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AUSTROADS RESEARCH REPORT

Medical Conditions as a Contributing Factor in Crash Causation



Austroads

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Austroads

Sydney 2011

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- promote improved practice and capability by road agencies.
- promote consistency in road and road agency operations.

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- Roads Corporation Victoria
- Department of Transport and Main Roads Queensland
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- Department for Transport, Energy and Infrastructure South Australia
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- Department of Lands and Planning Northern Territory
- Department of Territory and Municipal Services Australian Capital Territory
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SUMMARY

Road users with medical conditions may be at increased risk of being involved in a casualty crash, but the extent of the problem is not known. However, there is some evidence from the in-depth investigation of crashes that medical conditions and acute medical events play a significant role in crash causation.

The main purpose of the current study was to determine the extent to which a pre-existing medical condition or acute medical event was a contributing factor in crash causation for a representative sample of casualty crashes. The study involved examination of the circumstances surrounding drivers, riders, cyclists and pedestrians involved in casualty crashes on public roads in South Australia who were admitted to the Royal Adelaide Hospital over the three year period from January 2008 to December 2010. During the course of the study the records of 1490 individuals meeting the selection criteria were made available. Data for each of these 1490 crash involved participants was collected and matched from multiple sources to provide a holistic picture of the circumstances surrounding their crash involvement. Data collected and matched during the study included: medical assessments and interventions undertaken during hospitalisation, police data related to this and previous crashes, licensing history data related to conditional licensing status and infringements, and forensic science data related to mandatory testing for alcohol and drugs. This linkage approach to data collection allowed for a more holistic understanding of the role of medical conditions and acute medical events in crash causation.

In the 1490 cases examined in the study it was found that a medical condition or acute medical event was a contributing factor in the crash events with a high degree of certainty in 165 cases, accounting for 11% of all cases. A further 24 cases were identified as possible cases, giving a total number of 189 cases (12.7%).

A medical condition or acute medical event was found to be a contributing factor in crash causation across all road user types, however, drivers were found to be more likely than all other road users to be identified as being involved in a crash because of these. A medical condition or acute medical event was found to be a contributing factor in crash causation for 18.1% of the drivers in the study.

In almost 25% of medically related cases the participant was known to have experienced a loss of consciousness prior to being involved in the crash. The second most common medical event found among those identified with a medical condition were those who experienced a seizure that led to the crash, accounting for 17% of the crashes involving a medical condition or acute medical event. In both cases these events were seen to result in crash involvement for drivers and riders.

There were 42 participants involved in a crash in the study as the result of mental illness and/or as the result of a deliberate suicide attempt, accounting for more than 22% of the crashes in the study that were identified as occurring as the result of a medical condition or event. These participants were frequently identified as being intoxicated on alcohol at the time of the crash, often in a climate of known alcohol dependence.

In addition to those involved in the crash as the result of a medical condition there was a group of participants who were involved in the crash due to impairment as the result of alcohol intoxication. Alcohol impairment was identified as the leading contributing factor to crash causation in this study with 18.4% of all cases involving a participant who had a blood or breath alcohol level of 0.05 or more. While acute alcohol intoxication is not considered a medical condition as such, most would agree that intoxication in a climate of alcohol dependence is. Alcohol dependence was identified in the medical records to be a pre-existing medical condition for 146 of the participants in the study. More than 50% of those identified in medical records as being alcohol dependent were known to have an alcohol level above 0.05 at the time of the crash. Those involved in a crash due to alcohol

alone are not considered in any analysis of the group identified as experiencing a medical condition or event.

Those identified as being involved in a crash as the result of a medical condition or acute medical event were seen across all age groups. However, those participants who were 70 years or older were found to be involved in a disproportionate number of crashes involving a medical condition or event. While those 70 years of age or older accounted for 11.4% of participants in the study, they constituted more than 30% of those involved in a crash as the result of a medical condition or event. Those identified as being involved in the crash as the result of mental illness or a deliberate suicide attempt were found to be younger, with most participants being between the ages of 20 and 50 years.

Single vehicle crashes, particularly crashes into fixed objects, were the most common crash type seen amongst those participants involved in the crash as the result of a medical condition or acute medical event, accounting for 40% of all crashes for this group.

1 INTRODUCTION AND BACKGROUND

Impairment as the result of a medical condition or acute medical event and the role that impairment takes in crash causation has been recognised as a road safety issue in Australia and other industrialised nations for more than three decades. Their contribution to the overall crash problem, however, have frequently been overshadowed or seen as less important when compared to the risks posed by other road user groups including young drivers and those who are impaired as the result of alcohol. As the age of the road user demographic increases there has been a renewed interest in the role of medical conditions as an increasingly important area of research. This recognition has led to studies that have attempted to identify those medical conditions that pose the greatest risk to crash involvement.

These studies have been diverse in their approach and have included crash based study approaches [1-2], and studies that have examined specific medical conditions, in attempts to identify the risk ratios for individual conditions [3-4]. In some instances the research approach has been more generally focussed, emphasising the role of increasing age and the subsequent impact of multiple co-morbid medical conditions frequently seen in this group [5-9]. Among the important recent works addressing the issue of medical conditions in crash involvement has been those that have reviewed the literature of the current knowledge and those who have attempted to identify risk ratios for particular medical conditions, including Charlton et al and Dobbs [10-12]; and those that have undertaken comprehensive analysis related to crashes where at-scene crash investigation and follow-up occurred, including Hanna's retrospective analysis in 2005-2007 that was based on the US National Motor Vehicle Crash Causation Survey (NMVCCS) [2]. The conclusions drawn from Hannah's analysis suggested that medical emergencies accounted for only 1.3 % of all drivers in the study. These conclusions are in contrast to the results from a preliminary study undertaken by the Centre for Automotive Safety Research but are likely to reflect differences in methodology.

During the period 2002-2005 the Centre for Automotive Safety Research undertook an in-depth investigation of casualty crashes in the Adelaide metropolitan area. This study involved at-scene investigation and follow up of over 300 casualty crashes, including examination of the medical records of those persons who were treated or admitted to a public hospital in South Australia, or were fatally injured. Among the findings for that study it was found that almost half of the drivers, riders and pedestrians involved in the collisions had at least one pre-existing medical condition, and half of these individuals had two or more such conditions. Importantly, it was found that a medical condition was the direct causal factor in 13% of the casualty crashes investigated and accounted for 23% of all hospital admission or fatal crash outcomes [13].

The crashes investigated in the above in-depth study were not a representative sample of all casualty crashes; more than 90% occurred between 8 am and 8 pm, Monday to Friday. This had the potential to have resulted in a bias towards the elderly, who tend to travel mainly during daylight hours, and away from young and/or alcohol impaired drivers. In light of the identified limitations the current study, based on data collection for the period 2008 to 2010, was developed.

A deeper understanding of the circumstances surrounding a person's involvement in a crash as the result of a medical condition or event has the potential to inform those involved in decision making related to fitness to drive assessment and other stakeholders seeking countermeasures to reducing the crash involvement of this vulnerable group of road users. This exploration has the potential to aid in the evaluation of current countermeasures in the pursuit of possible new countermeasures.

A comprehensive set of data related to 1490 drivers, motorcycle riders, pedestrians and pedal cyclists involved in casualty crashes over a three year period formed the basis for this report. This data set involved collection of data from four multidisciplinary sources which included medical, police, licensing and forensic drug and alcohol information for each of the participants. The data

was then analysed to obtain a more holistic understanding of the circumstances surrounding each participants involvement in the crash investigated.

It was not the primary purpose of this report to generate countermeasures for reducing the incidence or impact of medical conditions that result in crash involvement but rather to provide a new understanding of the types of medical conditions or acute medical events that are most likely to contribute to a person's involvement in a crash. This data can then be used in conjunction with other research to formulate new countermeasures and inform on those already in place.

2 METHOD

2.1 Overview

The main purpose of the current study was to determine the extent to which a pre-existing medical condition or acute medical event are contributing factors in crash causation at all times of the day and on all days. The study involved examination of the circumstances surrounding drivers, motorcycle riders, cyclists and pedestrians involved in casualty crashes on public roads in South Australia who were admitted to the Royal Adelaide Hospital over the three year period from January 2008 to December 2010. During the course of the study the records of 1490 individuals meeting the selection criteria were made available. Data for each of these 1490 crash involved participants was collected and matched from multiple sources to provide a holistic picture of the circumstances surrounding their crash involvement. Data collected and matched during the study included: medical assessments and interventions undertaken during hospitalisation, police data related to this and previous crashes, licensing history data and forensic science data related to mandatory testing for alcohol and drugs. The documentation found in the medical records was the key source of evidence used in determining those participants who were involved in a crash as the result of a medical condition or acute medical event.

2.2 Medical records

The medical records related to the participants involved in crashes during the data collection period were sourced at the Royal Adelaide Hospital following approval from the Royal Adelaide Hospital Research Ethics Committee and the University of Adelaide Compliance and Ethics Unit prior to commencement of the study. The project was also endorsed by the Director of Trauma Services at the Royal Adelaide Hospital. Access to confidential information from these records was facilitated by Section 64D, Form 7 status within the *South Australian Health Care Act 2008* that has been declared and granted by the South Australian Health Minister to the Centre for Automotive Safety Research. This declaration has been in place since 1987 and was re-declared in February 2011.

The Royal Adelaide Hospital is a 650 bed tertiary referral hospital located in the centre of Adelaide. The hospital is one of two designated adult major trauma services in South Australia with the services provided by the hospital catering for over two thirds of the total state workload. The services offered by the Royal Adelaide Hospital extend to include provision of care to patients from the Northern Territory and some parts of western New South Wales and Victoria. As one of the major tertiary care providers in South Australia, the Royal Adelaide Hospital provides some specialist services that are not provided in other centres; included among these services are specialist trauma, spinal and orthopaedic care services, burns unit and brain injury and rehabilitation services.

Because of the extended brief of the Royal Adelaide Hospital, it is expected that the severity of injury seen amongst the patients who present for care may not necessarily reflect a representative sample for all those injured as a result of crash involvement. This needs to be considered when interpreting the data presented in this report. During the course of data collection for this study there were 253 cases where the person involved in the crash as a participant in the study was first seen at a regional hospital in South Australia before being transferred to the Royal Adelaide Hospital for continuation of care. These transfers most commonly occurred through the provision of services offered by the aero-medical retrieval services of MedSTAR, a 24 hour designated retrieval team, or the Royal Flying Doctor Service (RFDS), but also included road transfers by way of South Australian Ambulance Services (SAAS). A further 62 participants were transferred for specialist care offered by the Royal Adelaide Hospital that was not available in the metropolitan hospital they first attended. These 315 cases represent more than 21% of all cases that presented to the Royal Adelaide Hospital during the study period.

All persons who present to the Royal Adelaide Hospital for medical care that is of four hours duration or more are formally admitted to the hospital and are required to undergo International Classification of Disease coding utilising version ten, Australian Modification (ICD10-AM). This coding process is undertaken following the patient's discharge from in-patient services. Within the ICD10-AM are specific codes related to external sources of injury, some of which relate to road crashes. From these codes the ICD10-AM specialised case-mix coders at the Royal Adelaide Hospital were able to identify those individuals who presented to the hospital for four hours or more as a result of a motor vehicle accident. Lists of cases that met the criteria for possible inclusion in the study, once identified by the coding services, were then provided to the medical records management team on a weekly basis throughout the data collection period, who then made the records available for examination by the researcher. The original, primary source, medical records were examined in detail. The information available in the records included:

2.2.1 South Australian Ambulance Service (SAAS) and/or Medical Retrieval records

In 1157 of the 1490 cases in the study the person presented to hospital following crash involvement by way of the South Australian Ambulance Service (SAAS); this accounted for 77.5% of all cases. Medical retrieval of patients to hospital occurred by way of the MedSTAR aero-medical retrieval services in 195 cases and the Royal Flying Doctor Service (RFDS) in 118 cases, accounting for 21% of all cases. Fewer than 1.5% of patients self presented to hospital for care following crash involvement. Written documentation from these sources are included in the patient's medical records and provide data related to primary assessments undertaken at the crash scene and pre-hospital care. Data found in these records included:

- time, date and exact location of the crash
- descriptions of the crash mechanisms, including movements of vehicles leading to the crash
- impact points/damage on vehicles and descriptions related to cabin intrusion and entrapment
- position in vehicle and basic information related to other occupants
- information related to restraint use and airbag deployment
- information related to helmet use for cyclists and riders, including evidence of damage
- primary at-scene health assessments
- documentation related to self reported past medical history and medication use
- information related to alcohol or drug use where suspected or known
- medical interventions undertaken at scene and during transport to hospital.

2.2.2 Emergency Department records

In all cases the person presenting to hospital as a result of crash involvement is assessed and provided with emergency care by specialist emergency and trauma service medical, nursing and allied health members in the Emergency Department. Documentation related to the care provided in the department is included in each persons medical records. Following presentation, assessment and primary care, patients requiring admission are designated to in-patient care. The Emergency Department of the hospital includes an Emergency Extended Care Unit. This Unit frequently provides extended care for those following involvement in crashes who require care and observation for up to 24 hours following admission. Those patients requiring higher level and longer term care are admitted to in-patient service units as appropriate. Data related to the primary assessments and care provided during the emergency/ trauma care period, including those within the Emergency Extended Care Unit, included:

- descriptions of the circumstances of the crash as understood following patient interview
- primary and secondary surveys for injuries incurred in the crash
- diagnostic tests undertaken and the results of those tests
- information related to pre-existing medical conditions and medication use
- documentation related to suspected alcohol use and breath alcohol results where conducted
- primary medical interventions undertaken
- destination information: for example discharged from Trauma Services to home or transfer to other in-patient services.

2.2.3 Hospital in-patient records

Approximately 80% of those patients in the study requiring admission to hospital were transferred from the Emergency Department to other in-service areas, including specialty units such as Intensive Care or other specialty and general wards. Data within these in-patient records included:

- person identifiers such as age, sex, date of birth, ethnicity, place of birth, marital status and in some instances occupational status
- records related to previous hospital contact either from presentation to the Emergency Department or in-patient services
- medical and nursing assessment and progress notes related to injuries and other health issues: these were examined for documentation related to medical assessments and conclusions that may explain or refute an existing health condition in crash causation
- documentation from specialist medical teams and other allied health care members that may have been requested for patient review. These teams are dependent on the individual's situation and may involve such services as the Drug and Alcohol Resource Unit, Social Work, mental health care services and others where relevant
- results of further diagnostic testing
- medication records
- records related to injury interventions such as surgical procedures
- discharge medical summary reports generated by medical team
- date of discharge, and therefore length of stay, and discharge destination.

2.3 Police generated records

Two discrete sources of information related to Police records were made available: Vehicle Collision Reports (VCR) and the Traffic Accident Reporting System (TARS). The information in these sources was made available following negotiation and agreement of a Memorandum of Understanding between South Australian Police (SAPOL) and the Centre for Automotive Safety Research. This agreement is long standing. Information found in the Police crash records includes:

2.3.1 Vehicle Collision Reports

- date, time and location of crash
- names and driver licence numbers of those involved in the crash
- licence type at time of crash
- brief description of crash
- information related to the road environment including road configuration and speed zone
- vehicle type and registration details
- injury status for those involved in crash and hospital taken to.

2.3.2 Traffic Accident Reporting System

All of the above information is provided but also includes previous crash histories including dates, locations, descriptions of those crashes, at-fault status for each crash and identification of the category of at-fault.

2.4 Licensing records

The licensing records related to those drivers and riders involved in crashes during the data collection period were sourced at the Department of Energy and Infrastructure - Licensing Safety and Regulation Division. Records were accessed in most cases by driver licence number identified in the South Australian Police (SAPOL) collision records, utilising the Transport Regulation User Management Processing System (TRUMPS) program. Information gathered from this source included:

- class and type of licence held at time of crash involvement
- identification of any conditions or restrictions to licensure
- infringement history including identification of the type of infringement
- history related to any previous disqualifications and reasons for those disqualifications.

2.5 Forensic Science records

Since 1972 those crash involved drivers, motorcycle riders, vehicle occupants and pedestrians over the age of 14 years, who present to hospital as a result of a crash, have been required to undergo mandatory testing for blood alcohol concentration in South Australia. Since July 2008 the mandatory screening has also included screening for three drugs: methamphetamine, Tetrahydrocannabinol (THC) and 3,4-Methylenedioxymethamphetamin (MDMA). These tests require a blood sample to be taken by hospital medical personnel within eight hours of being involved in the collision, with most occurring within the first one to two hours following the crash. The samples are sent to and tested by the South Australian Forensic Science Centre. The results of these tests were made available for those drivers, motorcycle riders and pedestrians identified within the study for matching following confidentiality agreement. The records provided include the results following testing as well as the time that the sample was taken.

2.6 Results

Participants were identified as being involved in a crash as the result of a medical condition or acute medical event based on the information found in the medical records. This information led to the formulation of two distinct groups of participants: those who were found to be involved in a crash as the result of a medical condition or acute medical event with a high degree of certainty and those where a medical condition/acute event is likely to have played a contributing role but with less certainty, categorised as possible. Allocation of participants to these two distinct groups was based on the following criteria:

Medical condition/acute medical event contributing to the crash with a high degree of certainty

For a participant to be included in this category the medical records needed to include documentation provided by the attending medical personnel stating that a medical condition or event contributed to the crash; for example 'involved in a car accident as the result of a seizure', 'patient was a driver who lost consciousness before hitting a parked car'. This documentation in most cases included further information related to the results from medical assessments and/or medical investigations that provided further support to the medical assessments and subsequent assertions.

Medical condition/acute medical event as a likely contributor but with less certainty

In some cases the documentation provided by the attending medical personnel was less definitive, providing statements that were suggestive of a medical conditions involvement in the crash causation but with no explicit statement to support a more substantial assertion. Participants were included in this category following considered judgement of the documented evidence by the researchers, one of whom is a qualified medical officer with more than 30 years experience in traffic medicine and the other a registered nurse with more than 20 years in health care. All cases that had the potential to be included in this category were discussed at length to determine their suitability for inclusion. The researchers considered that their approach was conservative with only those cases that demonstrated the greatest likelihood of being related to a medical condition or event included. Inclusion of participants into this category within the study were relatively small in number (24 cases). Both researchers were in agreement for all cases that were included in this category.

The data collected from the medical records was linked with data from the three other multidisciplinary sources for each of the 1490 participants in the study. This linking of data provided a more complete understanding of the multiple factors that impact on a participant's engagement in the road environment. The data also provided an understanding of other key contributing factors to crash causation, in particular the role of alcohol and drugs; both of which will be discussed further in this report. The results from this study will be addressed in the following sections and include an examination of the person, licensing and crash characteristics for the sample group, descriptions and detailed accounts of the identified medical conditions found to contribute to crashes, and comparisons between those identified as being involved in the crash as the result of a medical condition or event and those who were not. The implications of these results are then discussed.

3 THE SAMPLE

3.1 Data sources

3.1.1 Hospital medical records

During the course of the three year data collection period 2,278 records were identified and made available for examination. An additional 103 cases were identified by the ICD10-AM coders but the records related to these were either not located in the medical records department or were unable to be made available for examination during the data collection period. All cases that were identified and made available were examined; there was no screening process in case selection outside of the inclusion criteria set for the study. In 788 cases the records were found to not meet the selection criteria and so these cases were excluded from the study. Reasons for their exclusion can be found in Appendix 1. In total there were 1490 case records made available for examination that met the selection criteria during the collection period and all cases were examined and included in the study.

Approximately 80% of the patients in the study requiring admission to hospital were transferred from the Emergency Department to other in-service areas. Their length of hospital stay will be discussed in more detail in a later section but was of more than one day in duration. The remaining 20% were managed in the Emergency Extended Care Unit and were generally discharged from those services to home within 24 hours of admission to hospital.

3.1.2 Police Records

Of the 1490 cases that met the inclusion criteria, 1406 were able to be matched with SAPOL crash records, thus just under 95% matching of cases was achieved. The remaining 84 cases were found to have no corresponding VCR or TARS data related to crash involvement that was able to be accessed by the researcher. As a general rule, the VCR and TARS datasets were used as a confirmation that the collision occurred on a public road and should a crash not be found to have a corresponding VCR they were excluded from the study. The inclusion of the above 84 cases, however, was deemed appropriate because all other data sources, including paramedical and other medical notation conducted at the scene of the crash, provided specific evidence confirming that the crash did occur on a public roadway, and so these cases were deemed to have met the study selection criteria.

