
Tuesday	1	2.8	9	15.3	10	10.5
Wednesday	4	11.1	8	13.6	12	12.6
Thursday	8	22.2	12	20.3	20	21.1
Friday	9	25.0	6	10.2	15	15.8
Saturday	4	11.1	6	10.2	10	10.5
Sunday	4	11.1	10	16.9	14	14.7
Total	36	100	59	100	95	100

Then number and percent of multiple vehicle rural and urban crashes by lighting conditions is presented in Table 8.18. Approximately 60% of cases involved in both rural and urban crashes were involved in crashes that occurred in daylight, while 33% and 25% of rural and urban cases respectively were involved in crashes that occurred at night. There were also a higher proportion of urban cases involved in crashes that occurred at dusk than for rural cases.

Table 8.18 Number and percent of cases involved in multiple vehicle rural and urban crashes by lighting conditions

Light	Rural		Urban		Total	
	Freq.	%	Freq.	%	Freq.	%
Daylight	22	61.1	35	59.3	57	60.0
Dark	12	33.3	15	25.4	27	28.4
Dawn	1	2.8	2	3.4	3	3.2
Dusk	1	2.8	7	11.9	8	8.4
Total	36	100	59	100	95	100

As noted above and indicated in Table 8.18, 27 cases had a multiple vehicle crash at night. The availability of street lighting for these cases is presented in Table 8.19. In all 12 rural cases, street lighting was unavailable. Due to the large proportion of urban cases where street lighting was unknown no valid observations can be made. As noted in the section that examined single vehicle crashes, the large number of unknown lighting data points is due to yet to be obtained Police data of the crash.

Table 8.19 Number and percent of cases involved in multiple vehicle rural and urban crashes by availability of street lighting

Street Lighting	Rural		Urban		Total	
	Freq.	%	Freq.	%	Freq.	%
None	12	100	1	6.7	13	48.1
Available and on	Nil	Nil	4	26.7	4	14.8
Unknown	Nil	Nil	10	66.7	10	37.0
Total	12	100	15	100	27	100

The weather conditions at the time of the crash for each case involved in a multiple vehicle crash are presented in Table 8.20. It is evident that there is a large number of cases where the weather conditions at the time of the crash is unknown. It is expected that once all Police reports of the crashes are gathered, the weather conditions associated with each crash will become clearer. Consequently, discussion of weather conditions will be deferred until the final version of this report.

Table 8.20 Number and percent of cases involved in multiple vehicle rural and urban crashes by availability of weather conditions

Weather Conditions	Rural		Urban		Total	
	Freq.	%	Freq.	%	Freq.	%
Fine	14	38.9	13	22.0	27	28.4
Raining	1	2.8	3	5.1	4	4.2
Fog / mist	1	2.8	Nil	Nil	1	1.1
Unknown	20	55.6	43	72.9	63	66.3
Total	36	100	59	100	95	100

8.2.3 Physical road environment in rural and urban cases

As part of the scene inspection, basic information relating to the road type, layout and surface is collected. Table 8.21 indicates that all but one case that were involved in urban crashes were involved in crashes that occurred on sealed roads. While approximately 92% of cases involved in rural crashes were involved in crashes that occurred on sealed roads. A small number of cases involved multi-vehicle rural crashes were involved in crashes that occurred on unsealed roads.

Table 8.21 Number and percent of cases involved in multiple vehicle rural and urban crashes by road surface

Road Surface	Rural		Urban		Total	
	Freq.	%	Freq.	%	Freq.	%
Sealed	22	61.1	52	88.1	74	77.9
Unsealed	3	8.3	1	1.7	4	4.2
Sealed with gravel shoulder	11	30.6	6	10.2	17	17.9
Total	36	100	59	100	95	100

The road layout of case crashes is presented in Table 8.22. Of the 36 cases involved in rural crashes, 35 (69%) were in crashes that occurred at mid-blocks (i.e., not at any form of intersection), with the balance occurring at intersections. The reverse was apparent for urban crashes, with 32% of cases having being involved in a crash at a mid-block with the balance having crashed at an intersection.

Table 8.22 Number and percent of cases involved in multiple vehicle rural and urban crashes by road classification

Road Classification	Rural		Urban		Total	
	Freq.	%	Freq.	%	Freq.	%
4-leg intersection	4	11.1	17	28.8	21	22.1
3-leg intersection	7	19.4	14	23.7	21	22.1
Multi-leg intersection	Nil	Nil	5	8.5	5	5.3
Roundabout	Nil	Nil	4	6.8	4	4.2
Mid-block	25	69.4	19	32.2	44	46.3
Total	36	100	59	100	95	100

With respect to median separation (Table 8.23), only 14% of cases involved in rural crashes were involved in crashes that occurred on carriageways divided by a median barrier. The equivalent figure for urban crashes was close to 60%.

Table 8.23 Number and percent of cases involved in multiple vehicle rural and urban crashes by median separation status

Separation Status	Rural		Urban		Total	
	Freq.	%	Freq.	%	Freq.	%
None	31	86.1	24	40.7	55	57.9
Divided by median / barrier	5	13.9	34	57.6	39	41.1
Unknown	Nil	Nil	1	1.7	1	1.1
Total	36	100	59	100	95	100

The road alignment associated with each case in rural and urban areas is presented in Table 8.24. Approximately 50% of rural cases were involved in crashes that occurred on straight sections, while the equivalent figure for urban cases was 83%.

Table 8.24 Number and percent of cases involved in multiple vehicle rural and urban crashes by road alignment type

Alignment	Rural		Urban		Total	
	Freq.	%	Freq.	%	Freq.	%
Straight	17	47.2	49	83.1	66	69.5
Curve	19	52.8	10	16.9	29	30.5
Total	36	100	59	100	95	100

9 ANALYSIS OF FATAL PASSENGER VEHICLE CRASHES

9.1 Overall Crash and Case Information

All of the results in this chapter are derived from the Australian Transport Safety Bureau (ATSB) Fatal File, which contains detailed information on all persons involved in fatal road accidents in Australia for the years 1988 to 1999. However, most of the analysis in this chapter will be limited to the years 1997 to 1999. Each individual involved in a fatal accident is regarded as a separate case, with the file containing 27,174 cases for the years 1988 to 1996 and 11,728 cases for the years 1997 to 1999, making a total of 38,902 cases.

This analysis of the Fatal File is restricted to looking only at individual cases that died as a result of a motor vehicle accident. For the years 1988 to 1996, of the 27,174 cases in the Fatal File, in 10,904 (40%) cases the person died. For 1997 to 1999, of the 11,728 cases, 5132 (44%) were fatalities. Analysis in this report, unless otherwise stated, will be restricted to these 5132 fatal cases.

Analysis will be further restricted to fatalities occurring within a passenger vehicle. A passenger vehicle is defined as a passenger car or a van/ute/4wd-type vehicle (coded as *vkind* 3 and 4). The coding within the Fatal File for passenger vehicles is different for accidents occurring before 1997, which is one of the reasons the present analysis was restricted to the years 1997 to 1999. The total number of passenger vehicle occupant fatalities for the years 1997 to 1999 was 3025. These 3025 deaths resulted from 2581 separate accidents. The number of passenger vehicles in which at least one occupant was fatally injured was 2647.

The aim of this chapter is to summarise the data pertaining to the previously described dataset in terms of an overview of the individuals involved, the types of crashes and vehicles and the type and severity of the injuries sustained.

9.2 Case Demographics

This section looks at some general demographic characteristics of people involved in fatal collisions where the occupant of a passenger vehicle died.

Table 9.1 considers the State in which fatalities occurred. Since New South Wales is the most populous state (33.8% of Australians reside in NSW), it is not surprising that it has the greatest number of fatalities to occupants of passenger vehicles (28.7% of all fatalities). New South Wales was closely followed by the second most populous state, Victoria in which 24.9% of the population live and in which 22.7% of the fatalities to passenger vehicle occupants occurred. The State that had the third most frequent passenger vehicle fatalities was Queensland (18.4%), followed by Western Australia (13.1%), South Australia (9.9%), Tasmania and the Northern Territory (both 3.1%) and the Australian Capital Territory (1.1%). Comparing rates of fatalities by State with the population of states in this way allows expected fatality rates for each State to be computed and these expected rates can be compared with the actual rates. Note that population data was derived from 1997 population statistics from the ATSB data file title, Road crash data and rates, Australian States and territories, 1925-2001 (2002).

Table 9.1 State in which fatalities occurred by passenger vehicle occupant, 1997-1999

State	Number of passenger vehicle fatalities	Percentage of Australian Fatalities (%)	State Population as a Percentage of Australian Population (%)
NSW	869	28.7	33.8
Vic	687	22.7	24.9
Qld	558	18.4	18.4
WA	395	13.1	9.8
SA	298	9.9	7.9
Tas	93	3.1	2.5
NT	93	3.1	1.8
ACT	32	1.1	1.6
Total	3025	100	100

It is also important to consider the position within a passenger vehicle of the people who died in an accident. Table 9.2 describes such statistics. Drivers represent 63.7% of all passenger vehicle occupants fatally injured; a finding that is not surprising given exposure. Fatalities occurring to passengers seated in the driver's seat and the front left passenger seat accounted for almost 86% of deaths to occupants of passenger vehicles. This provides justification for recent emphasis by car manufacturers and car safety researchers on protecting front seat passengers in different types of crash scenarios.