3.1.3 Licensing records

Of the 1222 drivers and motorcycle riders involved in the study 1159 were able to be matched with licensing records within the TRUMPS database, therefore 95% matching was achieved. In 45 cases the driver or motorcycle rider was found to hold an interstate or international licence and therefore these records were unavailable for examination and analysis. There were seven cases where the driver or rider were found to be driving unlicensed at the time of the crash and a further eleven cases where their licence status was unable to be determined.

3.1.4 Forensic Science records

Within the data set of 1490 cases there were 286 cases where no forensic blood results could be found, thus 81% matching was achieved. In 104 of these cases the person involved was a pedestrian, accounting for approximately 50% of all pedestrians in the study; the remaining unfound files related to drivers, motorcycle riders and cyclists, accounting for approximately 12% of these cases. In 48 cases where a blood sample was known to be taken for testing, the blood was found to have denatured prior to being tested and therefore unable to undergo accurate assessment.

3.1.5 Summary of successful matching of the multidisciplinary data sources

Data matching for the 1490 medical records that were available and meeting the selection criteria of the study was undertaken. Table 3.1 summarises the records that were successfully matched among the three other sources.

Table 3.1: Summary of matching from the multidisciplinary sources

	SAPOL crash data	DTEI licensing data	FSC alcohol/drug data
number of cases	1490	1222 drivers/riders only	1490
unable to be matched	84	63	286
number available	1406	1159	1204
percentage matched	95%	95%	81%

3.2 Person characteristics

3.2.1 Road user type

Participants in the study were identified by road user type. There were 845 drivers of cars or trucks, accounting for 56.7% of the study group. There were 377 motorcycle riders who accounted for 25.3%, 207 pedestrians, 13.9% and 61 cyclists, 4.1%. There was one motorised mobility scooter rider involved in the study. Figure 3.1 shows the distribution of participants by road user type. For the purposes of this figure the mobility scooter rider was considered with pedestrians.

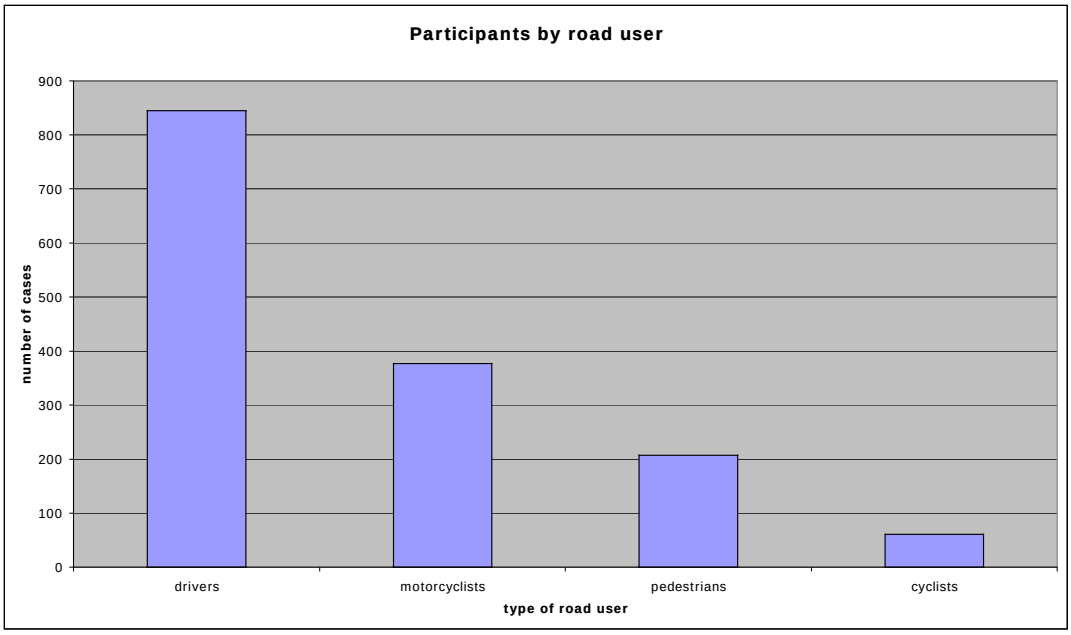

Figure 3.1: Participants by road user type

3.2.2 Age and sex distribution

The age and sex distribution for the study sample can be seen in Figure 3.2. In 59.4% of the crashes in the study the active participant was aged between 20 and 50 years. Overall males were found to be involved as active participants in 70% of the crashes while women made up around 30%. These percentages were consistent for those participants under the age of 80 years, although women were involved in less than 25% of the crashes in the 30-50 year age groupings. The sex distributions for those over 80 years of age were found to be more evenly distributed, with female participants involved in more than 43% of the crashes for this age group. Those aged 70 years or more accounted for 11.14% of the active participants in the study.

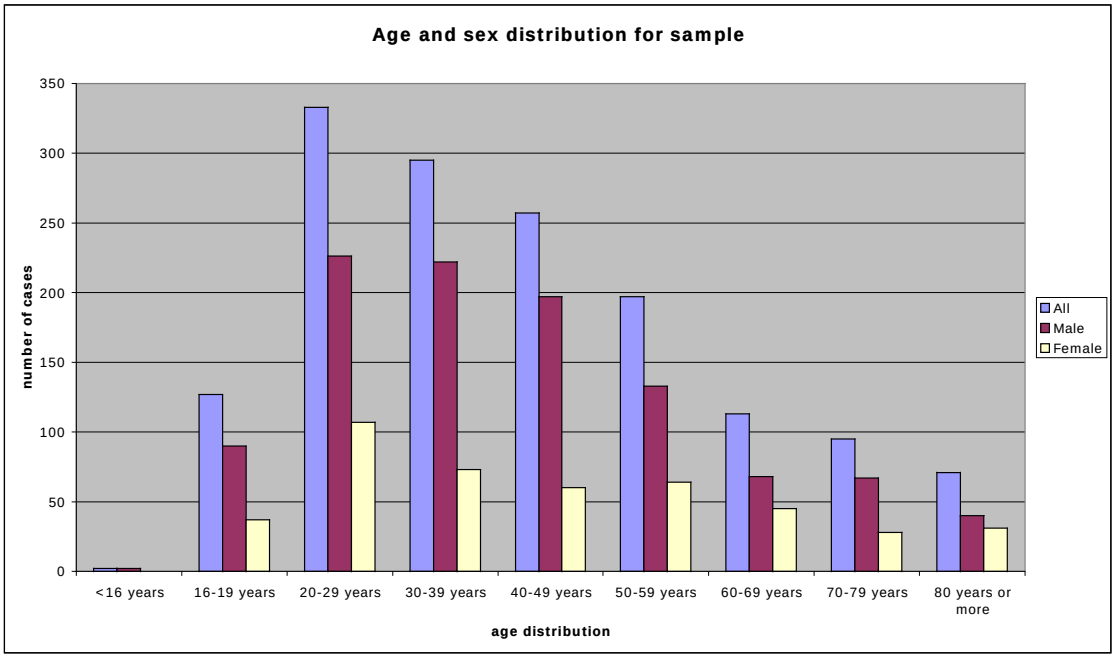

Figure 3.2: Age and sex distribution of participants

3.2.3 Age distribution by road user

The age distribution for the study sample by road user type can be seen in Figure 3.3. Those participants between the ages of 20 to 50 years were involved in crashes across all road user types. More than 88% of motorcycle riders were found to be aged between 20 and 50 years. Although those participants who were 70 years or older accounted for 11.14% of all crash participants in the study, they were more likely to be involved as a driver or pedestrian, accounting for 14.2% of all drivers and 17.4% of all pedestrians. Less than 6.5% of cyclists and 1.6% of motorcycle riders in the study were 70 years or older.

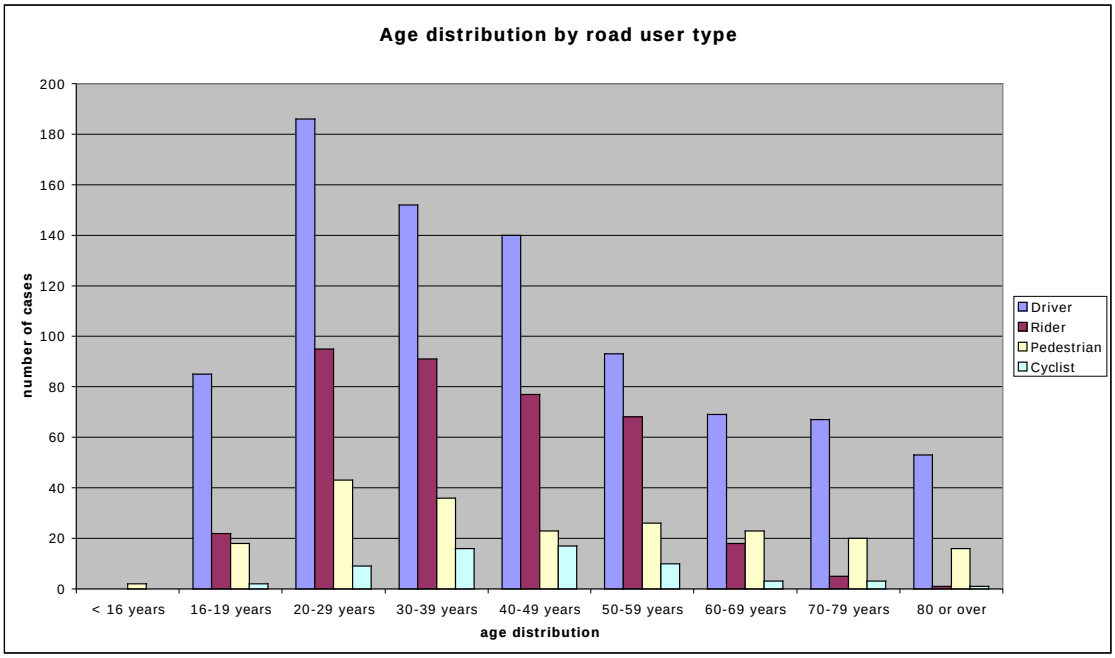

Figure 3.3: Age distribution by road user type

3.2.4 Sex distribution by road user

The sex distribution for the study sample by road user type can be seen in Figure 3.4. Males were found to be over involved across all road user types. Females were more likely to be drivers or pedestrians in the study, with fewer than 11.5% of cyclists and 6% of motorcycle riders being female.

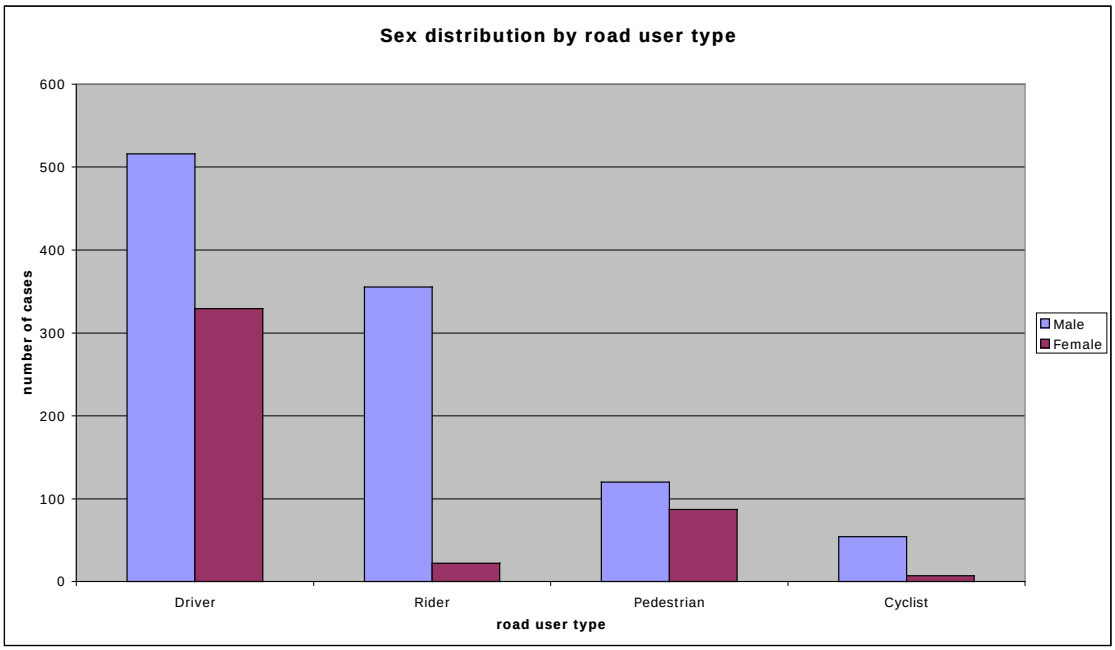

Figure 3.4: Sex distribution by road user type

3.2.5 Injury severity and length of hospitalisation

Length of hospitalisation as a result of injuries incurred in the crash were noted in medical records. This data source provides accurate length of stay whilst at the Royal Adelaide Hospital and includes length of stay related to rehabilitation services provided within the hospital. In 101 cases the participants were discharged from in-patient services at the Royal Adelaide Hospital and transferred to other health care facilities. These transfers were generally related to movement to other rehabilitation facilities (44 cases) or to a regional hospital (37 cases). Regional hospital transfers generally occurred to allow the patient to be closer to their home residence during the convalescence period. There were seven cases where the participant was transferred to a private hospital for continuation of care, three cases where the participant was transferred to a designated mental health facility and ten cases where participants were transferred to a residential care or a hospice care facility. Their length of stay in these other facilities is unknown.

In 21% of cases the participant was hospitalised at the Royal Adelaide Hospital for less than 24 hours, with more than 60% of all those involved in the study being hospitalised for five days or less. Close to 6% of cases resulted in the active participant being hospitalised for 35 days or more. In 45 cases (3%), the active participant who presented to hospital as a result of injuries incurred in the crash, died as a result of those injuries. More than 37% of these participants survived for less than 24 hours following their crash involvement, with more than 22% occurring within the first twelve hours. Fatal outcomes were seen across all age groups, however, those over 70 years of age demonstrated a higher number of fatal outcomes per person involved in a crash when compared to younger groups; for example 7.2% of those crash involved participants aged 70 years or more were fatally injured compared to 2.5% of those crash involved participants who were less than 40 years of age. Fatal outcomes were seen among drivers (53.5% of all fatalities), motorcycle

riders (22%) and pedestrians (24.5%). There were no cyclists involved in the study who were fatally injured. Figure 3.5 shows the length of hospitalisation for study participants, while Figure 3.6 identifies the age groups for those who had fatal outcomes following hospital admission as a result of the crash.

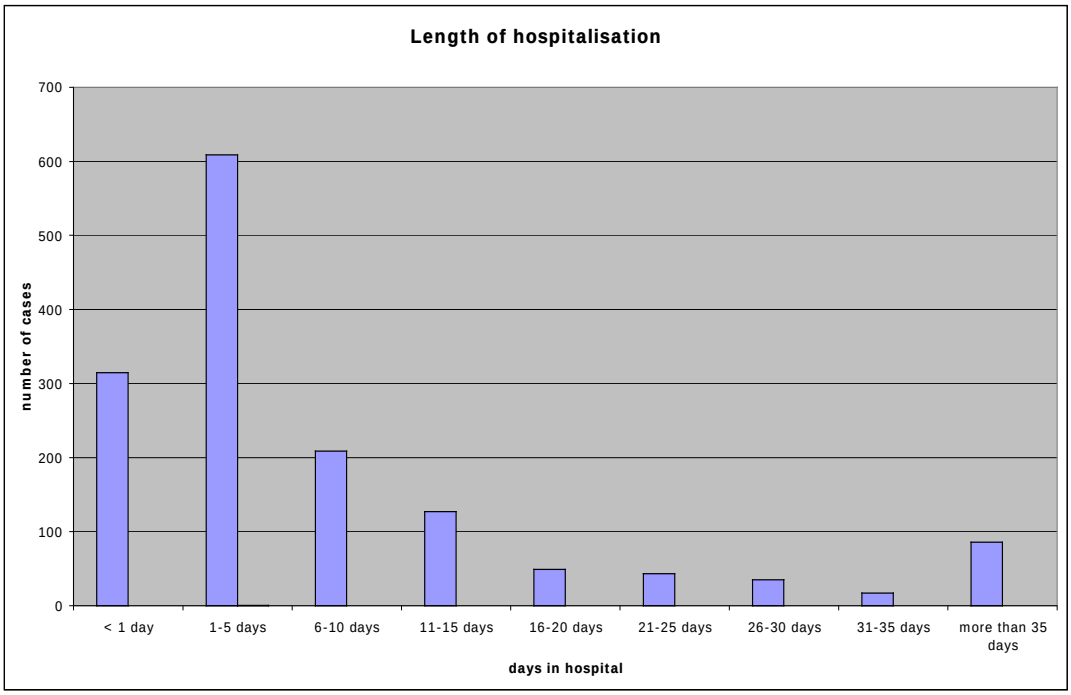

Figure 3.5: Length of hospitalisation for all participants

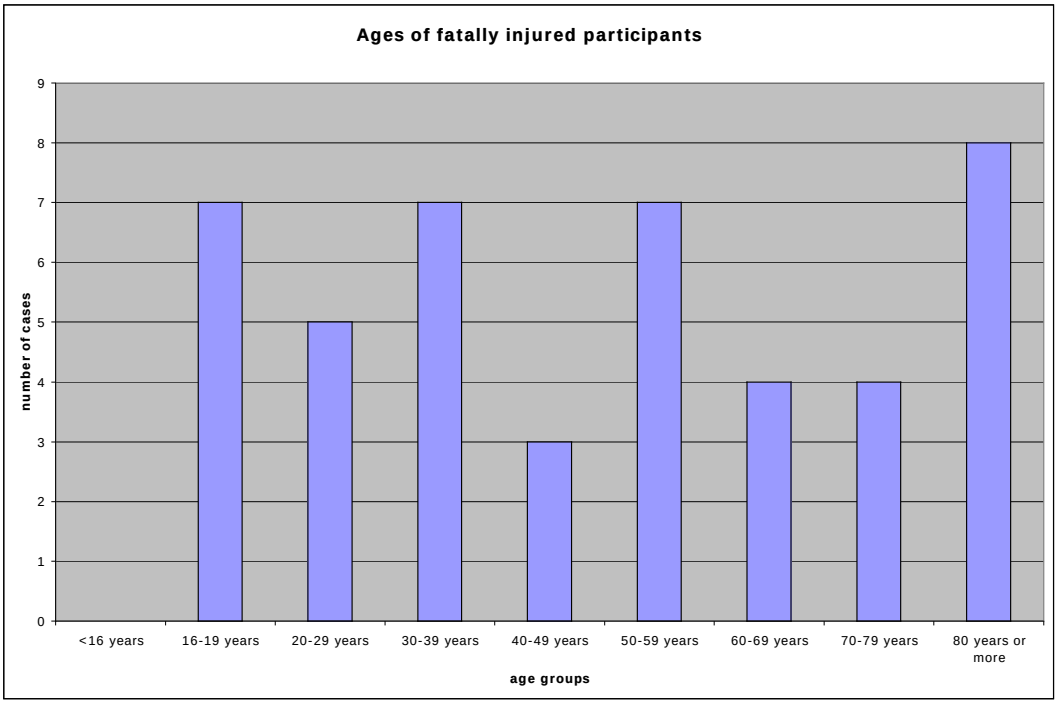

Figure 3.6: Age distributions for those participants who were fatally injured

3.2.6 Pre-existing medical conditions

Information regarding pre-existing medical conditions for the participants in the study was identified in the medical records documentation. Although some participants had previous exposure to the

Royal Adelaide Hospital as a patient, most were presenting for the first time and so the information regarding the presence of pre-existing medical conditions was most often based on self report at the time of presentation. This source of information is not always reliable as some participants either refused to disclose any relevant history or were selective in their disclosure. As well as asking participants for medical condition information, patients were asked to provide details of medication use at the time of crash involvement. In some instances the medication history provided clues to medical conditions that were not freely provided; for example the participant may disclose that they are prescribed an oral hypoglycaemic agent but not disclose that they have non-insulin dependent diabetes. This type of non-disclosure could occur as a result of deliberate withholding of information but may also reflect a genuine lack of understanding of their medical status. In other cases the participant did not disclose a medical condition, for example epilepsy, but it was later found by the researcher that the medical condition was identified in their conditional licensing status. The data collection related to pre-existing medical status included information related to alcohol dependence and current regular use of illicit drugs. Information related to pre-existing medical status was generally limited or unknown for those crash involved participants who were seriously injured and died soon after presentation.

Much of the available information related to pre-existing medical conditions for participants, particularly those presenting to the hospital for the first time, was limited to a list of conditions. Details relating to the degree or level of impairment as the result of particular condition(s) were also infrequently documented in medical records unless they were overtly implicated in the crash events; this was particularly the case when admission was for less than 24 hours. More detailed documentation regarding a medical condition was found in those cases where the participant was admitted to hospital over a longer period of time or when the participant required medical intervention for the condition during the hospitalisation period.

While compiling this data it was found that a considerable number of participants had multiple inter-related conditions, for example some patients had three or more specific cardiac related conditions simultaneously. In such cases the inter-related conditions were grouped together and sorted as one condition, in the above scenario, for example, these were counted once as ‘cardiac condition’. In a number of instances the presence of a particular medical condition is likely to have little or no bearing on the person’s driving ability or performance, while others have been demonstrated to impact on driving and therefore fitness to drive. A full list of the categories used for data collection purposes for this study can be found in Appendix 2.

It was found that more than 60% of all participants in the study had at least one pre-existing medical condition at the time of their crash involvement (898 participants) with 45% having three or more conditions and 5% who were known to have seven or more co-morbid conditions, some as many as twelve. As would be expected, the prevalence of pre-existing medical conditions was seen to increase with the age of the participant; for example it was noted that less than 50% of the participants under the age of 50 years had a known history of at least one pre-existing medical condition compared to more than 95% of those over the age of 70 years. Additionally those participants in the older age groups were found to have a larger number of co-morbid conditions, with 33% of all participants 70 years of age or older having five or more medical conditions compared to less than 6% of those under the age of 50 years.

Figure 3.7 provides information related to the most common pre-existing medical conditions found among all participants by road user. Cardiovascular disease, including hypertension, cardiac conditions and hypercholesterolaemia (high cholesterol) were found to be the most common medical conditions found amongst the study participants, along with depression. These conditions were noted among all road user types but were particularly noted among drivers. Alcohol dependence and current regular illicit drug use have been included among the more intrinsic medical conditions identified. Although alcohol dependence was found across all road user types, 23% of all pedestrians were found to have alcohol dependence compared to 8% of drivers and 6.6% or motorcycle riders. Note that there are two conditions found in the table that have been

described in acronym, these two conditions are NIDDM, non-insulin dependent diabetes and IDDM, insulin dependent diabetes.

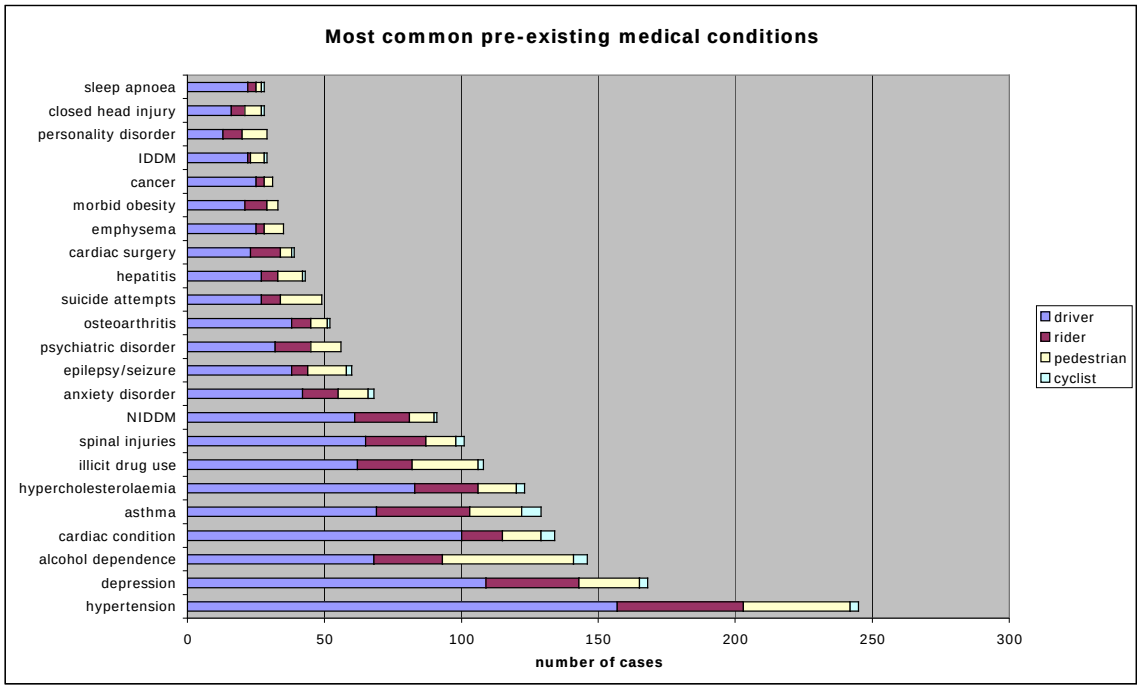

Figure 3.7: Most common pre-existing medical conditions found across all participant by road user type

3.3 Crash characteristics

3.3.1 Time of day and day of week of crash

The time of day and day of week of crashes in the study sample can be seen in Figure 3.8 and Figure 3.9. Crashes in this study occurred across all hours of the day and days of week. Crashes tended to increase as the day progressed and generally increased toward the end of the week, including week-ends.

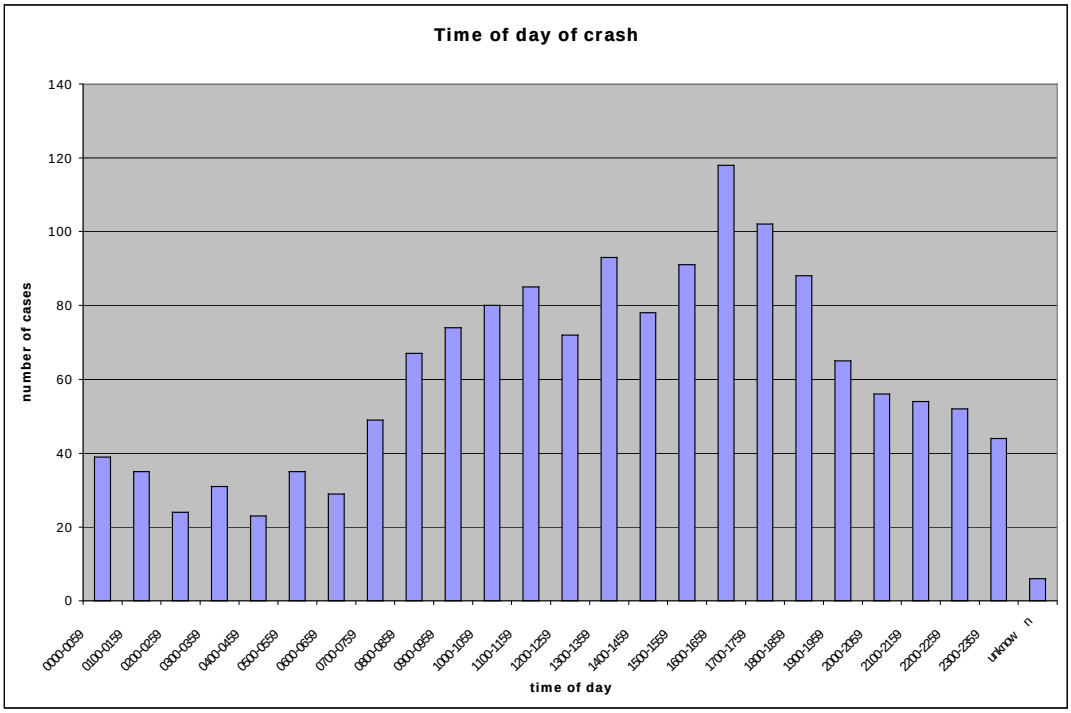

Figure 3.8: Time of day of crash

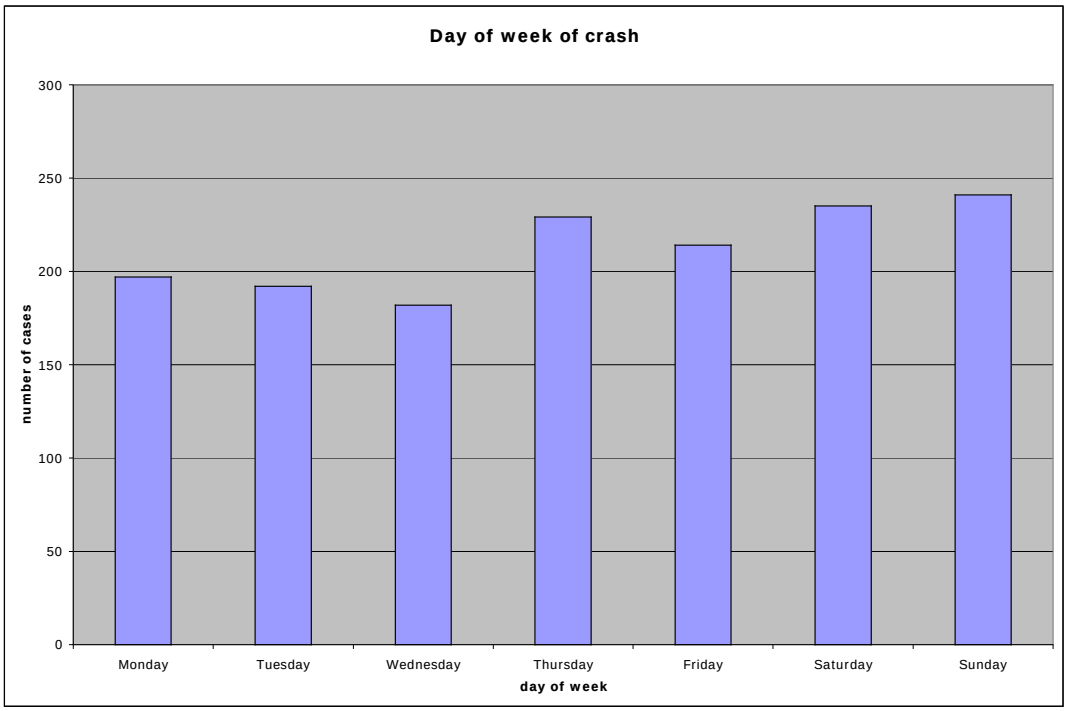

Figure 3.9: Day of week of crash

3.3.2 Location of crash

Crashes in the study were categorised by three distinct locations: metropolitan area, rural areas within a 100 kilometre radius of Adelaide and those occurring in areas greater than 100 kilometres from Adelaide. Crashes in both rural environments included regional towns as well as high speed rural roads. Those occurring in the metropolitan area accounted for approximately 57% of all crashes with 27% occurring within 100 kilometres of Adelaide and the remaining 16% occurring in areas beyond the 100 kilometre radius. As might be expected, pedestrian and cyclist crashes featured strongly in the metropolitan area and less so in rural areas beyond 100 kilometres of Adelaide. Figure 3.10 shows the location distribution by road user type.

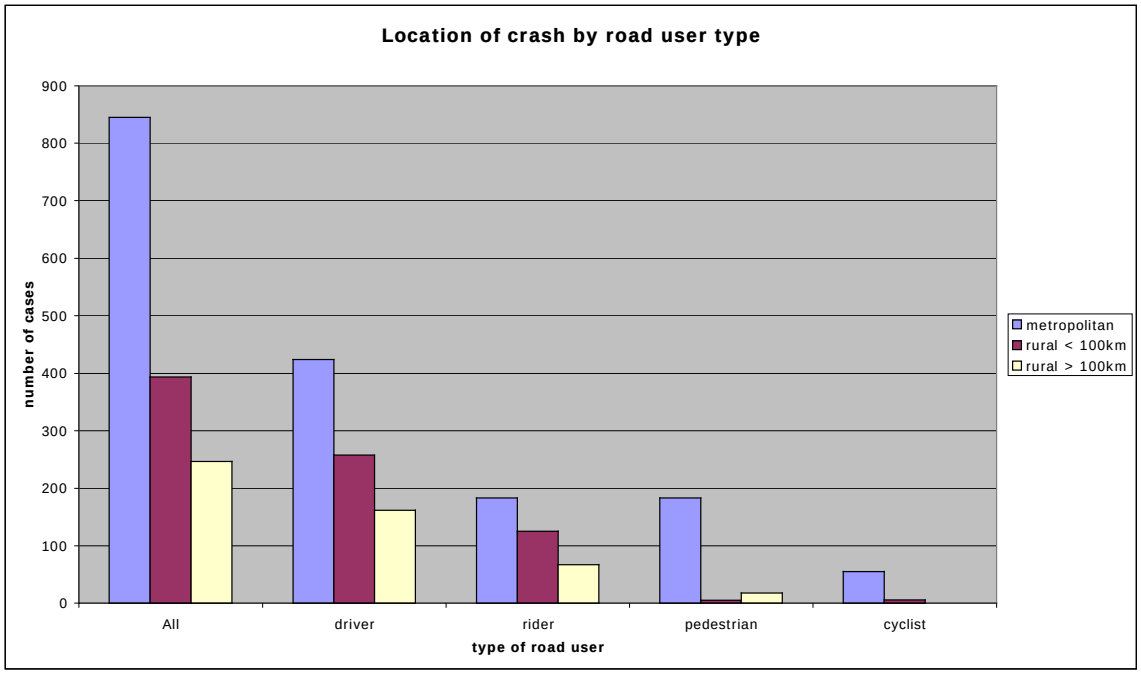

Figure 3.10: Location of crash

3.3.3 Crash site speed zones

Speed zones where crashes occurred were known for all but 42 crashes. Although crashes were seen across all speed limit zones more than 60% occurred in 50 or 60 kilometre per hour speed zones with 22% occurring on roads with speed limits of 100 or 110 kilometre per hour. Two crashes occurred in the vicinity of road works where the speed limit had been reduced to 25 kilometres per hour. Figure 3.11 shows the speed distribution of crashes in the study.

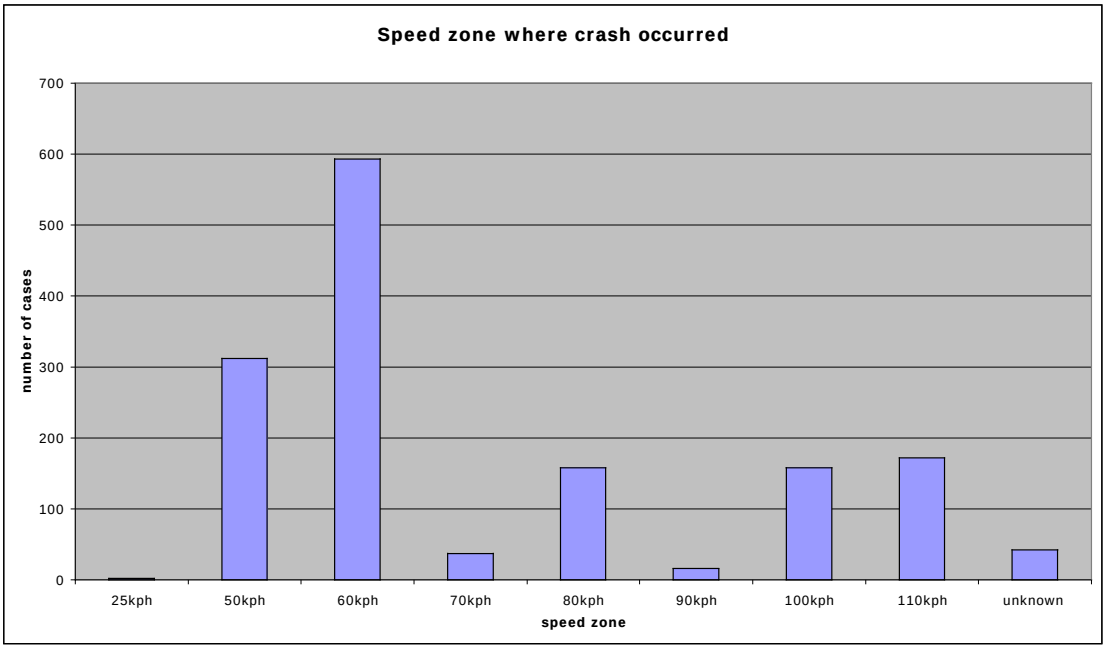

Figure 3.11: Sample speed zones at crash sites

3.3.4 Site of crash

Almost two thirds of all crashes in the study occurred in mid-block locations while intersection crashes accounted for 19.5% and T-junction crashes 14.5%. Most of the intersection crashes occurred in vicinities where traffic was controlled by traffic lights (70%). Figure 3.12 shows the distribution of crashes in the study by site.

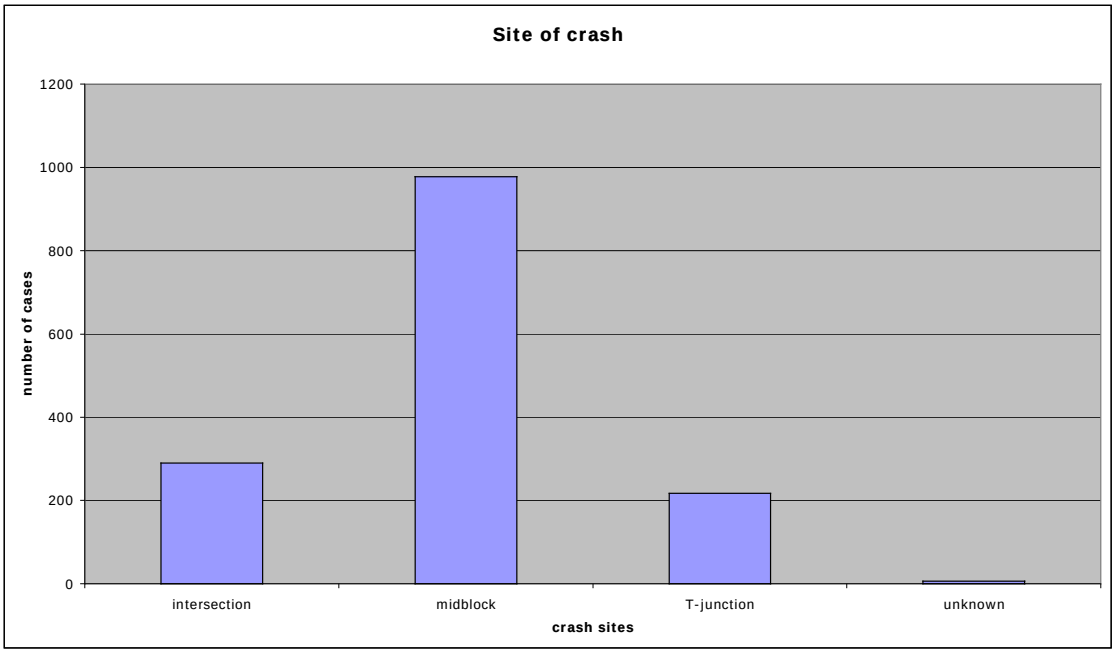

Figure 3.12: Site of crash

3.3.5 Type of crash

The types of crashes were categorised under ten broad headings. The distribution of crashes by crash type can be seen in Figure 3.13. The most common crash types related to hitting a fixed object or collisions between two or more motorised vehicles, accounting for more than 60% of all crashes in the study. Note that there were a total of 208 pedestrian crashes in the study. This includes all pedestrian cases where the pedestrian presented to the Royal Adelaide Hospital (207 cases) plus one pedestrian crash where the pedestrian died at scene and the driver presented to the Royal Adelaide Hospital as a result of injuries incurred in the crash.