Table 9.2 Seating position of the person fatally injured in passenger vehicles, years 1997-1999

Seat position	Frequency	%	Cumulative %
Driver	1927	63.7	63.7
Seated front left	671	22.2	85.9
Seated rear left	151	5.0	90.9
Seated rear right	114	3.8	94.6
Seated rear centre	49	1.6	96.3
Unknown rear seat	41	1.4	97.6
Seated other rear	22	0.7	98.3
Stand in rear of vehicle	12	0.4	98.7
Lie down rear seat	11	0.4	99.1
Seated front centre	10	0.3	99.4
Lie down rear of vehicle	5	0.2	99.6
Unknown front seat	5	0.2	99.8
Front passenger lap	3	0.1	99.9
Rear passenger lap	3	0.1	100
Stand on front seat	1	0.0	100
Total	3025	100	

The following tables report the demographic profile of those who died in passenger vehicles. Table 9.3 shows that males account for 62.5% (1892 of the 3025 cases) of occupants of passenger vehicles fatally injured in motor vehicle accidents for the years 1997-1999 and females' account for 37.5% (1133 of 3025). Males in the age group 15-24 years accounted for 22.8% (689 of 3025) of all the occupants of passenger vehicles fatally injured and are by far the most at risk age and sex group. The percentage of fatally injured occupants of passenger vehicle who were females of the same age group was 9.3% (280 of 3025). When comparing the fatality rates for males and females in the same age groups, females continue to be less at risk from age 15-24 up until the 45-54 years (4.1% versus 5.2%). However, for older age groups (> 74 years), there was little difference in rates of fatalities between the sexes. The risk of an occupant aged over 75 years dying in a passenger vehicle is 4.6% and 4.7% for males and females, respectively. In both cases, this represents approximately a 1% increase from the figures for occupants 20 years younger. Table 9.3 shows that males enter this age of increased risk earlier than females: deaths of males in the age group 65-74 years makes up 4.5% of all the deaths to occupants of passenger vehicles compared with a figure of 3.2% for females of the same age.

Table 9.3 Number and percent of male and female occupants of passenger vehicles fatally injured by age for 1997-1999

Age Group	Sex				Total	
	Male		Female			
	Freq.	%	Freq.	%	Freq.	%
Unknown	6	0.2	1	<0.1	7	0.2
<1	6	0.2	6	0.2	12	0.4
1 – 5	25	0.8	36	1.2	61	2.0
6 – 9	8	0.3	17	0.6	25	0.8
10 - 14	24	0.8	26	0.9	50	1.7
15 - 24	689	22.8	280	9.3	969	32.0
25 - 34	359	11.9	172	5.7	531	17.6
35 - 44	237	7.8	123	4.1	360	11.9
45 - 54	157	5.2	124	4.1	281	9.3
55 - 64	108	3.6	111	3.7	219	7.2
65 - 74	135	4.5	96	3.2	231	7.6
> 75	138	4.6	141	4.7	279	9.2
Total	1892	62.5	1133	37.5	3025	100

Although 3025 occupants of passenger vehicles died in motor accidents in the years 1997 to 1999, the number of fatal accidents for this group of road users for the same period was 2581, indicating that a proportion of the crashes involved multiple fatalities within a passenger vehicle. The number of passenger cars in which at least one occupant died was 2647.

Table 9.4 indicates that 74.3% (1031 of 1387 cases) of drivers of a passenger vehicle involved in a single vehicle collision in which at least one occupant was fatally injured were males, and male drivers in the age group 15–24 years represented 32.3% (448 of 1387) of all the cases. This emphasises the continuing need to target young male drivers with programs to reduce fatalities caused by single vehicle accidents. Comparing rates for males and females in each age group, Table 9.4 demonstrates that for all age groups, male drivers of passenger vehicles were more commonly involved in an accident in which an occupant of their vehicle died.

Table 9.4 Age and sex of drivers involved in single vehicle collisions in which an occupant of a passenger vehicle died, 1997-1999

Age	Unknown		Male		Female		Total	
	Freq.	%	Freq.	%	Freq.	%	Freq.	%
10 - 14	Nil	0	4	0.3	2	0.1	6	0.4
15 - 24	1	0.1	448	32.3	111	8.0	560	40.4
25 - 34	Nil	0	209	15.1	68	4.9	277	20.0
35 - 44	Nil	0	120	8.7	52	3.7	172	12.4
45 - 54	Nil	0	85	6.1	39	2.8	124	8.9
55 - 64	Nil	0	41	3.0	20	1.4	61	4.4
65 - 74	Nil	0	45	3.2	17	1.2	62	4.5
> 75	Nil	0	33	2.4	17	1.2	50	3.6
Unknown	11	0.8	46	3.3	18	1.3	75	5.4
Total	12	0.9	1031	74.3	344	24.8	1387	100

Similarly, Table 9.5 presents statistics regarding the age and sex of all the drivers involved in a multiple vehicle accident in which an occupant of a passenger vehicle died. Of the sample of multiple vehicle crashes in which an occupant of a passenger vehicle died, the most number of cars involved for a single accident was four. There were 1194 multiple vehicle crashes, involving 2501 cars. It can be seen from Table 9.5 that 64.5% (1614 of 2501) of the drivers of all the vehicles involved in such accidents were male, while males in the age groups 15–24 years, 25–34 years and 35–44 years represented 12.2% (306 of 2501), 12.2% (305 of 2501) and 10.8% (269 of 2501) of all the drivers respectively. Furthermore, male drivers represented a higher percentage of all the drivers involved than female drivers for all age groups excluding 10–14 year olds, where each sex had one case each.

Table 9.5 Age and sex of all drivers involved in multiple vehicle collisions in which an occupant of a passenger vehicle died, 1997-1999

Driver age	Unknown		Male		Female		Total	
	Freq.	%	Freq.	%	Freq.	%	Freq.	%
10 - 14	Nil	Nil	1	<0.1	1	<0.1	2	0.1
15 - 24	Nil	Nil	306	12.2	156	6.2	462	18.5
25 - 34	1	<0.1	305	12.2	178	7.1	484	19.4
35 - 44	1	<0.1	269	10.8	126	5.0	396	15.8
45 - 54	Nil	Nil	189	7.6	123	4.9	312	12.5
55 - 64	Nil	Nil	139	5.6	72	2.9	211	8.4
65 - 74	Nil	Nil	108	4.3	45	1.8	153	6.1
> 75	Nil	Nil	111	4.4	55	2.2	166	6.6
Unk.	26	1.0	186	7.4	103	4.1	315	12.6
Total	28	1.1	1614	64.5	859	34.3	2501	100

The next few tables contain some statistics regarding the height and weight of people fatally injured in passenger vehicles. Of the 3025 cases of occupants of passenger vehicles who died in a passenger vehicle, 2131 contained data on the height of the deceased. Table 9.6 presents statistics regarding the height of males and females who died in passenger vehicles, while Table 9.7 presents the height distribution for males and females fatally injured in a passenger vehicle. It can be seen from Table 9.6 that the average height of males fatally injured in passenger vehicles was approximately 173 cm compared with approximately 160 cm for females. The height range for males was 55 cm to 201 cm, while for females it was 51 cm to 186 cm.

Table 9.6 Summary statistics of the height of males and females who died in a passenger vehicle, 1997-1999

Summary statistic		Male	Female
Mean		173.27	159.55
Median		175.00	162.00
Mode		180	163
Std. Deviation		13.572	16.200
Minimum		55	51
Maximum		201	186
Percentiles	25	169.00	157.00
	50	175.00	162.00
	75	180.00	168.00
Number		1336	795

Table 9.7 Height distribution for males and females who died in a passenger vehicle, 1997-1999

Height (cm)	Sex				Total	
	Male		Female			
	Freq.	%	Freq.	%	Freq.	%
<= 149	35	1.6	65	3.1	100	4.7
150 - 154	7	0.3	80	3.8	87	4.1
155 - 159	35	1.6	150	7.0	185	8.7
160 - 164	93	4.4	194	9.1	287	13.5
165 - 169	170	8.0	163	7.6	333	15.6
170 - 174	314	14.7	98	4.6	412	19.3
175 - 179	281	13.2	39	1.8	320	15.0
180- 184	255	12.0	5	0.2	260	12.2
185+	146	6.9	1	0.0	147	6.9
Total	1336	62.7	795	37.3	2131	100

Of the 3025 cases of fatalities occurring within passenger vehicles, 1796 contained data on the weight of the deceased. Statistics regarding weight are depicted in Table 9.8 and Table 9.9. It can be seen from Table 9.8 that the average weight of males fatally injured in passenger vehicles was approximately 78 kg while the average weight for females was 66 kg. The weight range of males fatally injured in passenger vehicles was 5 kg to 180 kg, while for females the weight range was 6 kg to 200 kg.