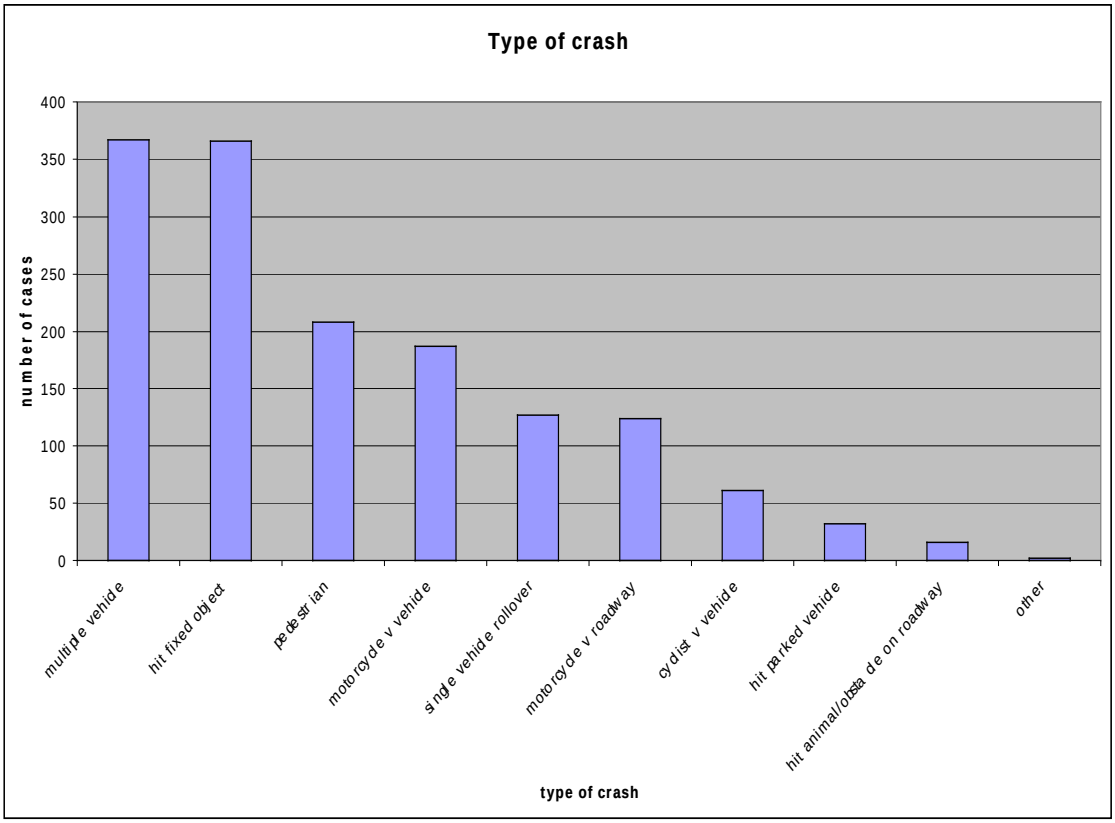

Figure 3.13: Type of crash

3.3.6 At-fault status for crash

The allocation of at-fault status for the crash was determined by SAPOL and was documented in the TARS database. In over 70% of cases the person involved in the study was identified by SAPOL as at-fault for the crash. In part this percentage, however, reflects the propensity for drivers and motorcycle riders involved in single vehicle crashes to be assigned at-fault for the collisions they were involved in. For crashes in the study involving multiple vehicles and pedestrians the allocation of at-fault for participants was found to be much less at 52%. Overall age played a small role in at-fault status for all crashes in the study with those in the youngest and oldest age groupings more likely than middle year groups to be allocated as at-fault for the crash. When multiple vehicle crashes are isolated, however, there was a much greater likelihood to be at-fault for the crash with increased age; for example those aged under 50 years were found to be at-fault for 44.8% of the multiple vehicle crashes they were involved in while those over 70 years of age were found to be at-fault for 76% of these crash types. Figure 3.14 shows the percentages of at-fault status by age grouping across all participants and crash types in the study while Figure 3.15 shows the percentage of at-fault status by age grouping for multiple vehicle crashes only. There

was little difference in at-fault status between males and females, with males being identified as at-fault for 73% of the crashes they were involved in and women 70%.

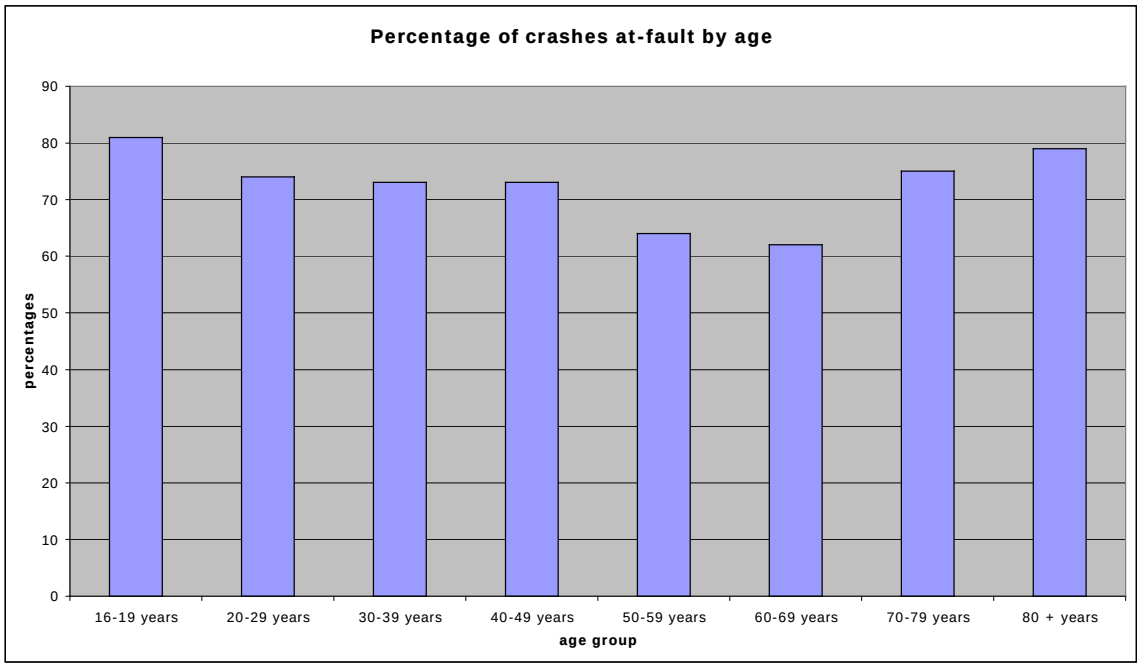

Figure 3.14: Percentage of crashes allocated as at-fault by age

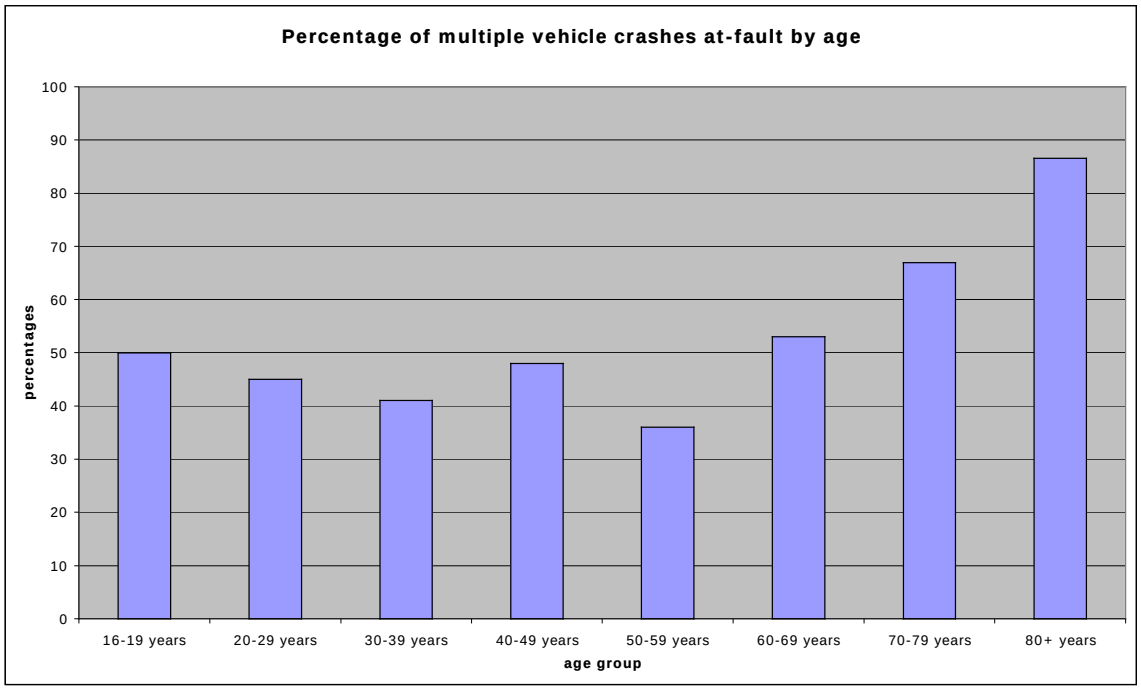

Figure 3.15: Percentage of those found to be at-fault for multiple vehicle crashes by age

3.3.7 Crash experience

The TARS database contains information related to the previous crash histories of drivers and motorcycle riders. The data provides details of the date, time and location of the previous crashes as well as a brief account of the crash events; the database also identifies at-fault status for those actively involved. The allocation of at-fault status in all cases are determined by Police (SAPOL). The use of this data for any analysis has inherent limitations. Firstly, the data source is based on driver licence numbers and is, therefore, a source of information for drivers and motorcycle riders only as it is unable to identify the previous crash involvement for pedestrians, cyclists or the mobility scooter rider. Secondly, the data is limited to crashes occurring in South Australia and so information related to those drivers with interstate or international licences or those who have been involved in crashes outside South Australia are not included in the available data. Thirdly, and importantly, the data is confounded by a lack of corresponding information related to length of driving experience and exposure detail. These limitations needs to be considered when interpreting the presented data. Given these limitations, close to 50% of the drivers and motorcycle riders in the study had no previous crash history. Fewer than 6% of drivers and motorcycle riders were involved in six or more crashes, with three participants having a recorded crash history of ten or more crashes. Figure 3.16 provides a breakdown of reported crashes, including the crash in this study, for drivers and motorcycle riders.

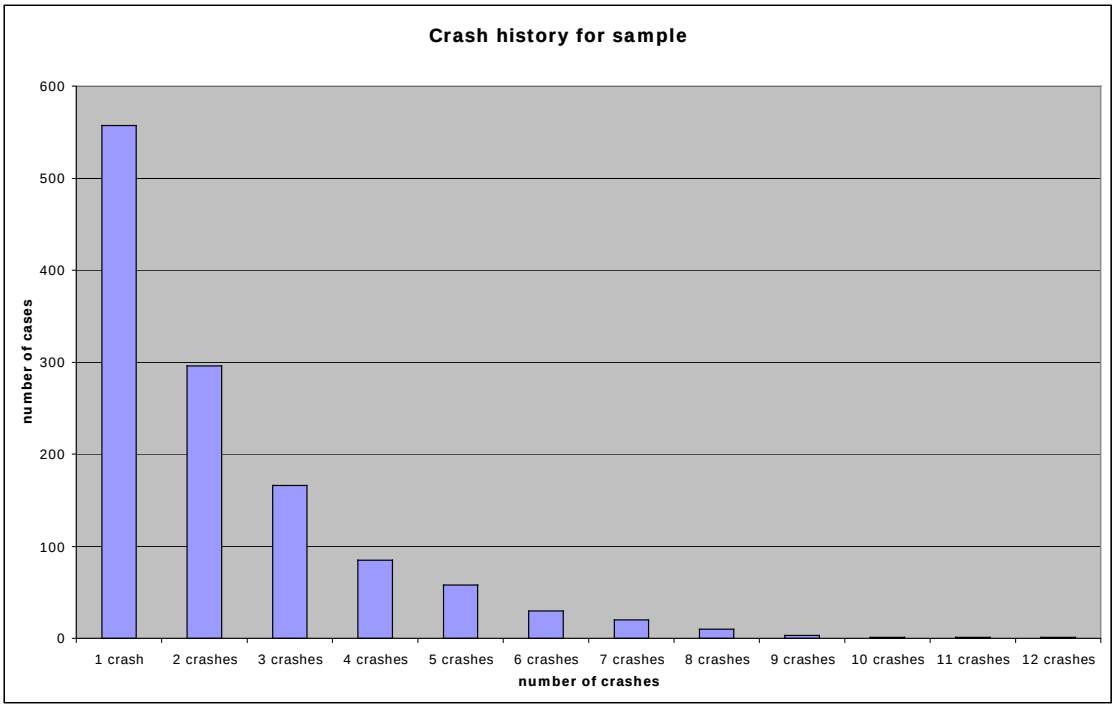

Figure 3.16: Crash history for drivers and motorcycle riders, including the crash in the current study

3.4 Licensing characteristics

3.4.1 Licence type at time of crash

Licence type held at the time of crash involvement was unknown for those drivers and riders travelling on interstate or international licences. From the cases where licensing details were able to be matched, 79% of the drivers and motorcycle riders were travelling on a full licence at the time of the crash, with 15% holding a provisional or probationary licence. There were fewer than 2.5% of drivers and motorcycle riders who were unlicensed or disqualified from driving at the time of the crash. Table 3.2 shows the breakdowns of licence type found among drivers and motorcycle riders by road user type.

Table 3.2: Licence status for drivers and riders at time of crash

Type of licence	Drivers	Motorcycle riders	Total
Full licence	630	289	919
Provisional	138	46	184
Learner	17	11	28
Disqualified	5	1	6
Unlicensed	15	7	22
Unknown	40	23	63

3.4.2 Conditions to licence holding

Of the 1159 drivers and motorcycle riders in the study that were able to be matched with licensing records there were 349 cases where there was at least one condition to licence holding identified on their licence, accounting for 30% of all licence holders in the study. The implications of a condition to holding being identified in licence status varied depending on the type identified. As expected those with a conditional licence related to the wearing of corrective lenses, for example, are expected to wear those corrective lenses at all times while driving. For those holding a conditional licence related to a reported medical condition, such as heart disease/hypertension or insulin dependent diabetes, for example, the conditional licensing status is limited to an annual or biennial medical review of the specifically identified medical condition that has been reported to the licensing authority and an assessment of fitness to continue to hold a licence related to that medical condition.

Drivers were more likely to hold a conditional licence (32% of all drivers) compared to motorcycle riders (22%). The most common condition to licence holding was the wearing of corrective lenses which was seen across both groups. Heart disease/hypertension was the most common medical condition specifically identified on licence conditions, with 90 licence holders (7.5%) falling into this group. This was followed by non-insulin dependent diabetes (2%), limb condition (1.8%), epilepsy (1.7%) and nervous/psychiatric disorders (1.6%). In 68 cases (5.5%) a reported medical condition that required annual or biennial medical review was included in conditional licensing status but the specific medical condition was not further specified (NFS). Figure 3.17 provides the breakdown of the number of participants in the study who held conditional licence status related to the wearing of glasses while driving and/or specific types of medical conditions identified in conditional licensing records.

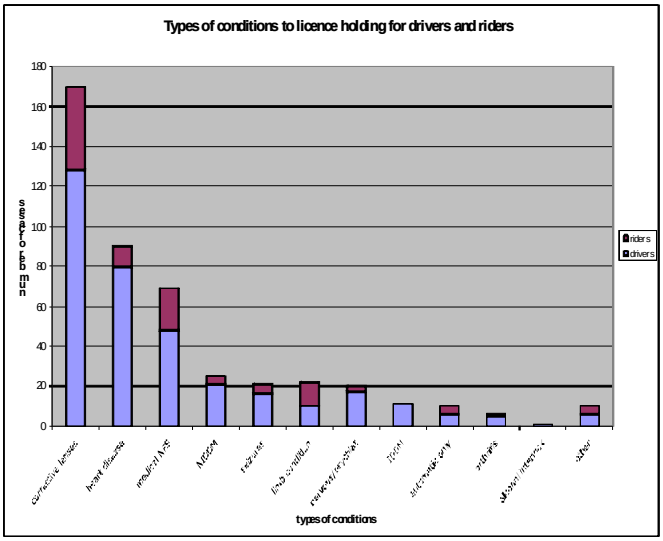

Figure 3.17: Types of conditions to holding for drivers and riders

3.4.3 Infringement experience

The infringement histories for the 1159 matched cases were examined by type and number. As was the case with crash experience, this information is confounded by a lack of data related to exposure detail and therefore should be viewed with caution. The most common infringement incurred by drivers and motorcycle riders related to speeding offences, with more than 69% of all drivers and riders found to have had at least one previous speeding infringement. The number of infringements related to speeding per person was also much higher than for other infringement types with 18.5% of the drivers and riders having a history of six or more speeding infringements; the worst 1% having a history of more than 25 infringements each. A previous history of drink driving offences was found for 22% of the drivers and motorcycle riders in the study. In more than 62% of this group their drink driving infringement history was limited to one offence; however, there were seven participants who had a history of six or more infringements related to drink driving. Similarly, 25% of participants had one or more infringements related to disobeying a sign or traffic signal. In more than 70% of these cases the participant's infringement history related to this was limited to one infringement.

Infringements for non-usage of a seatbelt were lower than other infringement types, with fewer than 15% of drivers and motorcycle riders having an infringement related to this. More than 33% of all drivers and 46% of all motorcycle riders had had their licence suspended or cancelled at some time during their licensing history; these disqualifications were related to their driving offences only and were unrelated to a medical condition**.** Figure 3.18 shows the number of infringements for the 1159 drivers and motorcycle riders in the study that were able to be matched with licensing data. Figure 3.19 shows the infringement history for drivers and motorcycle riders by type.

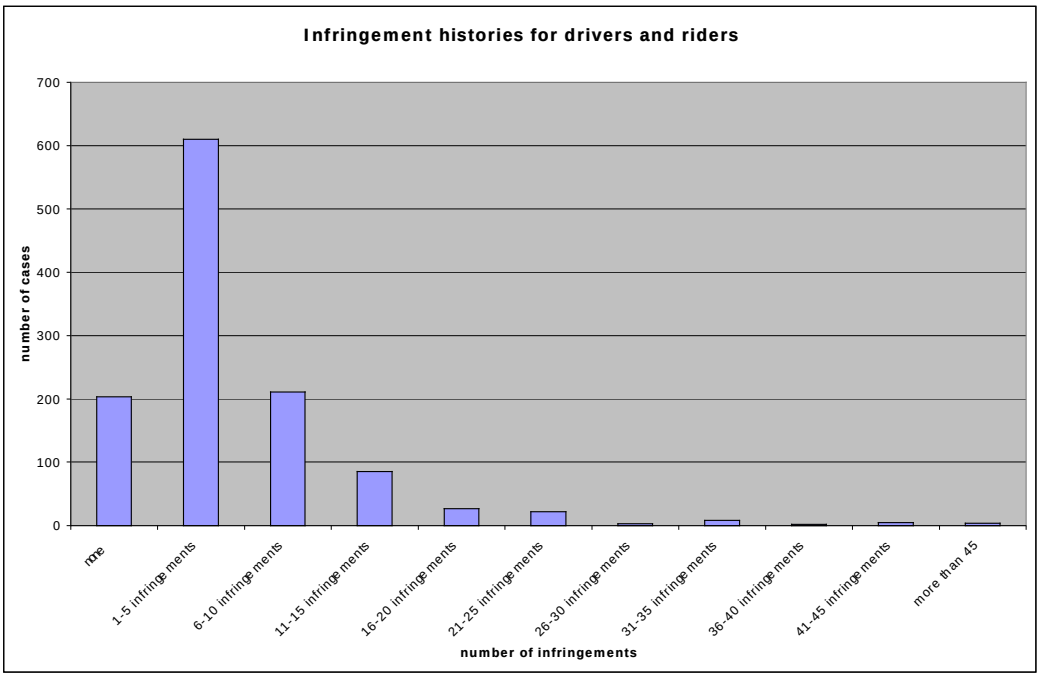

Figure 3.18: Infringement histories for drivers and riders

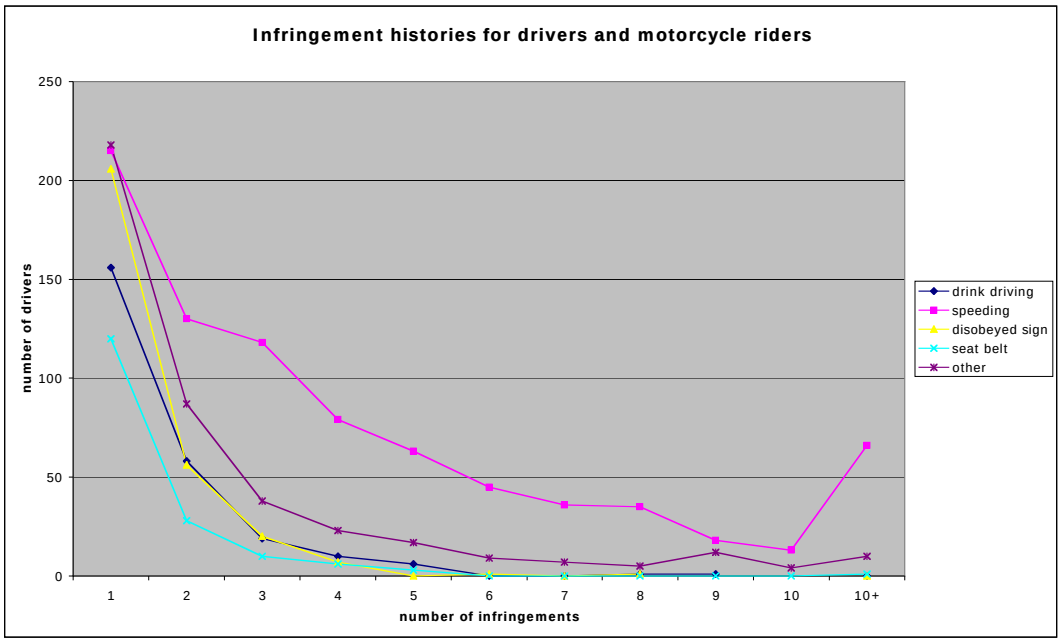

Figure 3.19: Infringement histories for drivers and motorcycle riders by infringement type

4 MEDICAL CONDITIONS AS A CONTRIBUTING FACTOR IN CRASH CAUSATION

Although an understanding of the participants pre-crash medical status, including the presence of a pre-existing medical condition(s), provides background information that may shed light on the person's abilities to perform in the road environment, these do not necessarily implicate that status as a contributing factor in their crash involvement. The medical records were examined in detail for medical documentation that supported or refuted a medical condition or acute medical event as a contributing factor in the crash.

This documentation included known circumstances surrounding the crash events, including evidence gathered by paramedical personnel at the crash scene, interviews undertaken with the crash involved participant as well as others involved in the crash and medical assessments and investigations undertaken during the course of hospitalisation. In many instances the medical documentation provided evidence of the role of a medical event in the lead up to the crash with conclusions drawn, however, this was not always the case. This lead to formulation of a group of participants where a medical event's contribution to the crash could be concluded with a high degree of certainty, and a group where the contribution of a medical event was likely but not certain, categorised here as possible.

In the 1490 cases examined in the study it was found that a medical condition or acute medical event was a contributing factor in the crash events with a high degree of certainty in 165 cases, accounting for 11% of all cases. A further 24 cases were identified as possible cases, that is that the crash was likely to have occurred as a result of a medical condition but with less certainty, giving a total number of 189 cases (12.7%).

Participants identified as being involved in the crash as the result of a medical condition or acute medical event were categorised under thirteen broad headings. In some cases the participants were identified as experiencing more than one medical condition or event making the allocation to one category challenging. In these cases a decision was made by the researcher to allocate the participant into the category most appropriately reflecting the major contributing factor or event identified.

A medical condition or acute medical event was found to be a contributing factor in crash causation across all road user types, however, drivers were found to be more likely than all other road users to be identified as being involved in a crash because of these. A medical condition or acute medical event was found to be a contributing factor in crash causation for 18.1% of the drivers in the study. It was found that 9.7% of all pedestrian crashes were related to a medical condition or acute medical event, while 3.7% of all motorcycle riders and 1.6% of all pedal cyclists were found to be involved as the result of a medical condition. Table 4.1 shows the breakdowns of those identified as being involved in a crash as the direct result of a medical condition or acute medical event by road user type.

Table 4.1: Numbers involved in crash as the result of a medical condition or acute medical event by road user

Road user type	driver of car or truck	motorcycle rider	pedestrian	pedal cyclist	mobility scooter driver	total
all cases in study	845	377	207	61	1	1490
medical condition certain	137	10	16	1	1	165
medical condition possible	16	4	4	-	-	24

Figure 4.1 shows the types of conditions found amongst these two groups and the number of cases within each category.

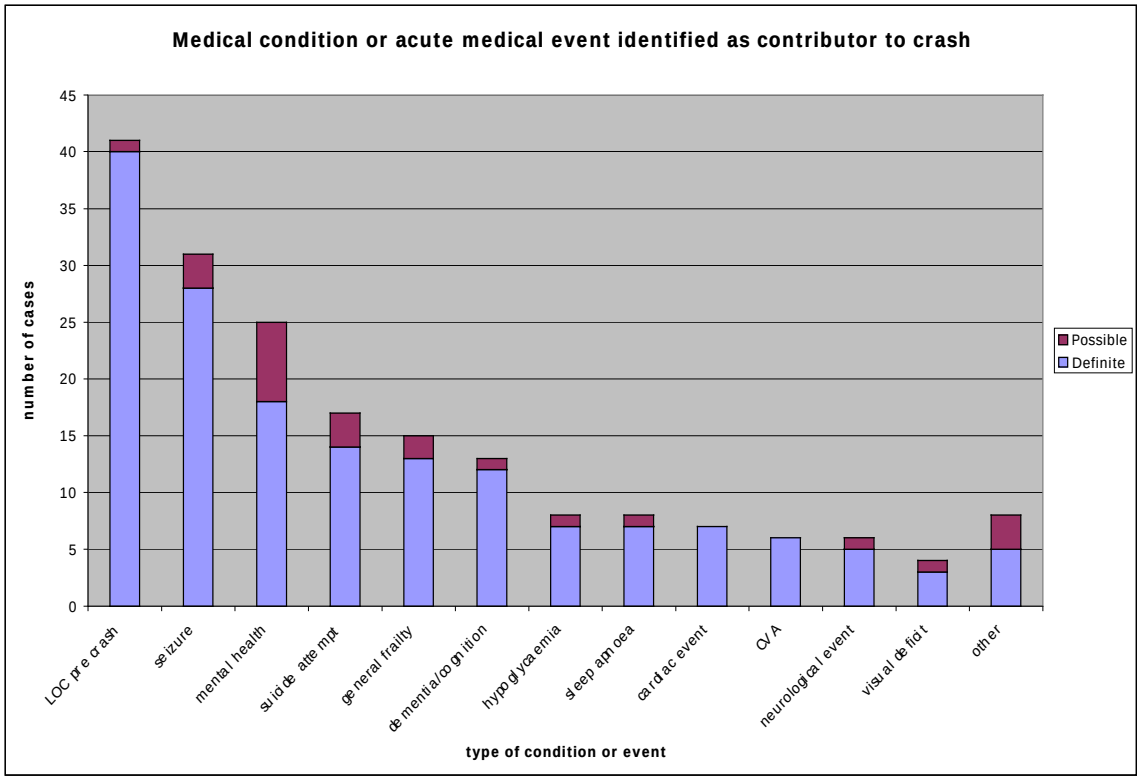

Figure 4.1: Medical conditions and acute medical events identified as a contributor to the crash for all participants

In 25% of the 165 cases where a medical event was identified as a contributing factor in crash causation with a high degree of certainty, the participant was known to have experienced a loss of consciousness prior to being involved in the crash. The reasons for this loss of consciousness will be explored further in a following section. The second most common medical event found among those identified with a medical condition were those who experienced a seizure prior to the crash, accounting for 17% of the crashes involving a medical event. In both cases these events were seen to result in crash involvement for drivers and riders. Drivers were found to be involved in crashes as a result of all medical condition types identified while motorcycle riders and pedestrians were less so. This is particularly the case for pedestrians, who were found to be over-represented in crashes related to mental health issues, including suicide attempts and as a result of dementia and cognitive decline. There were one cyclist and one motorised mobility scooter rider within the study group who was identified as being involved in a crash as a result of a medical condition. In these two cases the cyclist was identified as being involved in the crash as a result of mental illness while the mobility scooter rider was identified as being involved in the crash due to general poor health and functional decline. These cases will be discussed further in the more detailed accounts of the medical conditions in section 4.3. Figures 4.2 to 4.4 provide details of the types of conditions and number of cases involved by road user type. Because the numbers related to the cyclist and mobility scooter rider are low no further tables or figures will be included for these road users.

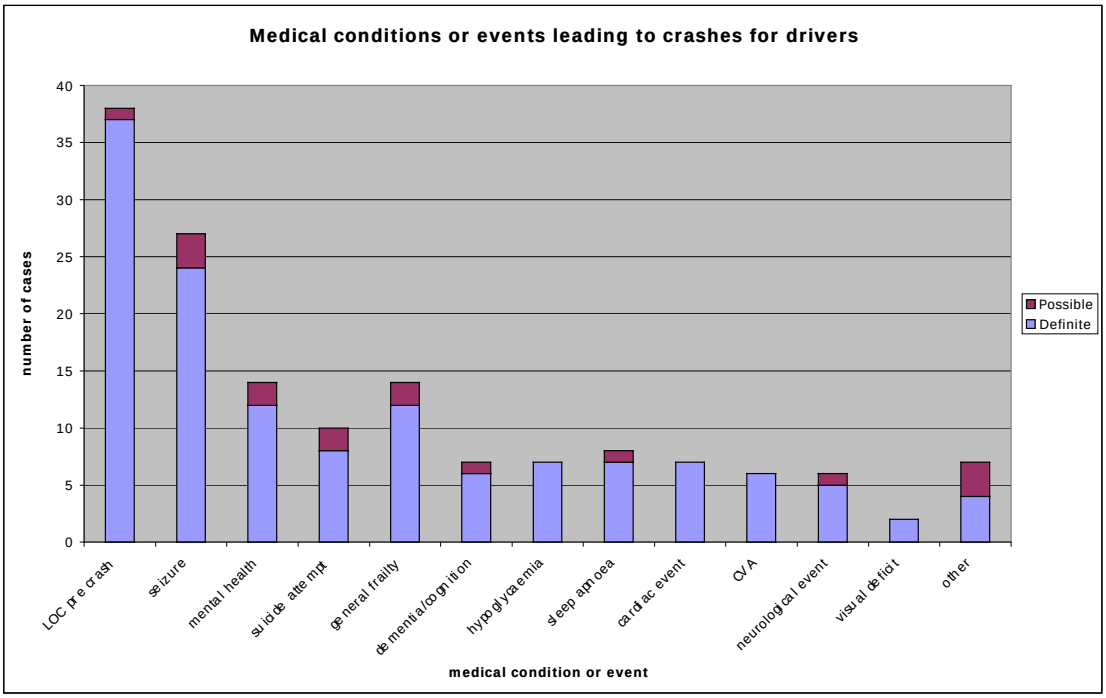

Figure 4.2: Medical conditions identified as contributor to crash for drivers

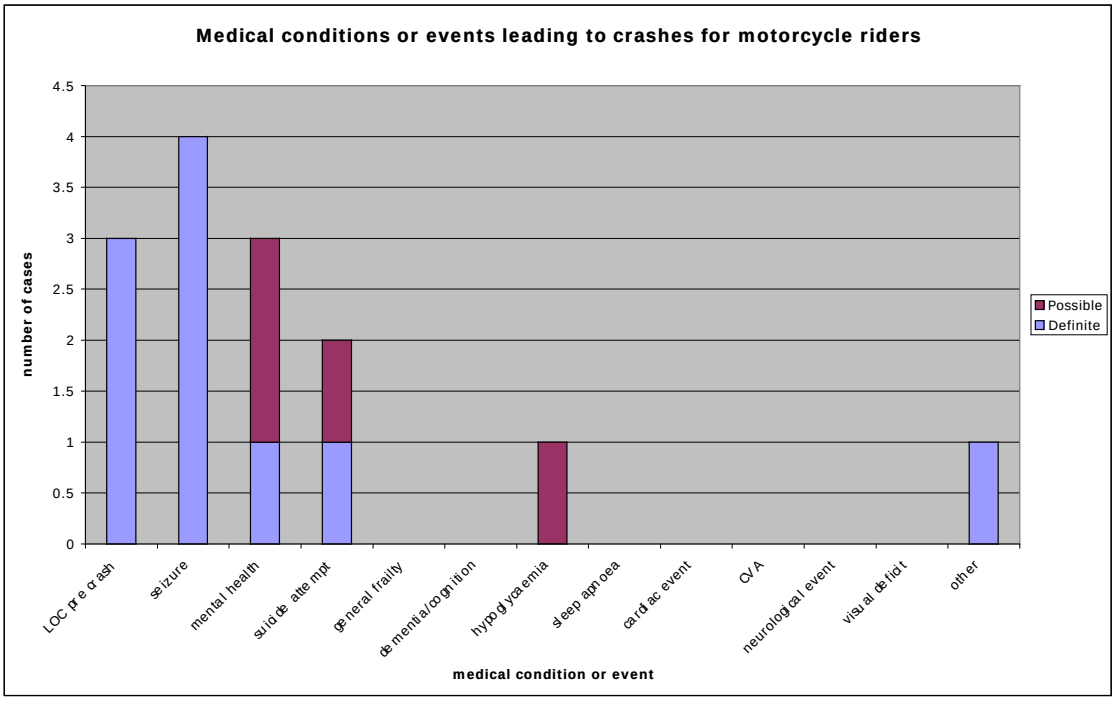

Figure 4.3: Medical conditions identified as contributor to crash for riders

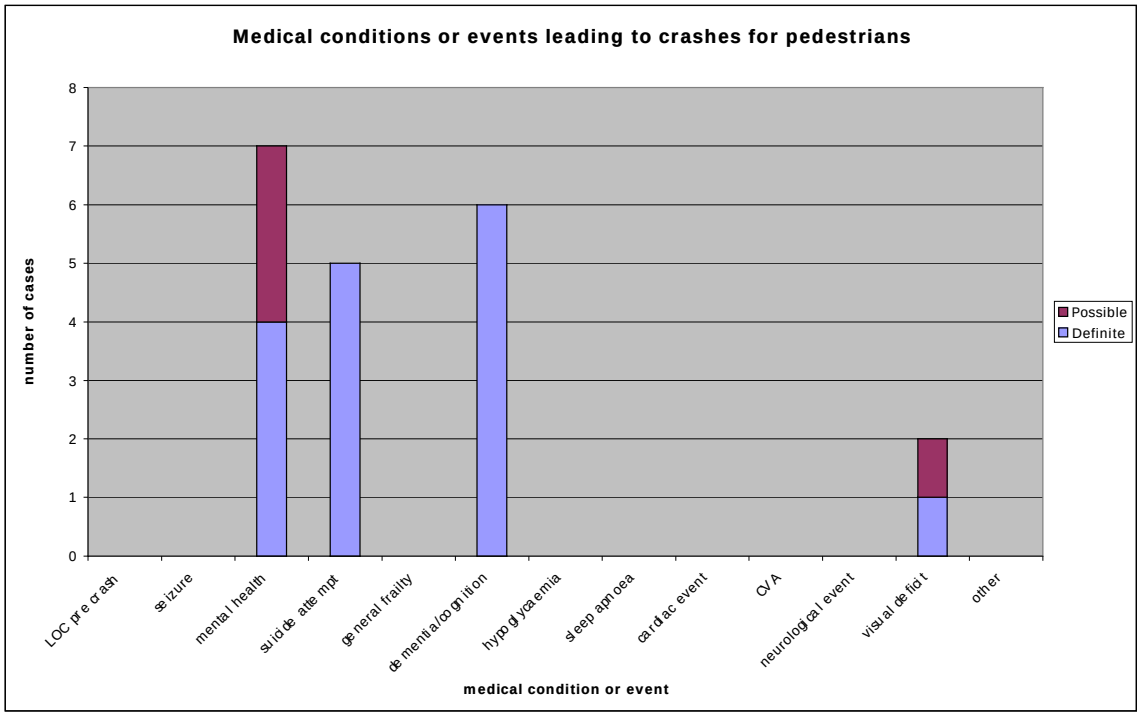

Figure 4.4: Medical conditions identified as contributor to crash for pedestrians

4.1 Loss of consciousness leading to crash

In 41 cases a driver or motorcycle rider was involved in a crash as a direct result of a loss of consciousness that preceded the crash events. In ten of these cases, medical assessment and investigations undertaken during the hospital in-patient period led to confirmation that the loss of consciousness occurred as a result of a cardiac event. In six of these ten cases the cardiac event was identified as heart block. There was one case where a driver was known to have a loss of consciousness that was found to be related to non-deliberate over-medication of a prescribed analgesic and one case where a driver was known to have a loss of consciousness that was associated with an uncontrolled episode of coughing. In 29 cases the loss of consciousness was either unspecified or the aetiology was yet to be confirmed at the time of discharge from hospital.

Those drivers and riders who were identified as having a cardiac event preceding the crash had no reported history of previous loss of consciousness prior to their crash. Among the 29 drivers where the cause of their loss of conscious was yet to be determined, however, there were ten drivers who had a reported history of two or more unconscious collapses in the weeks or months preceding their involvement in this crash, with some having histories of unconscious collapse spanning several years.

In two of the ten cases occurring as a result of a cardiac condition the driver or motorcycle rider reported having a sensation of light headedness immediately preceding the loss of consciousness but no time to act on those sensations, while all others reported no pre-warnings. Five of the remaining 31 drivers reported symptoms of light headedness, fatigue or chest pain earlier in the driving task or over some minutes preceding the loss of consciousness. In two cases a driver was known to have been involved in a previous motor vehicle accident(s) as a result of an earlier episode of loss of consciousness, including one driver who had been involved in two other crashes in the weeks preceding their involvement in this crash.

Further medical investigations of the cause of the loss of consciousness were pending in more than half of those cases where a definitive diagnosis had not been reached prior to hospital discharge. These investigations were primarily centred on identifying or eliminating cardiac and neurological causes, including epilepsy, for the loss of consciousness. The results of these investigations are not known.

In 75% of cases the loss of consciousness led to a single vehicle crash. These crashes consisted of 19 cases where the vehicle left the road and struck a fixed object such as a tree or pole, five cases where the vehicle struck a parked vehicle, three cases where the vehicle left the road and rolled and three cases where a motorcycle rider fell to the roadway. Eleven cases involved a crash with another vehicle.

In all cases the driver or motorcycle rider was hospitalised as a result of the crash. In two cases the drivers died as a result of a deterioration in their condition in the following days. The length of stay for surviving drivers and the motorcycle rider ranged between one and 76 days, with most being hospitalised for less than three days. The average length of stay was six days. Crashes occurring as the result of a loss of consciousness of a driver led to injury to others involved in the crash. There were nine occupants in this driver's vehicle who were transported to hospital as a result of injuries incurred in the crash. Eight drivers or occupants of other vehicles were also transported to hospital as a result of injuries incurred in the multiple vehicle collisions for this group.

Those who were found to have had a loss of consciousness prior to the crash were found across all age groups. The sex distribution consisted of 65% males and 35% females. Figure 4.5 shows the age and sex distribution for those involved in a crash as a result of a loss of consciousness prior to the crash, while Figure 4.6 shows the crash types seen among this group. Figure 4.7 identifies the times of days where crashes occurred. In all but three cases the crash occurred during daylight hours.