Table 9.8 Summary statistics for the weight of male and females who died in a passenger vehicle, 1997-1999

Summary statistic		Sex	
		Male	Female
Mean		77.16	66.12
Median		75.00	65.00
Mode		70	61
Minimum		5	6
Maximum		180	200
Percentiles	25	66.00	56.00
	50	75.00	65.00
	75	88.00	76.00
Number		1132	664

Table 9.9 Weight distribution for deceased male and female occupants of passenger vehicles, 1997-1999

Weight (kg)	Sex				Total	
	Male		Female			
	Freq.	%	Freq.	%	Freq.	%
1 - 15	9	0.5	18	1.0	27	1.5
16 - 30	14	0.8	12	0.7	26	1.4
31 - 45	13	0.7	25	1.4	38	2.1
46 - 60	139	7.7	190	10.6	329	18.3
61 - 75	399	22.2	249	13.9	648	36.1
76 - 85	235	13.1	87	4.8	322	17.9
86 – 100	214	11.9	58	3.2	272	15.1
101 - 115	69	3.8	16	0.9	85	4.7
116+	41	2.3	9	0.5	50	2.8
Total	1133	63.0	664	37.0	1797	100.0

One way of analysing which road safety measures are effective, or alternatively identifying areas that require further attention or a different approach, is to look at road safety trends over time. Thus, to conclude this section we look at some trends regarding the demographics of cases involving passenger vehicles. Trend data in this report is limited by looking at only three years of data. Firstly, Figure 9.1 shows the trend for fatalities to the occupant of a passenger vehicle with respect to State over the three years from 1997-1999. The distribution of fatalities by State seems fairly stable however some States show an increasing trend for deaths to occupants of passenger vehicles. However whether these trends are significant is difficult to ascertain because the data only covers a three-year period.

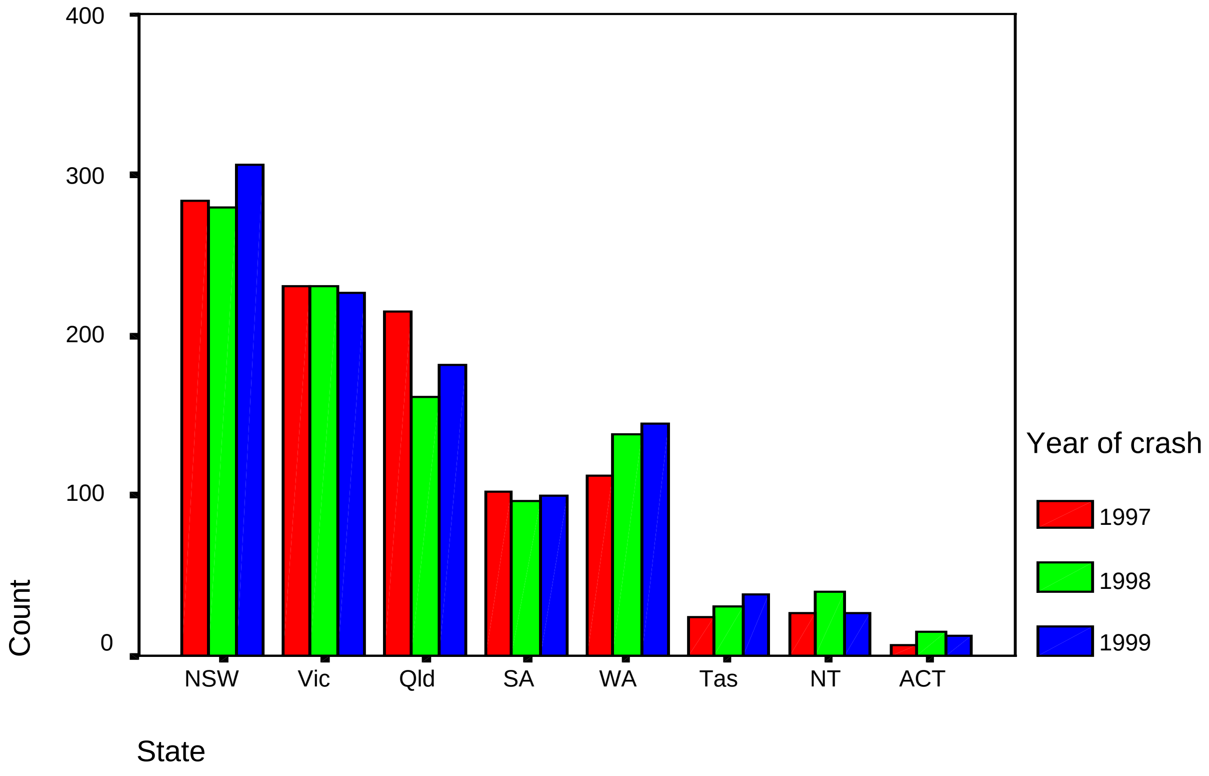

Figure 9.1 Trends for the frequency of fatalities to an occupant of a passenger vehicle by state

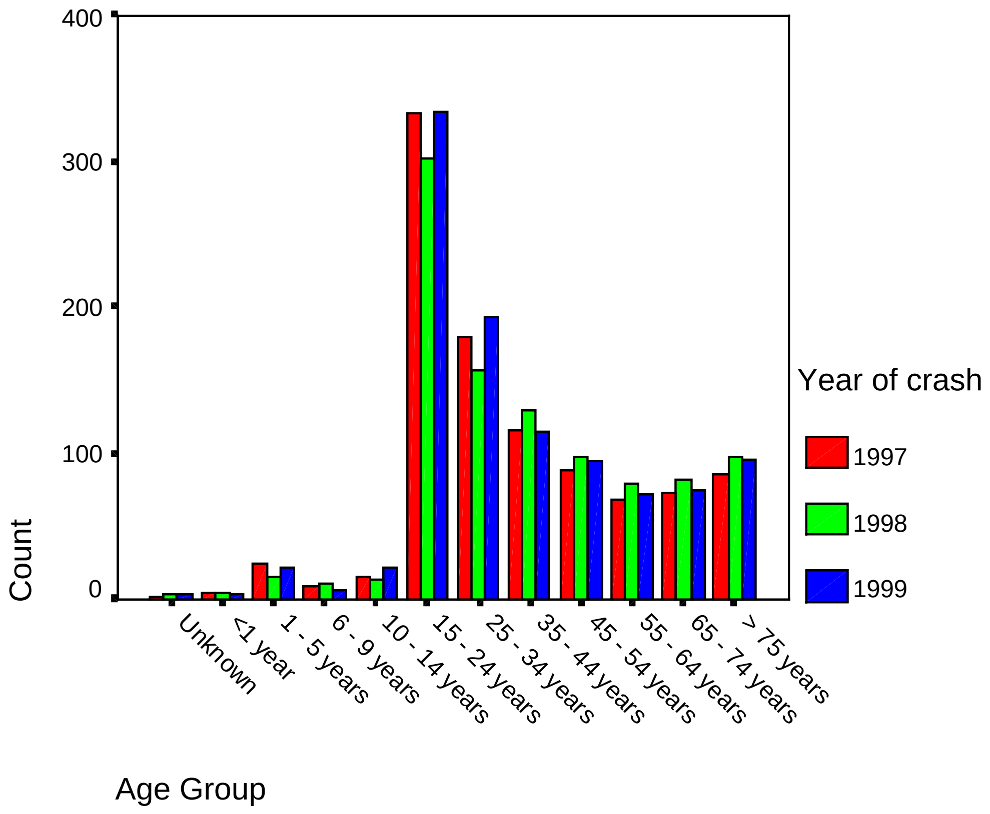

Figure 9.2 Trends for the age of people who died in a passenger vehicle, 1997-1999

Similarly, for trends regarding the sex and age of people fatally injured passenger vehicles, the statistics appear fairly stable from year to year, as shown in Figure 9.2 and Figure 9.3. In Figure 9.2 it is difficult to tell whether there are any trends within age groups of fatalities occurring within passenger vehicles because the longitudinal data only carries across three years. For Figure 9.3 it seems that there is an increasing trend for male occupants of passenger vehicles to be fatally injured. However, again, this can only be verified with data for more than three years.