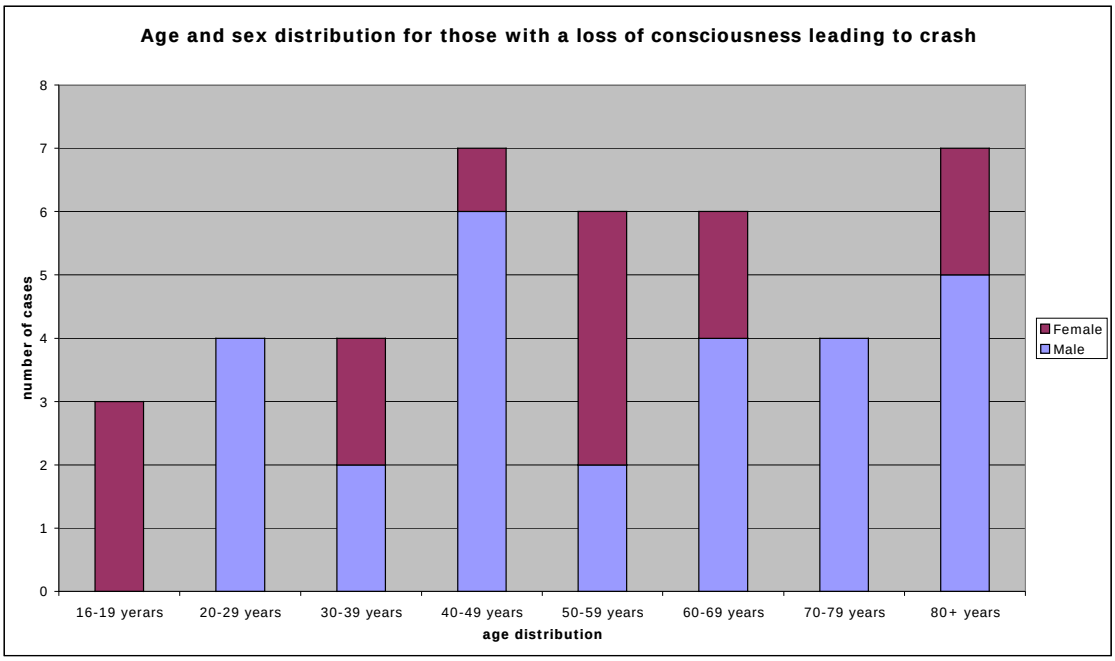

Figure 4.5: Age and sex distributions for all those experiencing a loss of consciousness leading to crash

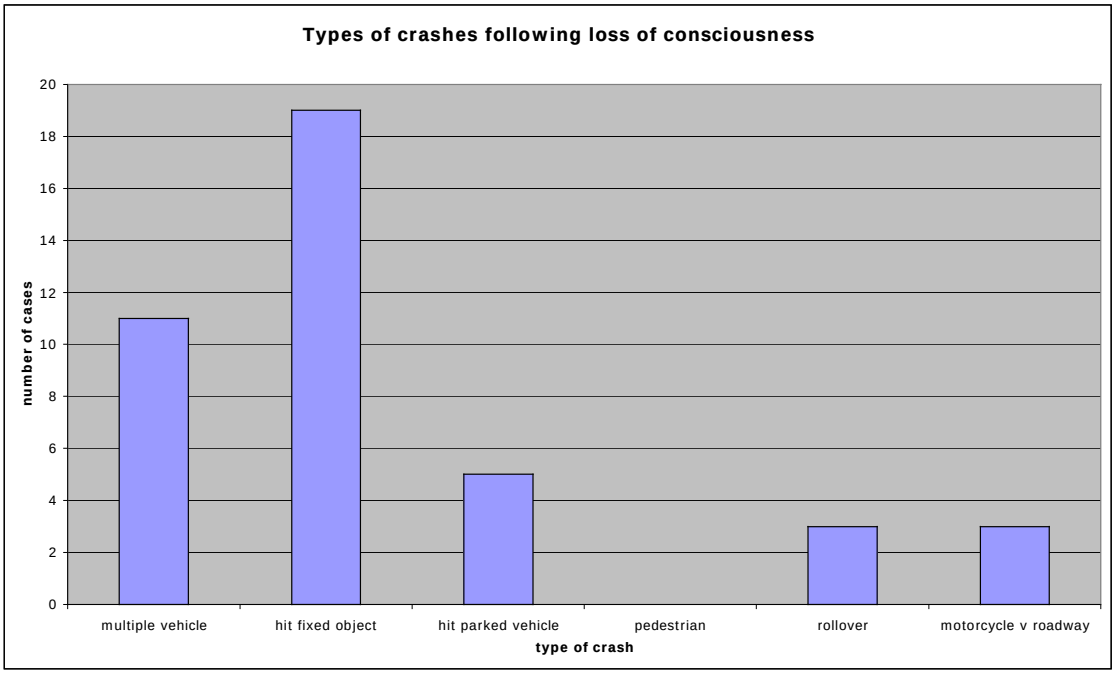

Figure 4.6: Types of crash experienced by drivers and motorcycle riders following a loss of consciousness

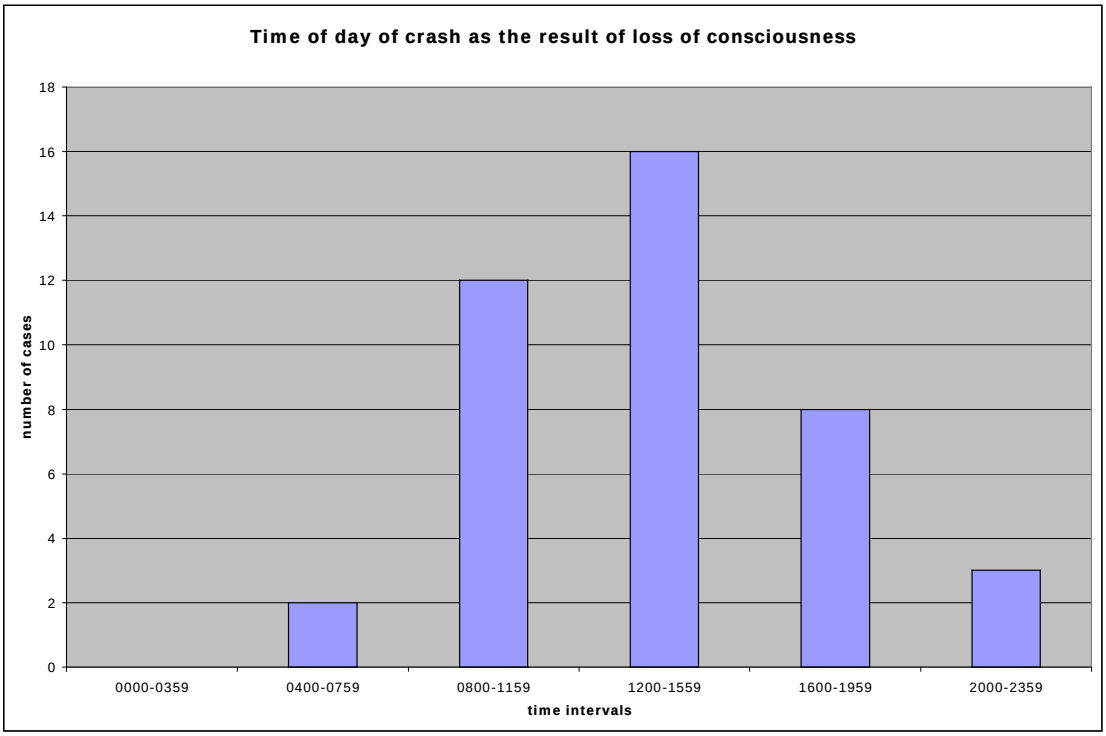

Figure 4.7: Time of day of crash as the result of a loss of consciousness

4.2 Seizure event leading to crash

There were 28 cases where a driver or motorcycle rider was involved in a crash as a result of seizure activity with a high degree of certainty and three cases where a participant was involved in a crash where pre-crash seizure activity was a likely contributor to the crash but with less certainty. In three cases the crash involved person was a motorcycle rider while all others were drivers of cars.

The drivers and motorcycle riders were categorised into three distinct groups: those with a known history of seizure activity who had a prior diagnosis of epilepsy that was established (39%), those who were presenting for the first time with a seizure but had a history of unexplained behaviours and/or loss of consciousness that had either not been medically investigated or epilepsy not confirmed (45%) and a third group who were presenting with first seizure and no previous history (16%). Alcohol intake and sleep deprivation have been implicated in seizure activity. In at least two cases the driver reported poor sleep quality in the lead up to the crash events and there were four cases involving drivers travelling between midnight and 4am that may suggest a fatigue factor. There was one case where the driver was understood to be intoxicated at the time of the crash but no blood alcohol or breath alcohol results were found to substantiate this claim.

Seizure with diagnosis of epilepsy established

This group consisted of eleven cases that were considered by the attending medical team to have occurred as a result of a seizure with a high degree of certainty and one case where it was likely but less certain. In the latter case the driver was critically injured as a result of the crash and the resulting low level of consciousness and subsequent medical interventions precluded any information to support or refute seizure involvement. Because a pre-existing seizure status was known for this group there was specific information related to seizure free intervals, medication use, conditions to licence holding and previous suspensions related to seizures that was available in the medical and licensing records. The seizure free interval was found to be less than twelve months in eight of these twelve cases, including one case where a driver had presented with their first seizure seven days prior to their involvement in this crash and one case where a driver was known to consistently experience seizure events every three to four months, in spite of reported adherence to anticonvulsant medication. There was one driver who had a seizure free interval of four years and there were three cases where no documentation could be found related to the seizure free interval.

In all but one case the driver or motorcycle rider was prescribed an anticonvulsant medication at the time, however, in one case that medication had been halved in the days preceding the crash, one case where the motorcycle rider was known to demonstrate poor adherence to his medication regime and in two cases the medication was reported to have not been taken for one or two days. A previous licence suspension had been put in place as a result of the person's seizure activity in four cases. In two of those cases the suspension was in place at the time of their involvement in the crash, one of which had been in place for more than ten years. The remaining two cases were found to be drivers who had one previous suspension each. These suspensions were in place for three months for one driver and six months for the other. Both of these drivers had the licence suspension lifted at the time of their crash involvement; in one case that suspension was lifted six weeks prior to their involvement in the crash and the other had the suspension lifted seven months prior to the crash. In all ten cases where the driver held an active licence, the licence was revoked on medical grounds following the crash. The average length of suspension was six to twelve months but these varied considerably, ranging from three months for one driver to six years for two drivers.

Newly diagnosed seizure with history of unexplained behaviours or loss of consciousness

This group consisted of twelve cases that were considered by the attending medical team to have occurred as a result of a seizure with a high degree of certainty and two cases where it was likely but less certain. In all of these cases the driver, motorcycle rider or a family member provided accounts of behaviours suggestive of seizure-like activity, such as unresponsiveness, and/or periods of unexplained loss of consciousness prior to their involvement in the crash. In ten of these cases these behaviours and unconscious episodes were reported to have occurred within the twelve months preceding their involvement in this crash. There were three cases where it was reported that the person had a history of unexplained seizure-like activity that occurred between three and nine years earlier with no episodes occurring in the interim period. Earlier medical investigations had been undertaken to determine the cause in two cases but no conclusions from these investigations had been reached; these events had not been medically investigated prior to the crash for the remaining eleven participants. As would be expected, none of these drivers or motorcycle riders had seizures identified as a condition to licence holding, but heart disease/hypertension was identified in conditional licence holding for three drivers. The licences were revoked on medical grounds in the twelve cases where seizure activity was confidently established, with one driver electing to surrender their licensing privileges permanently. These suspensions were generally for periods between two and six months pending further testing and medical clearance. There were no licence changes noted in the two cases that were considered as possible inclusions under this category.

First seizure with no previous history

In all five cases the involved driver or motorcycle rider was identified by the attending medical team as being involved in the crash as a result of a seizure with a high degree of certainty. In four of these cases a passenger in the vehicle or witnesses to the crash event corroborated an account of the crash that included seeing the driver or motorcycle rider experiencing seizure activity preceding the crash. In all cases the driver or motorcycle rider reported no pre-warning signs prior to their seizure, although most were known to have had no recall of the driving task for some time prior to their crash. In one case a driver was travelling on an international licence with the remaining four holding active licences with no conditions to licence holding imposed. In all four cases involving drivers with South Australian licences the licence was revoked as a result of their seizure and crash involvement. These suspensions varied between six months and eight years. The driver travelling on an international licence was advised to refrain from driving until their seizure status was investigated on the imminent return home.

In 65% of cases the seizure activity led to a single vehicle crash. These crashes consisted of 15 cases where the vehicle struck a fixed object such as a tree or pole, two cases where the vehicle struck a parked vehicle, one case where the vehicle left the road and rolled and two cases where a motorcycle rider fell to the roadway. Eleven cases involved a crash with another vehicle or vehicles, one involving a motorcyclist. Witnesses to these crashes frequently gave accounts of the driving behaviour being erratic in the lead up to the crash and in some cases an overt increase in speed. There was one case where, following the collision, the driver continued to travel for several kilometres before the vehicle came to a stop due to damage and tyre deflation.

In all cases the driver or motorcycle rider was hospitalised as a result of the crash. Their length of stay ranged between one and 32 days, with the average length of stay being eight days. No drivers or motorcycle riders were fatally injured. Crashes occurring as the result of a driver experiencing a seizure led to injury to others involved in the crash. Two occupants in this driver's vehicle were transported to hospital following the crash. There were seven drivers or occupants of other vehicles who required transport to hospital as a result of injuries incurred in the crash. Those who were found to have had a seizure in the lead up to the crash were found across all age groups, however, those in the 40-49 year age group were overly represented. Males featured strongly among this group with 82% of all cases involving a male driver or rider and females 18%. Figure

4.8 shows the age and sex distribution for those involved in a crash as a result of a seizure prior to the crash, while Figure 4.9 shows the crash types seen among this group. Figure 4.10 identifies the times of days where crashes occurred for this group. Four of the crashes for this group occurred in the early hours of the morning while most occurred during daylight hours.

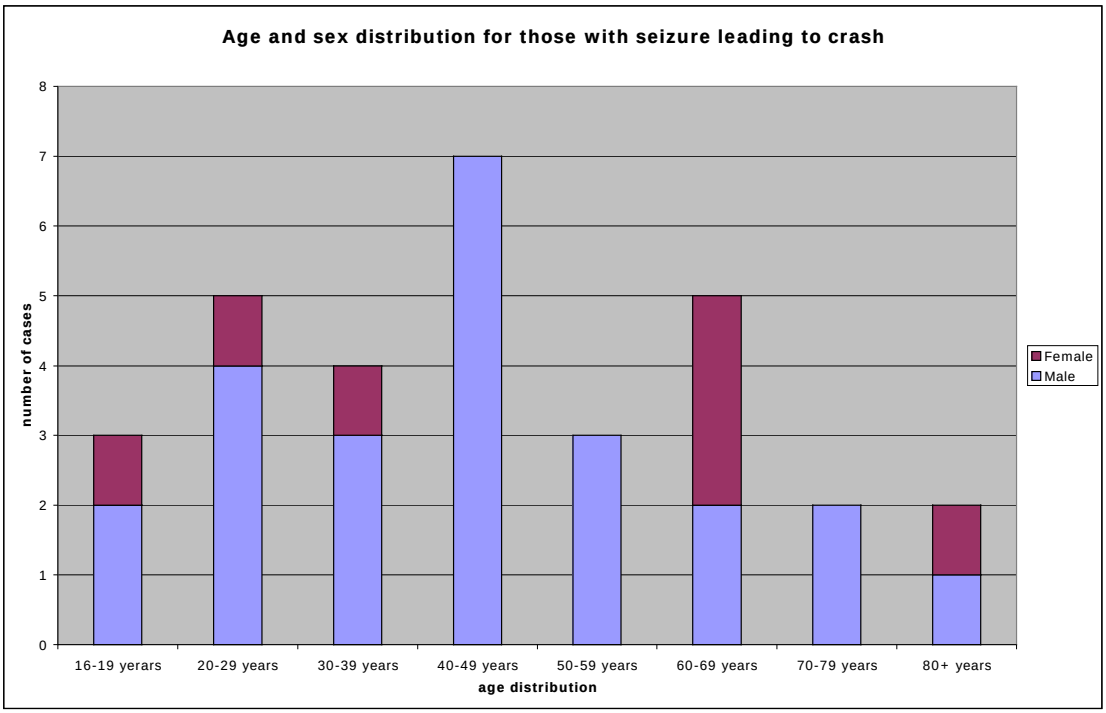

Figure 4.8: Age and sex distribution for those with seizure leading to crash

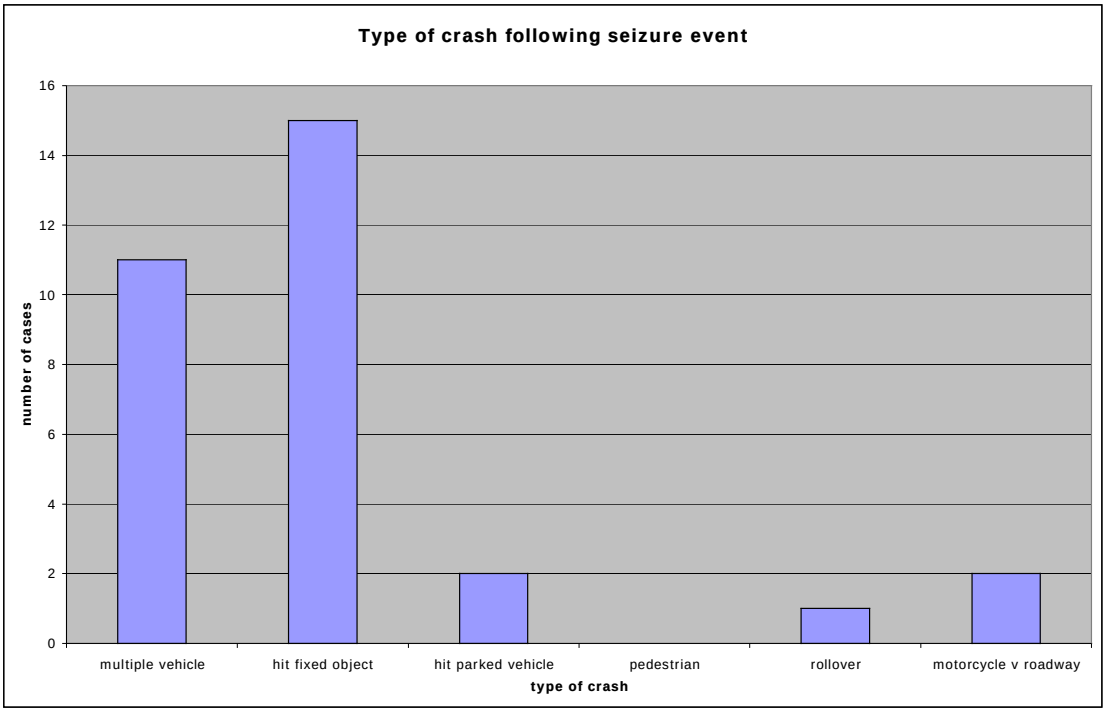

Figure 4.9: Types of crash following seizure

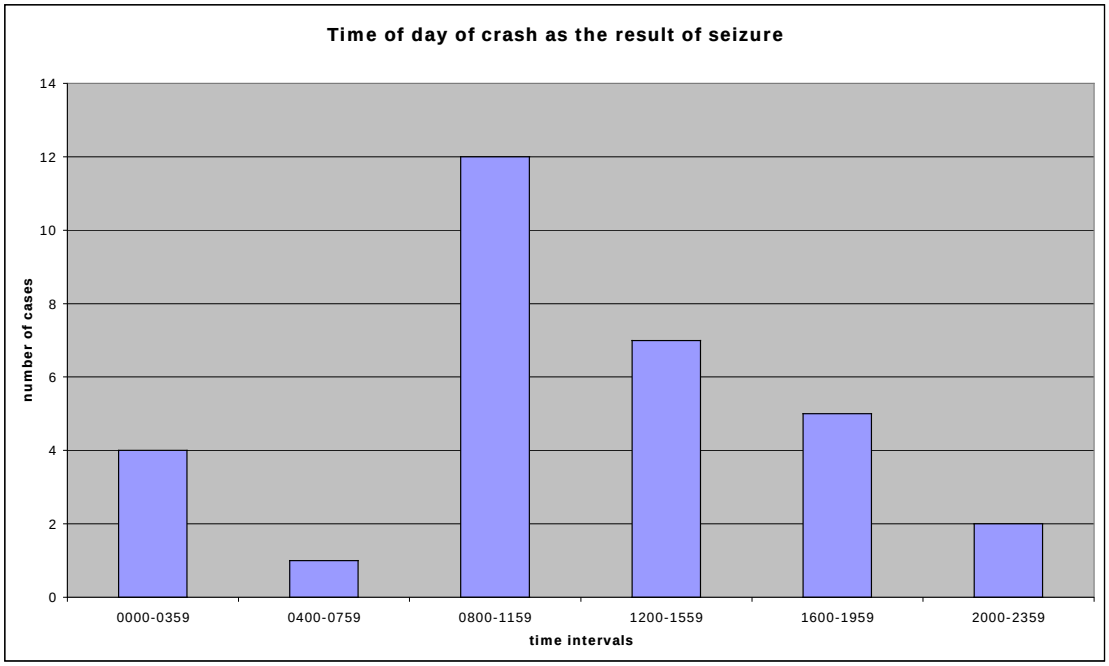

Figure 4.10: Time of day of crash as the result of seizure

4.3 Mental illness leading to crash

There were 18 cases where a participant was found by the attending medical team to have been involved in a crash as a result of a functional impairment related to a mental illness with a high degree of certainty. There were seven cases where a person was involved in a crash where that impairment was a likely contributor to the crash but with less certainty. This group consisted of fifteen drivers, seven pedestrians, two motorcycle riders and a cyclist.

As opposed to most other participants in the study, those identified as demonstrating mental illness as a contributor to a crash were more likely to have presented to the Royal Adelaide Hospital on a previous occasion. In all but one case these earlier presentations were related to mental health issues that were not related to involvement in a motor vehicle crash. A distinction has been made between those experiencing a mental illness and those who were seen as being involved in a crash as a result of a deliberate suicide act, addressed in a following section. This distinction was frequently challenging to determine and it is possible that some of the cases presented in this section may have involved a driver, motorcycle rider or pedestrian involved in a crash because of a deliberate suicide attempt. In some cases those participants have been assigned here as mental illness due to a lack of information to support a more definitive statement of suicide attempt. That lack of information stemmed most commonly from either the participant's refusal to engage with health care personnel or because the participant self discharged against medical advice before a more definitive assessment could be undertaken. It is suggested that the role of mental illness in the lead up to crashes in this study is likely to be higher than presented here, however the authors have deliberately been conservative in inclusion criteria in an attempt to define those where the impact of a mental illness was most clearly demonstrated.

In all cases the participant had a demonstrated history of mental illness involving at least two or more co-morbid conditions that were longstanding. The most common mental illnesses identified among this group included: major depression (16 cases), personality disorders (11 cases), anxiety disorder (9 cases), psychosis, including schizophrenia (9 cases) and bipolar-affective disorder (4 cases). In addition to these, current alcohol dependence and/or poly-substance abuse were

identified as co-morbid conditions in 18 of the participants in this group and a history of at least one previous suicide attempt that resulted in admission to hospital was identified in seven participants.

Although there was considerable variance in those presenting with a mental illness there were also some common themes identified. Included among these were reports describing an increase in recent stressors and an escalation in clinical manifestations of their illness in the days leading up to the crash. Recent stressors identified on psychiatric assessment included legal, financial and family relationship breakdowns in at least seven cases; in addition there were two cases where a driver and a pedestrian had been involved in an altercation with others immediately before being involved in the crash. There were five cases where the participant or a family member reported an escalation in manifestations such as an increase in auditory hallucinations and mania preceding the crash. Two pedestrians were known to have presented to hospital as a result of escalating mental illness in the weeks or months before their involvement in this crash. In one of these cases the pedestrian had presented on three occasions in the two weeks before the crash and the other had presented on nine separate occasions over the three preceding months. Poor adherence to medication regimes was considered to be the cause of the escalation in the mental illness status in at least four cases.

Very unusual crash events were a feature of at least two crashes involving a driver with a mental illness. In these two cases the drivers gave accounts of being confronted with a traffic situation requiring evasive action that was likely to resolve the issue, however, in both of these cases the driver reported making a spontaneous decision to take inappropriate actions, including deliberate acceleration, that increased the chance of the crash occurring in an attempt to make the accident ‘a real doozy of an accident’ or ‘make it look like a real accident’. Frequently it was noted by paramedic personnel or Police at scene that the person involved in the crash had undertaken unexplained or unusual driving manoeuvres preceding the crash. Non-restraint use at the time of crash involvement was identified for six drivers.

In most cases the clinical presentation and identification of mental illness as a contributor to the crash led to the participants undergoing psychiatric assessment. In some cases the participant absconded from hospital or discharged themselves against medical advice before an assessment could be undertaken. In at least eight cases the possibility of suicide attempt was addressed in these assessments but the participant either denied this or refused to engage in this aspect of the psychiatric assessment. In six cases the participant was detained under the *South Australian Mental Health Act* following psychiatric assessment, while others were provided with psychiatric care as a voluntary patient. This care frequently involved assessment and interventions related to their drug and alcohol use.

Eight of the 15 drivers in this group had their licences suspended following the crash. In six of these cases that suspension occurred on medical grounds, but in some cases the suspension coincided with a suspension related to their alcohol intoxication at the time of the crash. The remaining two were suspended as a result of their alcohol intoxication alone. There was one driver involved in a crash who held an interstate licence; the licensing authority in that state was advised of the person’s involvement in a crash; the notification included recommendation that the licence be suspended on medical grounds. In one case a pedestrian was assessed at being at risk as a driver and a recommendation to suspend their licence on medical grounds was also undertaken. Licence suspensions on medical grounds for this group ranged from twelve months to nine years. It was found that two drivers in this group had never held a licence. A pre-crash conditional licence related to a psychiatric illness was noted for three drivers while one driver held a conditional licence related to epilepsy.

Infringement and crash histories for this group were similar to other licence driver groups but there were several unusual cases. Included among these were three drivers who had between 17 and 22 traffic infringements each. These three drivers were also over-represented in previous crashes with one driver having a history of eight previous crashes that had been reported to Police.

In 48% of cases involving drivers with a mental illness the crash involved a single vehicle. These crashes consisted of nine cases where the vehicle struck a fixed object such as a tree or pole, one case where the vehicle struck a parked vehicle and two cases where the vehicle left the road and rolled. There was one case where a cyclist was struck by a car and one case where a motorcycle rider fell to the roadway. There were seven cases where a pedestrian was struck by a vehicle and four cases involved a driver who crashed their car into another vehicle or vehicles. In all but one crash involving a driver or motorcycle rider the participant was the sole occupant of the vehicle.

In all cases the driver, motorcycle rider or pedestrian was hospitalised as a result of the crash. Their length of stay ranged between one and 70 days, with the average length of stay being twelve days. No drivers, riders or pedestrians were fatally injured. In the one case involving a passenger, the passenger also required transport to hospital as a result of injuries incurred in the crash. No vehicle occupants of other vehicles were injured in the multiple vehicle crashes for this group.

Those who were found to have been involved in a crash as a result of a mental illness were generally younger than other medical condition groups, with close to 90% of cases involving a participant who was 50 years of age or less. Males made up 68% of this group while females were seen to be involved in 32% of these crashes. All pedestrians involved in the crashes in this group were males between the ages of 20 and 40 years. Figure 4.11 shows the age and sex distribution for those involved in a crash as a result of a mental illness, while Figure 4.12 shows the crash types seen among this group. Figure 4.13 identifies the times of days where crashes occurred for this group. Crashes as the result of mental illness were much more likely to have occurred later in the day and at night.

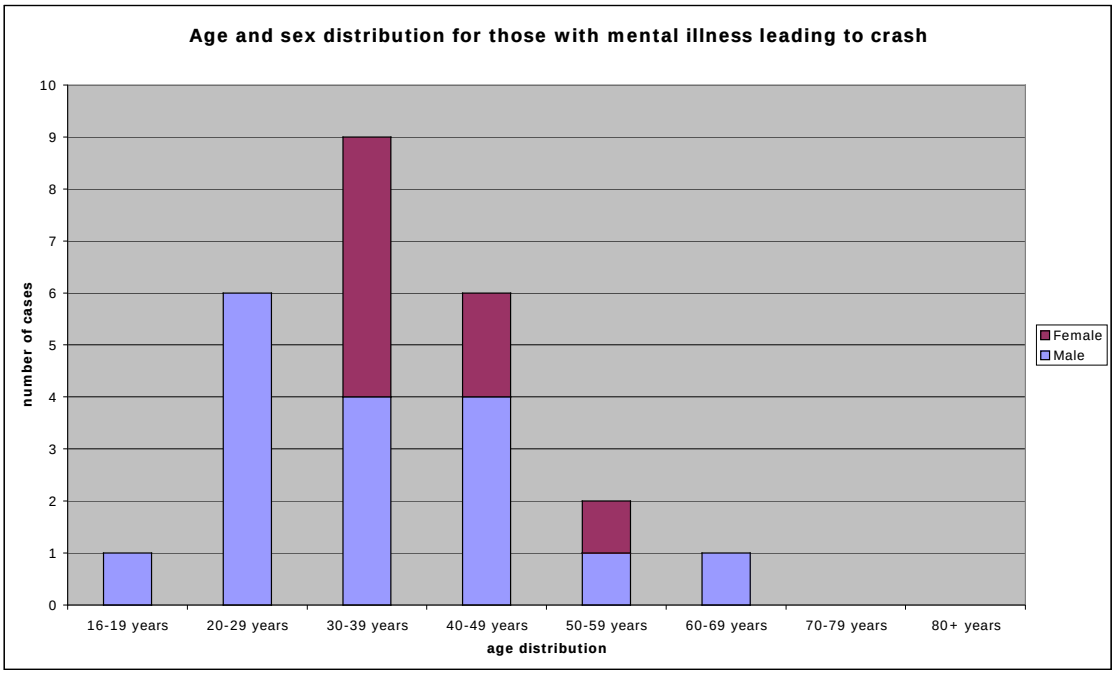

Figure 4.11: Age and sex distribution for those with mental illness resulting in crash

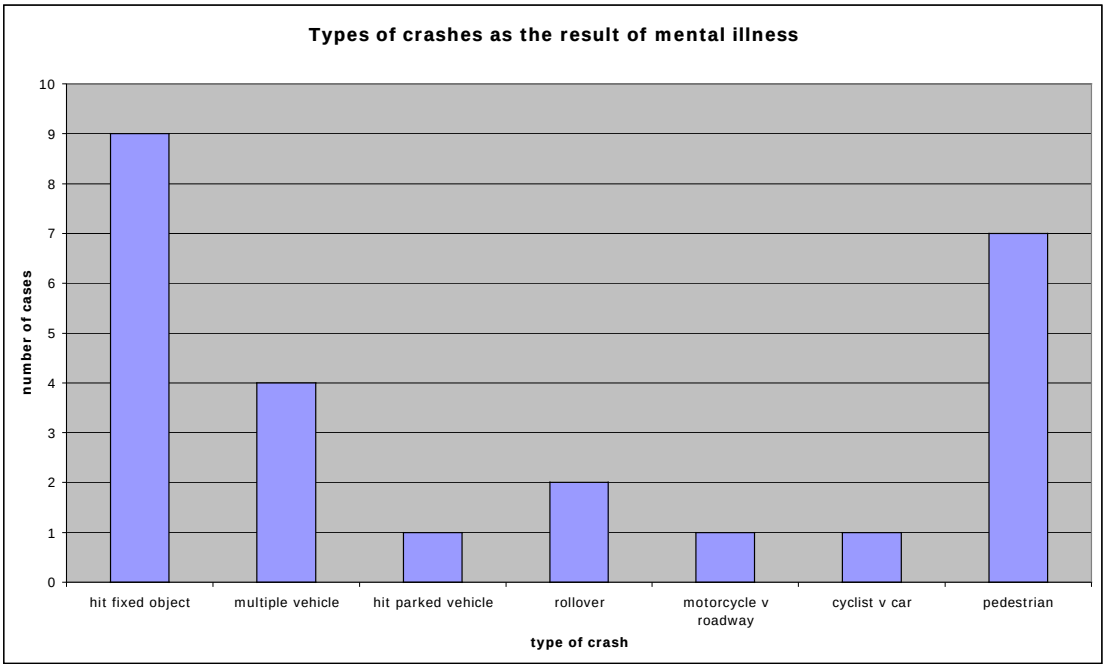

Figure 4.12: Types of crashes as a result of mental illness

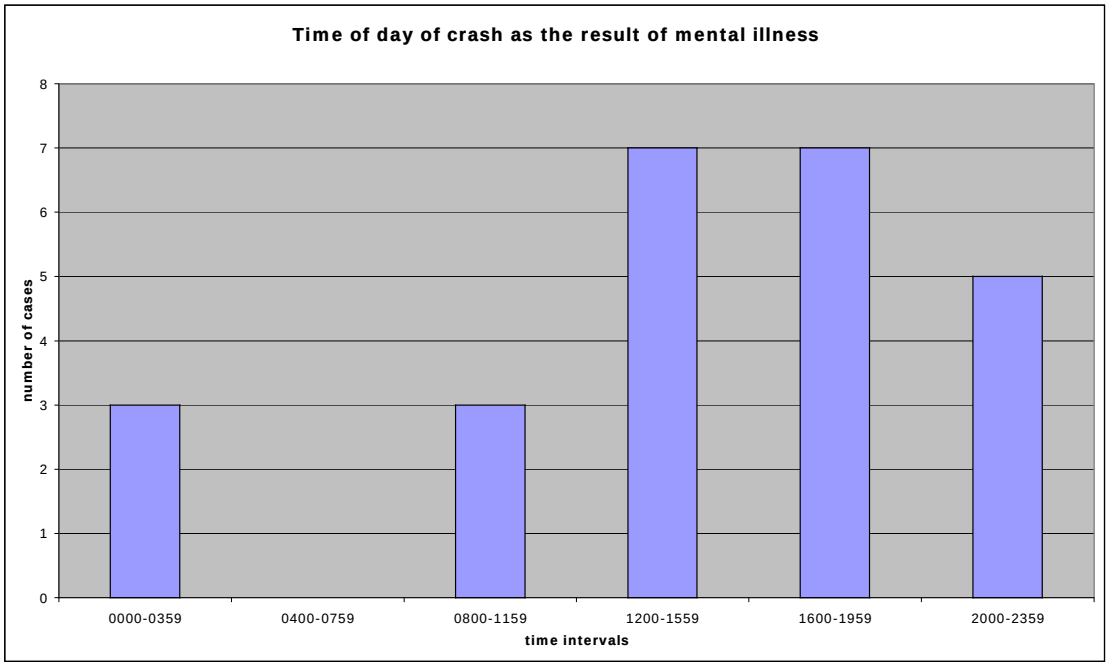

Figure 4.13: Time of day of crash as the result of mental illness

4.4 Suicide attempt leading to crash

There were 14 cases where a participant was identified by the attending medical team as being involved in a crash as a result of a deliberate suicide act with a high degree of certainty and three cases where a person was involved in a crash where a deliberate suicide act was deemed highly likely. This group consisted of eleven drivers, one motorcycle rider and five pedestrians.

In six of these 17 cases the participant had a known history of previous suicide attempts, including three cases where the participant had presented to a health care facility as a result of suicidal ideation in the days preceding their involvement in the crash. In 14 cases the participant was known to have at least one pre-existing medical condition related to mental illness with depression being the most common, followed by schizophrenia and bi-polar disorder. Alcohol and other drug use featured strongly in these suicide attempts with eleven of the 17 participants found to be intoxicated on alcohol and two participants who reported that they had ingested an over-dose of prescription medications prior to the crash. In two cases the participant died as a result of the injuries incurred in the crash, both cases involved pedestrians. Although neither of these pedestrians regained consciousness before their deaths, their actions prior to the crash clearly demonstrated a deliberate intention to undertake a suicide act. In one case the pedestrian had unsuccessfully attempted suicide by way of a drug over-dose earlier in the day and subsequently told acquaintances of their intention to attempt again, while the other pedestrian made contact with mental health services notifying them of their intentions immediately prior to the act.

In five cases the participant was detained under the *South Australian Mental Health Act* following the crash because of a continuing threat of suicide. In the remaining twelve cases it was deemed that the act was impulsive and the risk of further suicide attempt was either low or that the impulse had passed.

In 85% of cases involving drivers and motorcycle riders the crash involved a single vehicle. These crashes consisted of eight cases where the vehicle struck a fixed object such as a tree or pole, one case where the vehicle struck a parked truck and one case where a motorcycle rider, who was intending to strike a fixed object, fell to the roadway prior to that intended impact. There were five cases where a pedestrian was struck by a vehicle. In all but one crash involving a driver or motorcycle rider, the person was the sole occupant of the vehicle. As was the case for mental illness and perhaps expectedly, drivers in this group were frequently found to be unrestrained at the time of the crash.

In all cases the driver, motorcycle rider or pedestrian was hospitalised as a result of the crash with the two pedestrians, identified earlier, having fatal outcomes in the days following their crash involvement. The length of stay for surviving participants ranged between one and 44 days, with the average length of stay being eight days. In the one case involving passengers, the passengers also required transport to hospital as a result of injuries incurred in the crash. No occupants of other vehicles were injured in the multiple vehicle crashes for this group.

In all but two cases the participants were found to be 40 years of age or less. Males made up 70% of this group while females were involved in 30% of these crashes. All pedestrians involved in the crashes in this group were males between the ages of 24 and 32 years. Figure 4.14 shows the age and sex distribution for those involved in a crash as a result of a deliberate suicide act, while Figure 4.15 shows the crash types seen among this group. Figure 4.16 identifies the times of days where crashes occurred for this group, the majority of which occurred at night.