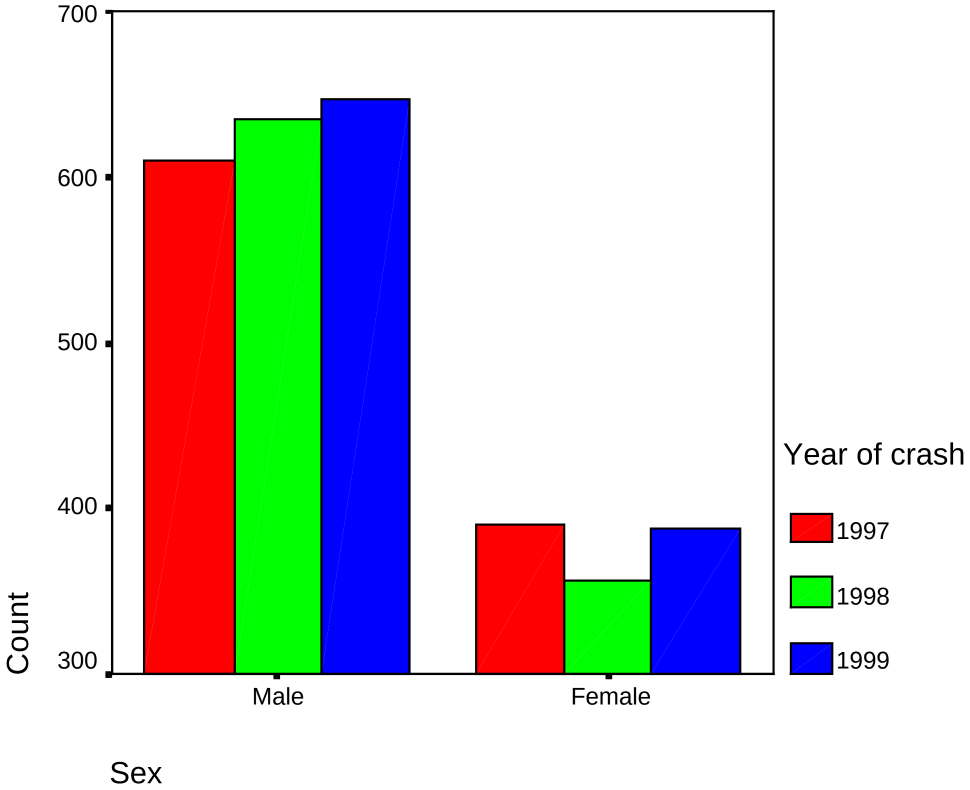

Figure 9.3 Trends for the Sex of people who died in passenger vehicles, 1997-1999

Table 9.10 presents trends for the years 1997-1999 of the seating position in the passenger vehicle of the person who was fatally injured. Again the distribution of people fatally injured according to location within the vehicle seems fairly stable.

Table 9.10 Trends for the location of the seating position of the occupant of a passenger vehicle fatally injured, 1997-1999

Road user location	Year of crash						Total	
	1997		1998		1999			
	Freq.	%	Freq.	%	Freq.	%	Freq.	%
Driver	630	63.0	610	61.6	687	66.4	1927	63.7
Seated front left	226	22.6	230	23.2	215	20.8	671	22.2
Seated front centre	3	0.3	3	0.3	4	0.4	10	0.3
Seated rear left	41	4.1	60	6.1	50	4.8	151	5.0
Seated rear centre	21	2.1	17	1.7	11	1.1	49	1.6
Seated rear right	46	4.6	31	3.1	37	3.6	114	3.8
Seated other rear	5	0.5	11	1.1	6	0.6	22	0.7
Lie down rear seat	1	0.1	7	0.7	3	0.3	11	0.4
Lie down rear of vehicle	4	0.4	Nil	0	1	0.1	5	0.2
Stand on front seat	1	0.1	Nil	0	Nil	0	1	0.0
Stand in rear of vehicle	9	0.9	3	0.3	Nil	0	12	0.4
Front passenger lap	Nil	0	1	0.1	2	0.2	3	0.1
Rear passenger lap	Nil	0	1	0.1	2	0.2	3	0.1
Unknown front seat	3	0.3	2	0.2	Nil	0	5	0.2
Unknown rear seat	10	1.0	14	1.4	17	1.6	41	1.4
Total	1000	100	990	100	1035	100	3025	100

9.3 Types of Crashes

In this section, we examine the nature of the crash and the vehicles involved where an occupant of a passenger vehicle died. Table 9.11 shows that for the years 1997 to 1999, there were 2581 accidents in which an occupant of a passenger vehicle died. Approximately half of these crashes were single vehicle crashes (1380 of 2581 cases) while a similar number involved more than one vehicle (1194 of 2581). As expected, there were very few crashes that involved only a passenger vehicle and a pedestrian in which an occupant of the vehicle died (7 of 2581 cases). Furthermore, the table tells us that nearly two fifths (445 of 1194 cases) of the multiple vehicle crashes involving fatalities to the occupant of a passenger vehicle were frontal collisions. For single collisions, nearly one third (439 of 1380) of the crashes were accidents in which the passenger vehicle overturned. This table is of significance to vehicle safety researchers because it demonstrates that it is important to consider both multiple and single vehicle crashes when considering ways to reduce road fatalities involving occupants of passenger vehicles.

Table 9.11 Crash Types versus Region of Impact for passenger vehicles in which at least one occupant died, 1997-1999

Impact Type	Crash type						Total	
	Single		Multiple		Pedestrian			
	Freq.	%	Freq.	%	Freq.	%	Freq.	%
Frontal	316	12.2	445	17.2	2	0.1	763	29.6
Passenger Side	170	6.6	252	9.8	Nil	Nil	422	16.4
Driver Side	238	9.2	290	11.2	3	0.1	531	20.6
Rear	15	0.6	29	1.1	1	<0.1	45	1.7
Rollover	439	17.0	35	1.4	Nil	Nil	474	18.4
Other	118	4.6	101	3.9	1	<0.1	220	8.5
Unknown or Not Applicable	84	3.3	42	1.6	Nil	Nil	126	4.9
Total	1380	53.5	1194	46.3	7	0.3	2581	100.0

Another statistic that may be of interest concerns the number of fatalities to occupants of particular types of passenger vehicles. Table 9.12 reveals most fatalities occurred to occupants of cars falling into the category Sedan/sports/coupe (58%). However there were a large number of fatalities to occupants of a station wagon (10%), 4WD vehicles (9.9%) and hatches (11.1%). However further claims regarding these statistics can only be made if one considers what percentage of the vehicles on the road fall into such categories. This could be achieved by reviewing data from the Australian Bureau of Statistics for vehicle registrations within Australia.

Table 9.12 Type of passenger vehicle in which an occupant died, 1997-1999

Vehicle Body Type	Frequency	%
Sedan/sports/coupe	1757	58.1
Hatchback	337	11.1
Station wagon	304	10.0
4WD-not car design	300	9.9
Car unknown	145	4.8
Utility-car design	96	3.2
Fwd control pass van	63	2.1
Panel van-car based design	17	0.6
Convertible	6	0.2
Total	3025	100

It is also of interest to know what types of impacts with a passenger vehicle caused the fatality of one or more of the occupants within that vehicle. Table 9.13 presents a cross-tabulation of the different crash partners in terms of multiple vehicle accidents where there was at least one fatality to an occupant of a passenger vehicle. Sometimes more than two vehicles were involved in the accident (in 99 of 1193 accidents) and sometimes more than one person died in the accident, often in two separate passenger vehicles. Table 9.13 provides statistics on all the crash partners for one of the passenger vehicles in which someone died for each accident (the struck vehicle). The small number of cases where there was more than one crash partner means that this should not adversely affect the accuracy of the results. Furthermore, one of the crashes listed in the Fatal File as a multiple car collision is actually a collision of a passenger vehicle with a parked vehicle of unspecified description. This accident is not included in Table 9.13. From Table 9.13 we see that from the 1193 multiple vehicle accidents in which an occupant of a passenger vehicle died, there were a total of 1307 crash partners.

Of potential interest to the researcher into road safety is the large number of accidents in which a fatality occurred to an occupant of a passenger vehicle due to a collision with a vehicle classified as a Van/ute/4wd (15.6% or 204 of 1307 crash partners) or as a rigid truck (16.1% or 211 of 1307). This could emphasise the need to reconsider the safety features of heavy vehicles or vehicles with "aggressive" bodies. Further analysis in terms of the population of different type of vehicles on Australian roads needs to be carried out to determine whether particular combinations of crash partners are over-represented.

Once again, we consider some trends in the types of crashes and the vehicles involved over a period of time. Table 9.14 demonstrates that while the overall numbers of accidents involving a fatality to an occupant of a passenger vehicle is relatively stable, there has been a slight trend towards increasing numbers of multiple vehicle collisions i.e. in 1997 the percentage of crashes which were multiple vehicle crashes was 44.1%, while in 1998 the percentage increased to 45.4% and further increased in 1999 to 49.3%.

Table 9.13 Impact partners for crashes in which an occupant of a passenger vehicle died, 1997-1999

Bullet Vehicle	Struck Vehicle				Total	
	Car		Van/ute/4WD			
	Freq.	%	Freq.	%	Freq.	%
Bicycle	1	0.1	Nil	Nil	1	0.1
MC	9	0.7	Nil	Nil	9	0.7
Car	537	41.1	27	2.1	564	43.2
Van/ute/4WD	204	15.6	24	1.8	228	17.4
Bus	23	1.8	2	0.2	25	1.9
Rigid truck	211	16.1	31	2.4	242	18.5
Art. Truck	174	13.3	34	2.6	208	15.9
Other	7	0.5	2	0.2	9	0.7
Unknown	20	1.5	1	0.1	21	1.6
Total	1186	90.7	121	9.3	1307	100

Table 9.14 Trends for type of crashes where an occupant of a passenger vehicle died, 1997-1999

Crash Type	Year of Crash						Total	
	1997		1998		1999			
	Freq.	%	Freq.	%	Freq.	%	Freq.	%
Single	480	55.4	465	54.4	435	50.6	1380	53.5
Multiple	382	44.1	388	45.4	424	49.3	1194	46.3
Pedestrian	4	0.5	2	0.2	1	0.1	7	0.3
Total	866	100	855	100	860	100	2581	100

While Table 9.15 shows that the proportion of fatalities to the occupant of a passenger vehicle that are frontal collisions is increasing (i.e. 25.9% in 1997, 33.1% in 1998 and 34.2% in 1999). In this case we have measured the number of fatalities, not the number of accidents because in a multiple car collision for the occupants of one vehicle, the crash may be a frontal collision, but for the occupants of the other vehicle, it may be a side impact. One might expect fatalities caused by frontal collisions to increase if the number of single vehicle crashes were increasing, but as this is not the case, one could venture to suggest that there is an increasing number of crashes in which a passenger vehicle collides head-on with another vehicle, resulting in a fatality to an occupant of the first vehicle. Table 2.16 confirms that over the three-year period 1997-1999, the proportion of fatalities to an occupant of a passenger vehicle involved in a multiple vehicle collision that can be classified as frontal collision has indeed increased from 32.7% to 41.6%, however the percentage peaked in 1998 at 43.2%.

Table 9.15 Trends for Impact zones for Passenger vehicle in which an occupant died, 1997-1999

Impact Zone	Year of Crash						Total	
	1997		1998		1999			
	Freq.	%	Freq.	%	Freq.	%	Freq.	%
Unknown or N/A	68	6.8	35	3.5	46	4.4	149	4.9
Other	108	10.8	78	7.9	71	6.9	257	8.5
Frontal	259	25.9	328	33.1	354	34.2	941	31.1
Passenger Side	185	18.5	169	17.1	147	14.2	501	16.6
Driver Side	197	19.7	190	19.2	219	21.2	606	20.0
Rear	17	1.7	14	1.4	25	2.4	56	1.9
Rollover	166	16.6	176	17.8	173	16.7	515	17.0
Total	1000	100	990	100	1035	100	3025	100

Table 9.16 Trends for impact zones for fatalities to occupants of passenger vehicles in multiple vehicle collisions, 1997-1999

Impact Zone	Year of crash						Total	
	1997		1998		1999			
	Freq.	%	Freq.	%	Freq.	%	Freq.	%
Unknown	23	4.9	10	2.1	23	4.2	56	3.8
Other	61	13.1	29	6.1	34	6.2	124	8.3
Frontal	152	32.7	205	43.2	228	41.6	585	39.3
Passenger side	104	22.4	99	20.8	103	18.8	306	20.6
Driver side	103	22.2	108	22.7	128	23.4	339	22.8
Rear	11	2.4	8	1.7	20	3.6	39	2.6
Rollover	11	2.4	16	3.4	12	2.2	39	2.6
Total	465	100	475	100	548	100	1488	100

One could also measure the effectiveness of road safety strategies or the need for greater focus on particular areas by examining the trend for the type of passenger vehicle in which an occupant died. Table 9.17 shows that the overall numbers of fatalities occurring within particular types of passenger vehicles have remained relatively stable over the given time period.

Table 9.17 Trends for fatalities to occupants of different types of passenger vehicles, 1997-1999

Vehicle body type	Year of crash						Total	
	1997		1998		1999			
	Freq.	%	Freq.	%	Freq.	%	Freq.	%
Sedan/sports/coupe	624	62.4	550	55.6	583	56.3	1757	58.1
Station wagon	99	9.9	109	11.0	96	9.3	304	10.0
Hatchback	105	10.5	114	11.5	118	11.4	337	11.1
Convertible	3	0.3	1	0.1	2	0.2	6	0.2
Utility-car design	43	4.3	23	2.3	30	2.9	96	3.2
Panel van-car design	4	0.4	8	0.8	5	0.5	17	0.6
Passenger van	23	2.3	20	2.0	20	1.9	63	2.1
4WD-not car design	99	9.9	97	9.8	104	10.0	300	9.9
Unknown	Nil	0	68	6.9	77	7.4	145	4.8
Total	1000	100	990	100	1035	100	3025	100

Furthermore, for multiple vehicle accidents in which an occupant of a passenger vehicle died, the type of vehicles which were the “crash partners” of the passenger vehicle remained fairly consistently distributed, except that 1999 saw a significant decrease in fatalities caused by impacts with 4WD vehicles, as shown in Table 9.18. Recall from the discussion concerning Table 9.13 that for a multiple vehicle accident, fatalities can occur in more than one passenger vehicle and there can be more than one “crash partner”.

Table 9.18 Trends for type of vehicle which collided with a passenger vehicle in which at least one occupant died, 1997-1999

Vehicle 2 Type	Year of crash						Total	
	1997		1998		1999			
	Freq.	%	Freq.	%	Freq.	%	Freq.	%
Bicycle	Nil	0	Nil	0	1	0.2	1	0.1
MC	1	0.2	3	0.7	5	1.0	9	0.7
Car	164	40.2	187	44.8	213	44.2	564	43.2
Van/Ute/4WD	85	20.8	84	20.1	59	12.2	228	17.4
Bus	5	1.2	5	1.2	15	3.1	25	1.9
Rigid truck	71	17.4	71	17.0	100	20.7	242	18.5
Art. Truck	69	16.9	56	13.4	83	17.2	208	15.9
Other	4	1.0	4	1.0	1	0.2	9	0.7
Unknown	9	2.2	7	1.7	5	1.0	21	1.6
Total	408	100	417	100	482	100	1307	100

9.4 Injuries

In this section we broadly examine the injuries sustained by the occupants of passenger vehicles when they are involved in a collision. However, as previously mentioned, the data of the Fatal File only considers crashes in which an occupant died. Hence, looking at cost caused by non-fatal injuries represented in this file would be misleading as the sample of non-fatal injuries is not random. So in this case, we only look at injuries to occupants who eventually died as a result of injuries sustained in a car accident.

Furthermore, it should be noted that in a car accident there could be several injuries that are considered fatal. In the case of the Fatal File, when a car accident results in the death of a passenger, the Coroner may list several causes of death. Furthermore, the Coroner may decide that the death occurred either as a direct result of the accident (i.e. "failure of an organ or system which suffered significant direct injury in the crash"); or because of factors indirectly related to the crash (i.e. "failure of an organ or system OTHER than that directly injured in the crash where it is clear that the failure occurred as a secondary result of the injuries"); or because of a factor not related to the crash (such as when interaction between a prior medical condition and trauma from the crash results in death or because of treatment-related factors or injuries suffered after the crash).

Table 9.19 demonstrates that the overwhelming majority of deaths occurred directly as a result of the crash. For this reason, we shall restrict all further analysis in this section to deaths directly caused by the crash. If two people die in the one passenger vehicle, each is treated as a separate case.

Table 9.19 Cause of death of the occupant of a passenger vehicle in relation to crash, 1997-1999

Cause of Death	Frequency	%	Cumulative %
Unknown	107	3.5	3.5
Non crash	15	0.5	4.0
Indirect crash death	136	4.5	8.5
Direct crash death	2767	91.5	100
Total	3025	100	

Of potential interest to those trying to reduce fatalities to occupants of passenger vehicles is the anatomical location of the primary fatal injury was sustained. Sometimes the Coroner will list more than one area of the body sustaining an injury that ultimately proved fatal. However, in the Fatal file, for the 2767 cases of occupants of passenger vehicles who died as a direct result of the crash, only in 12% of the cases did the coroner specify more than one body region as the location of the injury or injuries that caused the fatality. Usually the generic term "multiple" was used to specify cases where the occupant suffered fatal injuries to more than one body region. It is for this reason that the present analysis is further restricted to only looking at the first body region listed by the coroner, when examining the frequency of the body region that sustained the fatal injury. From Table 9.20 we see that the vast majority of fatal injuries to occupants of passenger vehicles who died as a direct result of their injuries occurred to the head region. However, a large number of deaths were the result of injuries to multiple body regions. The nature of such injuries requires further analysis.

One way of looking at the cost to society of car accidents is to consider the financial cost of a particular accident and then work out the rate at which that type of accident occurs. One can measure this cost by looking at the amount of hospitalisation required by the occupant after the crash as well as the loss of earnings caused by the temporary or permanent removal of that occupant from the workforce. An often-used metric for approximating the cost of road accidents is the concept of HARM (see Fildes and Cameron, 1998), which takes many different factors (such as amount of hospitalisation required, level of severity of injury and potential loss of earnings) into account when calculating the cost to society of a particular road accident. By measuring cost in this way, one can also measure the potential level of benefit to society of reducing certain types of injuries, fatalities or accidents. Such information is important as it provides car manufacturers and legislators with a clear understanding of the cost-effectiveness of implementing particular safety measures.

Table 9.20 General body region of primary fatal injury sustained by occupants of passenger vehicles who died as a direct result of their injuries, 1997-1999

Body Region	Frequency	%	Cumulative %
Unknown	17	0.6	0.6
Not applicable	289	10.4	11.1
Head	869	31.4	42.5
Face	3	0.1	42.6
Neck	45	1.6	44.2
Thorax	334	12.1	56.3
Abdomen / pelvic	43	1.6	57.8
Spine	55	2.0	59.8
Upper extremity	2	0.1	59.9
Lower extremity	5	0.2	60.1
External	51	1.8	61.9
Multiple	1041	37.6	99.5
Injury NFS	13	0.5	100
Total	2767	100	

Table 9.21 shows that the overwhelming majority of such cases where the occupant of a passenger vehicle died as a direct result of their injuries were not admitted to hospital (i.e. they died before they reached the hospital or died at the scene of the accident). Specifically, 53.6 % died instantaneously, 11.1% died before medical treatment arrived, 4.9% died during treatment at the scene and 1.6% died in transit to the hospital. Thus it is likely that their cost to society would have been quite low in terms of hospitalisation. However a significant proportion (22.6%) did require hospitalisation. The length of their stay in hospital before dying is not available.

Table 9.21 Timing of death for occupants of passenger vehicles who died as a direct result of their injuries, 1997-1999

Timing of Death	Frequency	%	Cumulative %
Unknown	40	1.4	1.4
Instantaneous	1483	53.6	55.0
Died no witness	129	4.7	59.7
Before medical	308	11.1	70.8
During medical	136	4.9	75.7
In transit	45	1.6	77.4
Hospital	625	22.6	100
After discharge	1	0.0	100
Total	2767	100	

Metrics such as HARM also classify the severity of injuries to body regions according to their cost. Table 9.22 depicts the occurrence of different grades of injuries to different body regions. Again, the analysis is only carried out for primary fatal injuries sustained by occupants of passenger vehicles. It should be noted that many of the injuries were listed in severity levels other than the maximum (injuries which cannot be survived), implying that they may have required some treatment prior to death. In fact injuries graded as maximum only made up 16.7% of all the primary fatal injuries. This would increase the HARM value for that particular occupant. Further analysis of the degree of severity of injuries to particular body regions (to occupants who survived the crash as well as those who eventually died) would be useful in determining cost-effective ways of reducing the cost of road accidents. Most primary fatal injuries occurred to the head and chest (45.2% and 30.2% respectively), while the two most common severity and body region pairings were serious head injuries (14.1%) and serious chest injuries (12%).

Table 9.22 General Body Region of Injury by AIS severity for occupants of passenger vehicles who died as a direct result of motor vehicle accidents

Region of AIS1 Injury	AIS Severity: N/A		Minor		Moderate		Serious		Severe		Critical		Max		Not Known		Total	
	Freq.	%	Freq.	%	Freq.	%	Freq.	%	Freq.	%	Freq.	%	Freq.	%	Freq.	%	Freq.	%
N/A	289	10.4	Nil	0	Nil	0	Nil	0	Nil	0	Nil	0	Nil	0	Nil	0	289	10.4
Head	Nil	0	25	0.9	33	1.2	304	11.0	389	14.1	270	9.8	226	8.2	3	0.1	1250	45.2
Face	Nil	0	24	0.9	14	0.5	4	0.1	Nil	0	Nil	0	Nil	0	Nil	0	42	1.5
Neck	Nil	0	1	0.0	8	0.3	2	0.1	3	0.1	2	0.1	3	0.1	Nil	0	19	0.7
Thorax	Nil	0	12	0.4	44	1.6	116	4.2	331	12.0	204	7.4	130	4.7	Nil	0	837	30.2
Abdomen / pelvic contents	Nil	0	2	0.1	31	1.1	10	0.4	23	0.8	11	0.4	2	0.1	Nil	0	79	2.9
Spine	Nil	0	Nil	0	23	0.8	5	0.2	2	0.1	28	1.0	30	1.1	Nil	0	88	3.2
Upper Extremity	Nil	0	3	0.1	15	0.5	7	0.3	Nil	0	Nil	0	Nil	0	Nil	0	25	0.9
Lower Extremity	Nil	0	2	0.1	6	0.2	35	1.3	2	0.1	1	0.0	Nil	0	Nil	0	46	1.7
External	Nil	0	10	0.4	Nil	0	1	0.0	1	0.0	10	0.4	70	2.5	Nil	0	92	3.3
Total	289	10.4	79	2.9	174	6.3	484	17.5	751	27.1	526	19.0	461	16.7	3	0.1	2767	100

Table 9.23 again shows that across all types of passenger vehicles, the most common body region in which a fatal injury occurred was to the head and chest. The two most common pairings for region of injury and vehicle type was head injuries occurring within a Sedan/sports/coupe-type vehicle (26.9%) and chest injuries occurring within a Sedan/sports/coupe-type vehicle (18.5%). Of all the primary fatal injuries occurring to occupants of passenger vehicles, 57.9% occurred in Sedan/sports/coupe-type vehicles. Injuries occurring to occupants Station wagons and Four wheel drive vehicles made up 10.3% and 9.6% of the primary fatal accidents occurring to occupants of passenger vehicles.

Table 9.23 Region of Fatal AIS injury by type of car in which the occupant of a passenger vehicle died, 1997-1999

Region of AIS1 Injury	Vehicle Body Type: Car unknown		Sedan/ Sports/ Coupe		Station wagon		Hatch-back		Con-vertible		Ute-car design		Panel van-car design		Fwd cntrl pass van		4WD		Total	
	Freq.	%	Freq.	%	Freq.	%	Freq.	%	Freq.	%	Freq.	%	Freq.	%	Freq.	%	Freq.	%	Freq.	%
N/A	84	3.0	92	3.3	38	1.4	14	0.5	Nil	0	11	0.4	Nil	0	8	0.3	42	1.5	289	10.4
Head	31	1.1	745	26.9	116	4.2	150	5.4	4	0.1	43	1.6	8	0.3	23	0.8	130	4.7	1250	45.2
Face	Nil	0	29	1.0	3	0.1	7	0.3	Nil	0	Nil	0	1	0.0	1	0.0	1	0.0	42	1.5
Neck	1	0.0	7	0.3	4	0.1	4	0.1	1	0.0	Nil	0	Nil	0	Nil	0	2	0.1	19	0.7
Thorax	14	0.5	512	18.5	98	3.5	100	3.6	Nil	0	19	0.7	4	0.1	20	0.7	70	2.5	837	30.2
Abdomen / pelvic contents	Nil	0	49	1.8	10	0.4	6	0.2	Nil	0	3	0.1	Nil	0	2	0.1	9	0.3	79	2.9
Spine	5	0.2	51	1.8	9	0.3	13	0.5	Nil	0	2	0.1	1	0.0	1	0.0	6	0.2	88	3.2
Upper Extremity	1	0.0	16	0.6	1	0.0	3	0.1	Nil	0	1	0.0	Nil	0	1	0.0	2	0.1	25	0.9
Lower Extremity	2	0.1	29	1.0	4	0.1	7	0.3	Nil	0	3	0.1	Nil	0	1	0.0	Nil	0	46	1.7
External	Nil	0	71	2.6	2	0.1	11	0.4	1	0.0	1	0.0	1	0.0	1	0.0	4	0.1	92	3.3
Total	138	5.0	1601	57.9	285	10.3	315	11.4	6	0.2	83	3.0	15	0.5	58	2.1	266	9.6	2767	100

Table 9.24 indicates that a large proportion of chest injuries occurred in frontal collisions (37.7% or 316 of 837 chest injuries). On the other hand, head injuries were strongly present across side impacts, frontal collisions and rollovers (40.8%, 26.1% and 19% respectively).

Table 9.24 Region of AIS fatal injury by the region of impact for occupants of passenger vehicles, 1997-1999

Region of AIS1 Injury	Impact Type															
	Unknown or N/A		Other		Frontal		Passenger Side		Driver Side		Rear		Rollover		Total	
	Freq.	%	Freq.	%	Freq.	%	Freq.	%	Freq.	%	Freq.	%	Freq.	%	Freq.	%
N/A	42	1.5	13	0.5	70	2.5	41	1.5	44	1.6	10	0.4	69	2.5	289	10.4
Head	46	1.7	113	4.1	326	11.8	243	8.8	258	9.3	25	0.9	239	8.6	1250	45.2
Face	1	0.0	4	0.1	21	0.8	5	0.2	7	0.3	1	0.0	3	0.1	42	1.5
Neck	Nil	0	3	0.1	7	0.3	3	0.1	4	0.1	Nil	0	2	0.1	19	0.7
Thorax	32	1.2	68	2.5	316	11.4	127	4.6	178	6.4	11	0.4	105	3.8	837	30.2
Abdomen / pelvic contents	4	0.1	9	0.3	34	1.2	9	0.3	12	0.4	1	0.0	10	0.4	79	2.9
Spine	8	0.3	9	0.3	25	0.9	16	0.6	14	0.5	1	0.0	15	0.5	88	3.2
Upper Extremity	1	0.0	2	0.1	8	0.3	5	0.2	7	0.3	Nil	0	2	0.1	25	0.9
Lower Extremity	Nil	0	Nil	0	23	0.8	7	0.3	15	0.5	Nil	0	1	0.0	46	1.7
External	3	0.1	4	0.1	24	0.9	13	0.5	24	0.9	6	0.2	18	0.7	92	3.3
Total	137	5.0	225	8.1	854	30.9	469	16.9	563	20.3	55	2.0	464	16.8	2767	100

Table 9.25 indicates that the trend over the three-year period, 1997-1999, for the region of the body in which a fatal injury occurs remains fairly constant from year to year, with head and chest injuries making up the greatest proportion of injuries. The percentage of primary fatal injuries that occurred to the head dropped from 55.4% in 1997 to 40.6% in 1998. The lower frequency of primary fatal head injuries remained at the lower level in 1999 (40.3%).

Table 9.25 Trends for the Region of the fatal injury of an occupant of a passenger vehicle, 1997-1999

Region of AIS1 Injury	Year of crash							
	1997		1998		1999		Total	
	Freq.	%	Freq.	%	Freq.	%	Freq.	%
External	36	4.1	19	2.1	37	3.8	92	3.3
Lower Extremity	7	0.8	21	2.3	18	1.8	46	1.7
Upper Extremity	3	0.3	12	1.3	10	1.0	25	0.9
Spine	37	4.2	25	2.8	26	2.6	88	3.2
Abdomen / pelvic contents	23	2.6	28	3.1	28	2.8	79	2.9
Thorax	253	28.9	316	34.8	268	27.3	837	30.2
Neck	1	0.1	8	0.9	10	1.0	19	.7
Face	10	1.1	17	1.9	15	1.5	42	1.5
Head	485	55.4	369	40.6	396	40.3	1250	45.2
N/A	20	2.3	94	10.3	175	17.8	289	10.4
Total	875	100	909	100	983	100	2767	100

9.5 Road Conditions and External Factors

It is also important to examine factors other than those involving the vehicle that could have lead to an occurrence of a fatal road accident involving a passenger vehicle. The data set for the analysis is again all crashes in which an occupant of a passenger vehicle died (N=2581).

One factor that can have a great impact on the likelihood of an accident is the setting of appropriate speed limits. Table 9.26 shows that a disproportionate number of accidents occur in high speed zones (32.1% occurring in 100 km/h and 12.3% occurring in 110 km/h zones), thus emphasizing the need to pay a great deal of attention to building effective safety devices into road and roadsides that have high speed limits. The percentage of accidents occurring in 60 km/h zones was 21.2%. This high figure can be explained by the fact that a large percentage of urban roads in Australia have a 60km/h limit.

Table 9.26 Speed limit at crash site for accidents in which at least one occupant of a passenger vehicle died, 1997-1999

Speed Limit	Frequency	%	Cumulative %
Unknown	382	14.8	14.8
30	1	0.0	14.8
40	4	0.2	15.0
50	4	0.2	15.1
60	547	21.2	36.3
70	119	4.6	41.0
80	254	9.8	50.8
90	63	2.4	53.2
100	829	32.1	85.4
110	318	12.3	97.7
Unlimited (NT)	60	2.3	100
Total	2581	100	

Also of interest are the conditions in which the accident occurred. Table 9.27 shows that in 1999, there were more crashes in which an occupant of a passenger vehicle died during the day than at night (56.9% compared with 39.4%). The percentage of accidents occurring at dawn was 1.9%, while at dusk it was also 1.9%. Most crashes occurred during fine weather (72.3%). The data for this table was restricted to 1999 because the data for earlier years was not coded in a consistent manner.

Table 9.27 Weather Conditions by Natural Light at the time at which an accident where the occupant of a passenger vehicle died for the year 1999

Weather Conditions	Natural light									
	Day		Night		Dawn		Dusk		Total	
	Freq.	%	Freq.	%	Freq.	%	Freq.	%	Freq.	%
Fine	363	42.2	232	27.0	14	1.6	13	1.5	622	72.3
Strong winds	1	0.1	Nil	Nil	Nil	Nil	Nil	Nil	1	0.1
Snow/sleet/hail	1	0.1	Nil	Nil	Nil	Nil	Nil	Nil	1	0.1
Rain-unspecified	4	0.5	12	1.4	Nil	Nil	2	0.2	18	2.1
Rain-heavy	14	1.6	7	0.8	Nil	Nil	Nil	Nil	21	2.4
Rain-light mod	32	3.7	15	1.7	Nil	Nil	1	0.1	48	5.6
Fog	2	0.2	5	0.6	1	0.1	Nil	Nil	8	0.9
Unknown	72	8.4	68	7.9	1	0.1	Nil	Nil	141	16.4
Total	489	56.9	339	39.4	16	1.9	16	1.9	860	100

When deciding how to improve safety conditions, it is important to examine on which types of roads most of the fatalities are occurring. From Table 9.28, it can be seen that two-way undivided roads that are not National Highways require special attention when considering upgrading the safety features of the Nation's roads. That is, 80.1% of road accidents in which the occupant of a passenger vehicle died occurred on two-way undivided roads, whereas only 11.9% (246 of 2068 accidents) of these occurred on National Highways.

Table 9.28 Road configuration and road type on which an accident in which the occupant of a passenger vehicle died occurred, 1997-1999

Road Configuration	Road Type									
	Unknown		National Hwy		Hwy/ arterial road		Other road		Total	
	Freq.	%	Freq.	%	Freq.	%	Freq.	%	Freq.	%
Other	Nil	Nil	Nil	Nil	6	0.2	4	0.2	10	0.4
Dual c/way fwy	Nil	Nil	24	0.9	52	2.0	Nil	Nil	76	2.9
Divided	1	<0.1	53	2.1	245	9.5	51	2.0	350	13.6
Two way undivided	6	0.2	246	9.5	691	26.8	1125	43.6	2068	80.1
One way	Nil	Nil	Nil	Nil	1	0.0	3	0.1	4	0.2
Unknown	3	0.1	18	0.7	24	0.9	28	1.1	73	2.8
Total	10	0.4	341	13.2	1019	39.5	1211	46.9	2581	100

The finding that crashes that occur on two way undivided roads contribute so greatly to deaths of occupants of passenger vehicles may prove to be a future priority area in reducing the national road toll (Table 2.16).

Table 9.29 indicates that that 32.1% of the 1194 multiple vehicle crashes involving a fatality to an occupant of a passenger vehicle were frontal collisions that occurred on two-way undivided roads. Improving safety features of such roads could help to significantly reduce fatalities to occupants of passenger vehicles. Driver side and passenger side impacts occurring on two-way undivided roads accounted for 16.2% and 15.2% of all multiple vehicle impacts where a death of an occupant of a passenger vehicle occurred.

Table 9.29 Road configuration by Impact zone for multiple collisions in which an occupant of a passenger vehicle died, 1997-1999

Impact Type	Road configuration													
	Unknown		One way		Two way undivided		Divided		Dual c/way fwy		Other		Total	
	Freq.	%	Freq.	%	Freq.	%	Freq.	%	Freq.	%	Freq.	%	Freq.	%
Rollover	Nil	Nil	Nil	Nil	26	2.2	6	0.5	3	0.3	Nil	Nil	35	2.9
Rear	4	0.3	Nil	Nil	13	1.1	5	0.4	7	0.6	Nil	Nil	29	2.4
Driver Side	13	1.1	Nil	Nil	194	16.2	72	6.0	9	0.8	2	0.2	290	24.3
Passenger Side	9	0.8	1	0.1	182	15.2	57	4.8	3	0.3	Nil	0	252	21.1
Frontal	4	0.3	Nil	Nil	383	32.1	48	4.0	10	0.8	Nil	Nil	445	37.3
Other	1	0.1	Nil	Nil	86	7.2	9	0.8	5	0.4	Nil	Nil	101	8.5
Unknown or N/A	1	0.1	Nil	Nil	31	2.6	7	0.6	3	0.3	Nil	Nil	42	3.5
Total	32	2.7	1	0.1	915	76.6	204	17.1	40	3.4	2	0.2	1194	100

It is also interesting to look at what proportion of fatal accidents occurred at intersections. Table 9.30 shows that the vast majority of crashes in which an occupant of a passenger vehicle died actually occurred between intersections, in the "mid-block" and that there were no traffic controls at the place where the crash occurred (79.1%). Accidents involving a fatality to an occupant of a passenger vehicle occurred at intersections with lights in 4.2% of cases; at intersections with no lights in 4.3% of cases; at an intersection with a stop sign in 3.2% of cases; and at intersections with a give-way sign in 5.6% of cases.

Table 9.30 Location with respect to intersection by type of traffic controls at the site of an accident in which at least one occupant of a passenger vehicle died, 1997-1999

Traffic controls	Location							
	Mid-block		Within intersection		Rel to int-other		Total	
	Freq.	%	Freq.	%	Freq.	%	Freq.	%
Road works	15	0.6	2	0.1	Nil	Nil	17	0.7
R-way crossing sign	4	0.2	Nil	Nil	Nil	Nil	4	0.2
Give way	5	0.2	144	5.6	1	<0.1	150	5.8
Stop sign	2	0.1	82	3.2	Nil	Nil	84	3.3
Turn left with care	1	<0.1	Nil	Nil	Nil	Nil	1	0.0
Intersection lights	2	0.1	109	4.2	2	0.1	113	4.4
Flashing lights	6	0.2	1	0.0	Nil	Nil	7	0.3
Boom gates	3	0.1	Nil	Nil	Nil	Nil	3	0.1
Lights with walk signals	1	<0.1	Nil	Nil	Nil	Nil	1	<0.1
None or not working	2041	79.1	112	4.3	16	0.6	2169	84.0
Unknown	3	0.1	28	1.1	1	0.0	32	1.2
Total	2083	80.7	478	18.5	20	0.8	2581	100

9.6 *Overview*

This section has provided an overview of some of the factors, which contribute to the deaths of occupants of passenger vehicles. The scope of the data is at present limited to fatalities, however it is hoped that in the future similar analysis will be possible for injuries to occupants of passenger vehicles. However, already some interesting results can be derived from the analysis of the present chapter. Table 9.2 enabled one to see that drivers were most at risk of being fatally injured in a passenger car, while Table 9.4 showed that young male drivers were the most likely to be involved in accidents in which the occupant of a passenger car died. Table 9.13 emphasised that more attention needed to be paid to the design of heavy vehicles or vehicles with aggressive bodies so that they cause less severe outcomes when impacting with a passenger vehicle. It is also evident from the review of injury information that a large proportion of occupants sustain severe head and chest injuries.

The chapter also reported the problem of the increasing trend of multiple vehicle head on collisions that result in the death of an occupant of a passenger vehicle (see Table 2.16) However, through Table 9.28, a potential remedy to this problem was suggested. Reducing the number of two lane undivided roads, or improving the roadside safety features of such roads could serve to reduce the number of multiple vehicle frontal collisions and thus significantly reducing the number of fatalities across Australia.

10 DISCUSSION AND FUTURE DIRECTIONS

As noted earlier, ANCIS (the Australian National Crash In-Depth Study) is a collaborative research project comprising Monash University, the automobile manufacturers of Australia, Federal and State Government transport and insurance agencies, vehicle component suppliers and members of the Australian automobile associations. Its objective is to provide a representative sample of vehicle crashes from around Australia for use in improving vehicle crashworthiness and crash involvement. This first ANCIS report is intended to provide preliminary results of the 180 detailed in-depth crashes examined to date as well as some recent trends in fatal vehicle crashes from around Australia.

At this stage, it should be noted that the findings are somewhat limited by the number of cases available and the small number of participating states in data collection (Victoria and New South Wales only). During 2003, Tasmania will join the program and negotiations are underway to expand the data collection into other jurisdictions. However, caution should be taken in the interpretation of these data, especially in assuming they represent the whole of Australia at this time.

The data collection activity was predominantly confined to urban crashes (54% urban to 46% rural) from the two most urban states in Australia. It is a high priority to include other states that have a higher number of rural crashes to ensure these data become more representative of Australia generally. It is intended for ANCIS to continue beyond 2003 to expand the number of cases available and increase its research value.

This report is indicative, though, of what can be expected from in-depth road crash data. Statistical significance of these results will always be a challenge because of the small number of cases, compared to mass data analyses, typically collected from police reports across the states and territories. However, they are rich in terms of the level of detail they collect and are therefore more likely to provide detail on causal relationships between human, vehicle and road and environment factors.

They are valuable for developing more detailed accounts of the types and causes of injuries and crashes, crash and injury severities and the many factors associated in the lead up to a crash beyond a simple primary cause. It is argued that these data can provide another level of crash and injury analysis that will enhance our understanding of occupant and road trauma and lead to new countermeasures and intervention programs to address tomorrow's road safety programs.

10.1 Overall Findings

Without wanting to dwell too much on these preliminary findings, it nevertheless is worthwhile highlighting some of the more interesting and new results uncovered from this analysis.

Injured Occupants

Roughly one-third of all injured occupants were drivers, 17% were front passengers and 1 in 10 were in the rear. Unbelted rates were 11% for drivers, 19% front passengers and 31% rear passengers. Children comprised 5% of the sample, older occupants (above 65 yrs) 15%, young adults (25 yrs or less) 23% and the remaining 57% were other adults. Overweight and obesity was observed in more than one-third of the population. Sixty-three percent of the injured occupants sustained a MAIS of 3 or more, which was slightly lower in frontals (62%) than side impacts (65%), especially near-side impacts (72%).

Vehicles

More than half the vehicles involved were 4 years old or less but this is biased by the entry age criteria. Large cars comprised 40% of the crashed vehicle sample, small cars 39%, 4WDs 8%, sports and luxury vehicles 7%, and medium sized cars 6%. The big-four Australian manufactured vehicles made up two-thirds of all crashed vehicles. Two-thirds of the vehicles inspected did not have a driver airbag and three-quarters were without a passenger airbag. Side airbags were not present in more than 90 percent of the crashed vehicles examined.

The mean impact severity was 49km/h and higher in frontal crashes (58km/h) than side impacts (38km/h). Crash severity is typically lower in side impacts, given the minimal amount of structure between the impacting object and the occupant in a near-side crash and that both the impacted vehicles share the impact force in this crash configuration. It was not possible to compute impact severity in rollover crashes.

Crashes

Frontal crashes comprised 48% of the sample, side impacts 36%, rollovers 12 %, and rear impacts 4%. The proportion of side impacts in multi-vehicle crashes was much higher in urban areas (51%), while frontals predominated in two-thirds of all rural crashes. Single vehicle crashes were noted in 55% of rural crashes and 45% of urban ones. More than one-third of the crashes occurred in 60km/h speed zones or less, 35% for 90 or 100km/h zones, one-quarter in 70 or 80km/h speed zones, and 2% on 110km/h freeways.

The majority (60%) of the crashes occurred during daylight hours, 28% at night and 12% either dusk or dawn. A sizeable 84% occurred during fine weather while the rest experienced either rain or fog. Intersections were the predominant site for 61% of urban crashes while mid-block sections accounted for 70% of rural crashes. Only 4% of urban crashes occurred at roundabouts. Almost one-third of the crashes (31%) occurred on curves or bends.

The crash site details reported here were minimal during the first years of the study but gradually more details have been collected at each site throughout the course of the first three years. In particular, the site examiners now assign associated causal factors for the human, the vehicle and the road at each location. This will enable a more comprehensive analysis of the crash involvement features in future reports.

10.2 Future Directions

As pointed out earlier, these results are limited by the minimal amount of data available and the bias towards survivable urban crashes in Victoria and New South Wales. The Project Management Team has already taken three initiatives to overcome these limitations.

First, current partners in ANCIS have all agreed in principal to continue their commitment to the program for an additional 3-year period. This will enable the number of cases in the database to expand markedly, thereby increasing the robustness and reliability of the findings. Current plans are for ANCIS to continue indefinitely so that trends in crashes and injuries can be monitored as new vehicles and safety programs are introduced and take effect. Of course, this will depend very much on the value of these data for the participating organisations and their abilities to continue to fund the program.

Second, approaches have been made to other states in Australia to join the program. Tasmania has agreed to join the ANCIS program for an initial trial period through the Department of Infrastructure and Environmental Resources (DIER). Data collection will commence in that state during 2003 for a limited period to demonstrate their value in highlighting crash causation and benefits of current initiatives. It is expected that these data will enhance those already collected in the other states and will act to provide a higher level of representative ness.

In addition, other Australasian jurisdictions have been approached to join ANCIS and discussions so far have been positive and promising. As each new jurisdiction comes on-stream, negotiations will commence with other states and territories to join the program. Our ultimate vision is for ANCIS to operate across enough of Australia (and hopefully New Zealand) to provide representative in-depth data on crashes occurring across the whole region.

Third, there was a marked lack of fatal crash outcomes in the study, essentially the result of focussing entirely on hospital admissions. ANCIS seeks to provide a representative database of serious casualties and therefore is lacking the most severe type of crash. Consequently, we have approached the Coroners of New South Wales, Victoria and Tasmania to enlist their involvement in future data collection. This will ensure that a representative sample of fatal outcomes is also added to the database in future years.

It should be stressed that an important aspect of ANCIS activities is for local research agencies to collect these data on behalf of MUARC and the Program Management Committee. This will ensure that those undertaking the work are aware of local requirements and conditions and best placed to respond to particular regional sensitivities.

10.3 Future Reports

The ANCIS Project team are committed to providing annual reports on the database along the lines provided here. As the database expands, it is hoped to expand the types and depth of analyses possible. State by state comparisons should be possible ultimately to highlight local problems and difficulties needing intervention.

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APPENDIX: DCA CODE CHART