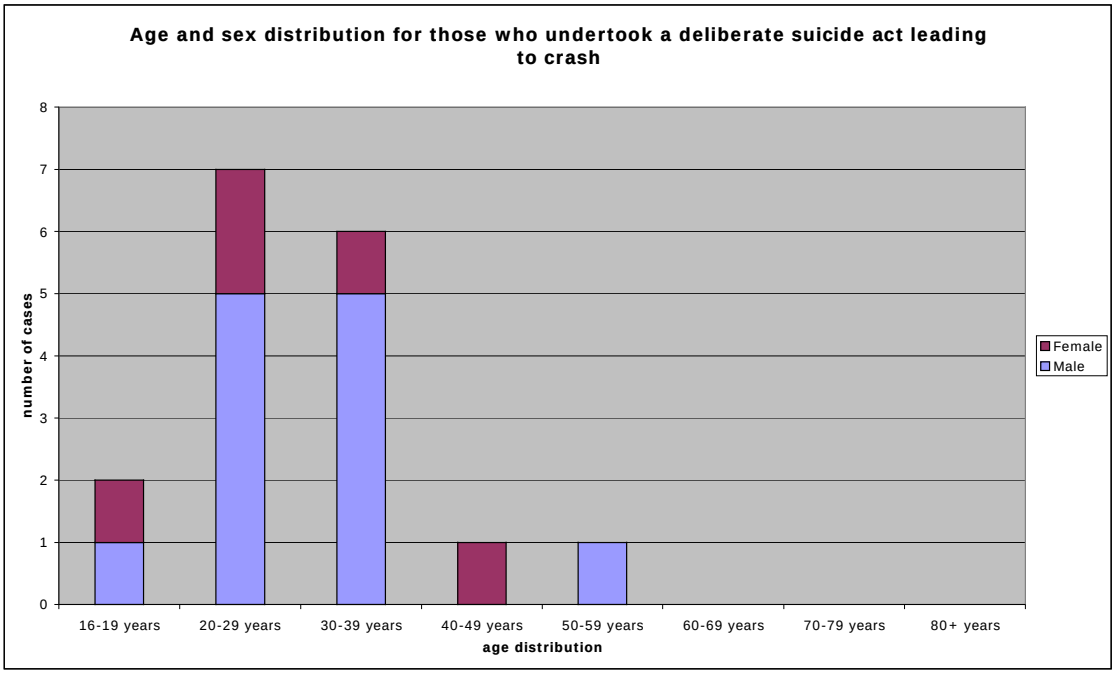

Figure 4.14: Age and sex distribution for those involved in a crash as the result of a deliberate suicide act

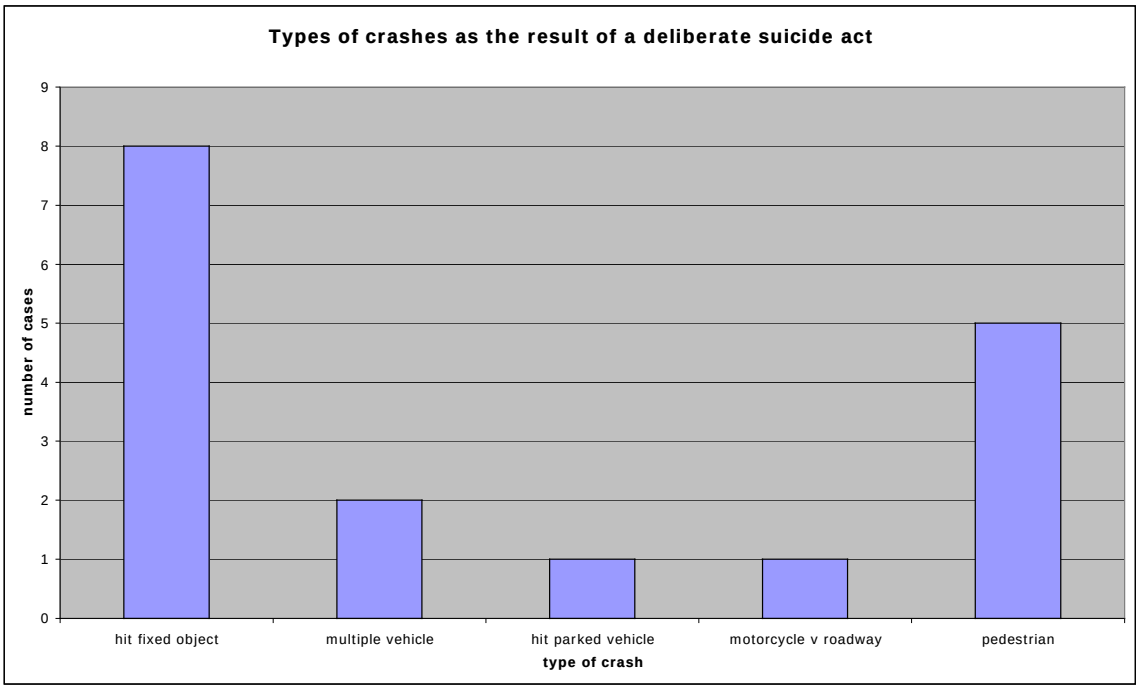

Figure 4.15: Types of crashes as a result of deliberate suicide act

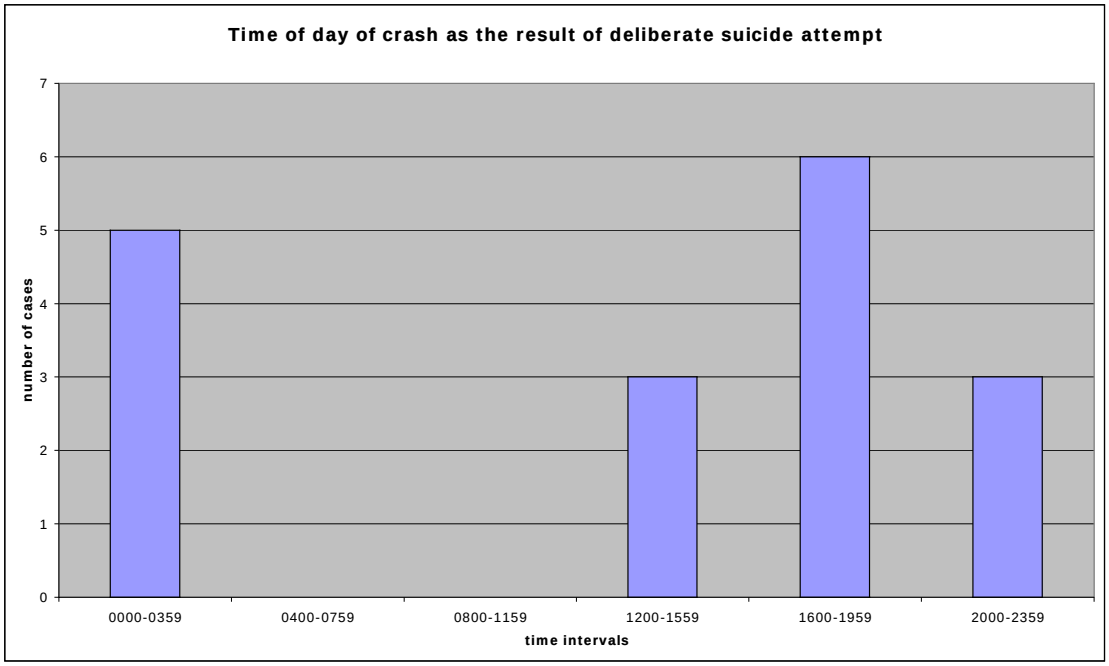

Figure 4.16: Time of day of crash as the result of a deliberate suicide attempt

4.5 General poor health and declining function leading to crash

There were a collection of participants involved in the crashes investigated who were unable to be identified as being involved in the crash for any one specifically determined medical cause. These participants were identified on medical assessment as being in poor general health and frequently demonstrated issues related to poor mobility as well as clinical manifestations related to their multiple heath deficits, that supported the notion of a decline in the functional abilities that are critical to driving performance. This group of participants are classified here as being involved in the crash due to general poor health with declining functional ability.

There were 13 cases where a participant was identified by the attending medical team as being involved in a crash as a result of their general poor health with a high degree of certainty and two cases where a participant was involved in a crash where their poor health is likely to have contributed. This group consisted of 14 drivers and one motorised mobility scooter (gopher) rider.

There were common features found amongst this group of participants. In all cases the drivers and mobility scooter rider were elderly, with 75% being 80 years of age or older. Typically the group were found to have a history of multiple chronic co-morbid medical conditions that were longstanding. The number of co-morbid conditions ranged between three and twelve for each participant with the average amongst the group being seven. These pre-existing medical conditions were generally of a more serious nature with the potential to impact on the participant's activities of daily living, including driving performance. Included among these were multiple co-existing cardiac conditions, hypertension, peripheral vascular disease, chronic renal failure, visual impairment, poor mobility capabilities related to rheumatoid or osteoarthritis, non-insulin dependent diabetes - often poorly controlled, cancer, anaemia and previous CVA (stroke). In five cases there was documentation specifically identifying the participants longstanding dependence on aids for mobility including walking frames and or walking sticks. In three cases the participant had presented to a hospital in the months preceding their crash involvement as a result of a demonstrable recent decline in their health status and there was one case where a participant had recently completed radiotherapy and chemotherapy.

The crash accounts provided by Police and paramedics at scene frequently demonstrated unusual driving performance either in the lead up to the crash or following the primary impact. Examples of this include four drivers who stated that they hit the accelerator instead of the brake, one driver who entered the carriageway on the wrong side and came into oncoming vehicles and one driver who reversed at speed, travelling across a parkland and colliding with fixed objects twice before the vehicle came to rest. Drivers were frequently unable to account for why they had performed these unusual behaviours. In eight cases the driver or mobility scooter rider failed to give way and came into the path of other vehicles. In six of those cases the other vehicle was a large truck, bus or recreational vehicle that was likely to have been clearly visible. The crash histories for three of the drivers were found to have increased in the two years preceding their involvement in this crash, with one of the drivers having been involved in three at-fault crashes in the preceding 18 months.

Thirteen of the 14 drivers in this group were found to hold conditional licences related to a reported medical condition. In ten cases the medical condition identified was heart disease/hypertension; two drivers had non-insulin dependent diabetes identified and one driver held a conditional licence related to a nervous/psychiatric disorder. There were two drivers who were found to have existing licence suspensions on medical grounds at the time of the crash and the motorised mobility scooter rider was known to have had his motor vehicle licence suspended on medical grounds the year before his involvement in this crash. One driver was known to have undergone a practical driving assessment on two separate occasions in the year of this crash, passing on the second attempt. In nine cases drivers had their licences suspended following the crash, three of whom surrendered their licence permanently.

In four cases involving drivers with general poor health the crash involved a single vehicle; in each of these cases the driver struck a fixed object or multiple fixed objects. There were ten cases involving a driver or mobility scooter rider who struck another vehicle or vehicles.

In all cases the driver or rider was hospitalised as a result of the crash. In two cases the participant died either as a result of the injuries incurred in the crash or as the result of a deterioration in their general condition in the following days. The length of stay for surviving drivers and the mobility scooter rider ranged between one and 41 days, with the average length of stay being 16 days. In three cases the driver was transferred to respite care or nursing home accommodation following their hospitalisation. The driver or rider was the sole occupant of the vehicle in all cases. Two drivers of other vehicles required transport to hospital as a result of injuries incurred in the multiple vehicle crashes for this group.

Those who were found to have been involved in a crash as a result of general poor health were found to be elderly and between 77 and 94 years of age; there were four drivers over 90 years of age. Males made up 80% of this group while females were seen to be involved in 20% of these crashes. Figure 4.17 shows the age and sex distribution for those involved in a crash as a result of general poor health, while Figure 4.18 shows the crash types seen among this group. Figure 4.19 identifies the times of days where crashes occurred. In most cases the crashes for this group occurred during daylight hours.

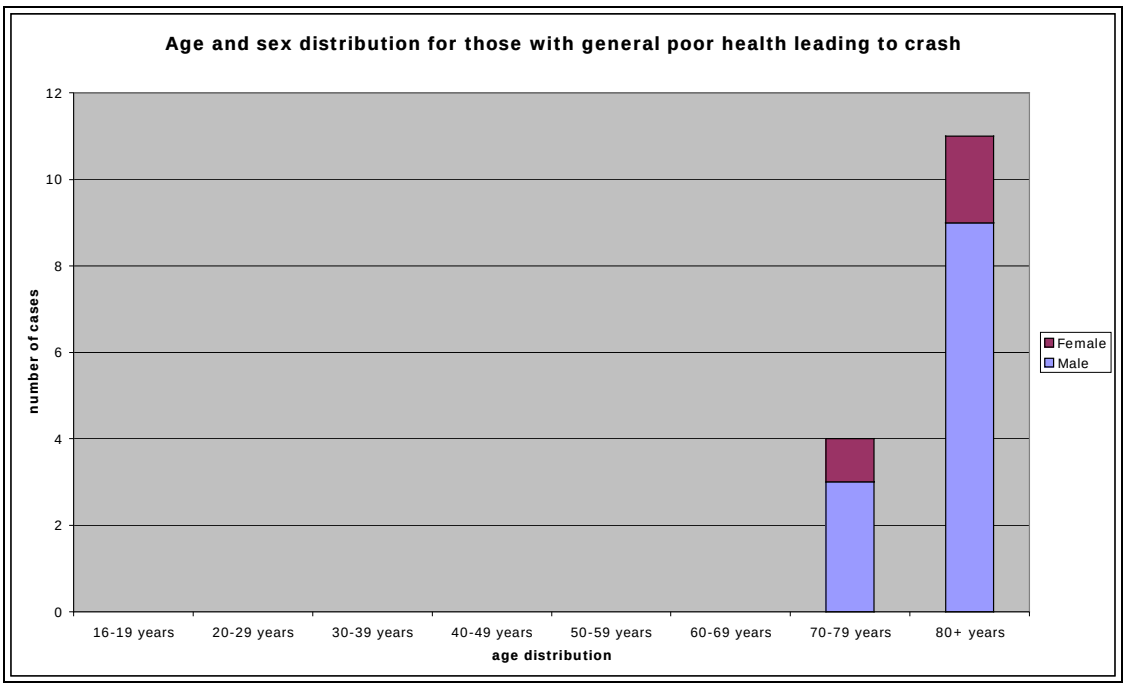

Figure 4.17: Age and sex distribution for those involved in crash as the result of general poor health

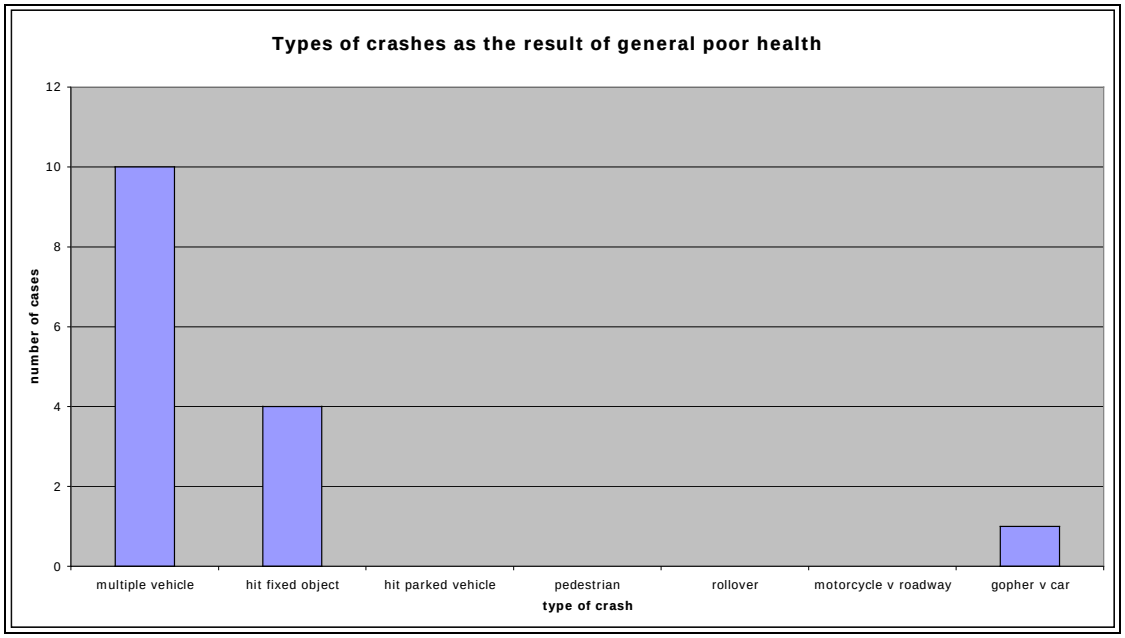

Figure 4.18: Type of crash as a result of general poor health

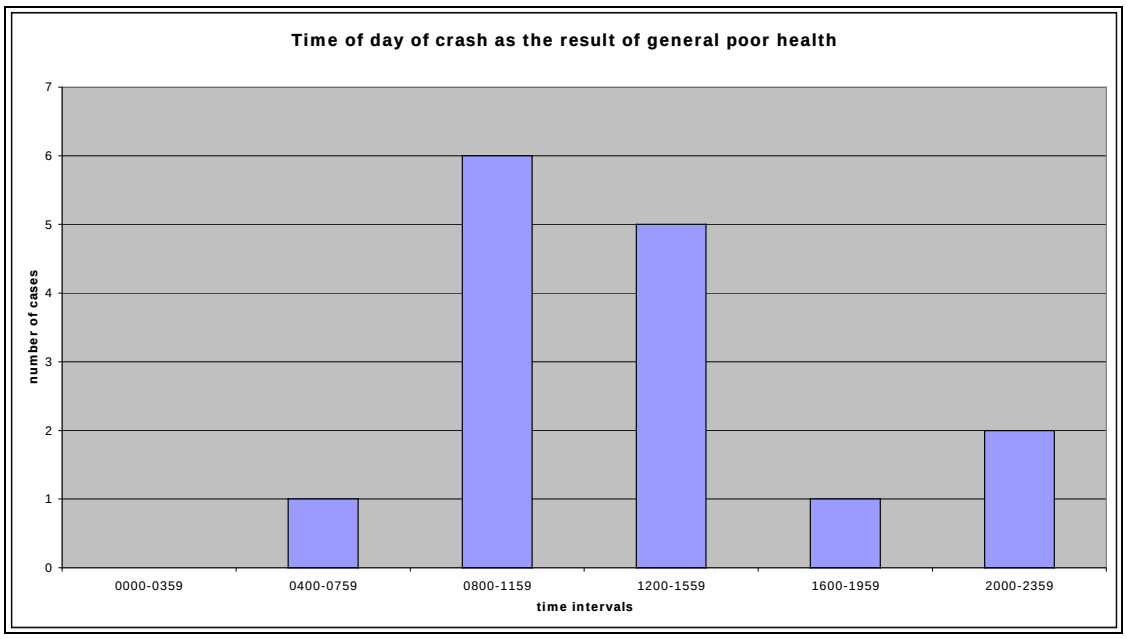

Figure 4.19: Time of day of crash as the result of general poor health

4.6 Dementia and cognitive decline leading to crash:

There were 12 cases where a participant was identified by the attending medical team as being involved in a crash as a result of a dementia related illness or cognitive decline with a high degree of certainty and one case where a participant was involved in a crash where dementia or cognitive decline was deemed as a possible contributor in the crash causation. This group consisted of seven drivers and six pedestrians.

In all cases the participant had demonstrated a pre-existing cognitive deficit, with eight participants having a pre-crash diagnosis of dementia that was well established. The forms of dementia were identified in some cases by type including HIV dementia/AIDS dementia complex, alcohol induced dementia, Alzheimer's, and dementia secondary to ischaemic brain disease; while the remainder were categorised more broadly as dementia alone. In two cases involving pedestrians the participant resided in a permanent residential care facility but had absconded from those facilities in the lead up to the crash. In one other case the participant, a driver, had been admitted to hospital six months earlier because of a frontal cranial haemorrhage and was known to have been discharged into a residential care facility following that admission. For reasons unknown to the medical team, this participant had returned to her home residence following that placement and had resumed driving. Among the remaining five cases there was one case where the participant had undergone an aged care assessment (ACAT) in the months preceding the crash that identified confusion and declining cognition. In the four remaining cases family members gave accounts of confusion and declining cognition that had resulted in diminished abilities to undertake activities of living independently.

The seven drivers were found to be involved in single vehicle crashes into fixed objects in three cases and multiple vehicle crashes in four cases. In two of the three cases where the driver struck a fixed object the driver accounts of the crash included statements related to hitting the accelerator instead of the brake and losing control. The phenomenon of hitting the wrong pedal was also noted among drivers in the general poor health group and may reflect a decrease in executive functioning ability. Three of the four multiple vehicle crashes involved a driver striking the rear of a forward vehicle. In one of these cases the driver had been seen driving slowly and erratically over several kilometres and Police had been notified. The driver slid slowly into the rear of a vehicle that

had deliberately been placed to bring the vehicle to a stop. The driver in this case had travelled a considerable distance from their home with no explanation of why they were at this location or where they were intending to go. The fourth multiple vehicle collision involved a driver who was identified as possibly involved in the crash as a result of cognitive decline. In this case the driver was seen to enter a major highway from a side street without evidence of giving way, coming into the path of another vehicle. It was understood that the driver had a pre-existing confusion that had been longstanding but there was no specific documentation related to a definitive diagnosis or conclusion drawn connecting the driver's confusion to the crash.

Five of the seven drivers had their licensing privileges suspended following the crash. The suspensions imposed were generally for extended periods between five and eight years. In one of these cases the driver was required to undertake a formal driving assessment before a licence could be reinstated. No licence changes were seen for the driver considered as a possible case in this group. The remaining driver died in hospital in the days following the crash.

In all cases the driver or pedestrian was hospitalised as a result of the crash. As stated earlier one driver died due to a deterioration in their general condition in the following days. The length of stay for surviving drivers and pedestrians varied considerably with three pedestrians and one driver requiring hospitalisation for more than 28 days, one of whom was hospitalised for 176 days. In seven cases the participant was transferred to a residential care facility following their hospitalisation, including the two pedestrians who returned to the residential community they resided in prior to the crash. Drivers involved in these crashes were travelling alone in all but one of these crashes. In the one case where a passenger was involved, that passenger also required transport to hospital as a result of injuries incurred in the crash. No vehicle occupants of the other vehicles involved in the multiple vehicle crashes were injured.

Those who were involved in a crash as a result of dementia or cognitive decline were found to be older with more than 38% being 80 years or more, two of whom were 90 years or more. Males and females were more evenly distributed within this group with males making up 54% and females 46%. Figure 4.20 shows the age and sex distribution for those involved in a crash as a result of dementia or cognitive decline, while Figure 4.21 shows the crash types seen among this group. Figure 4.22 identifies the times of days where crashes occurred for this group. In all cases the crash occurred during daylight hours.

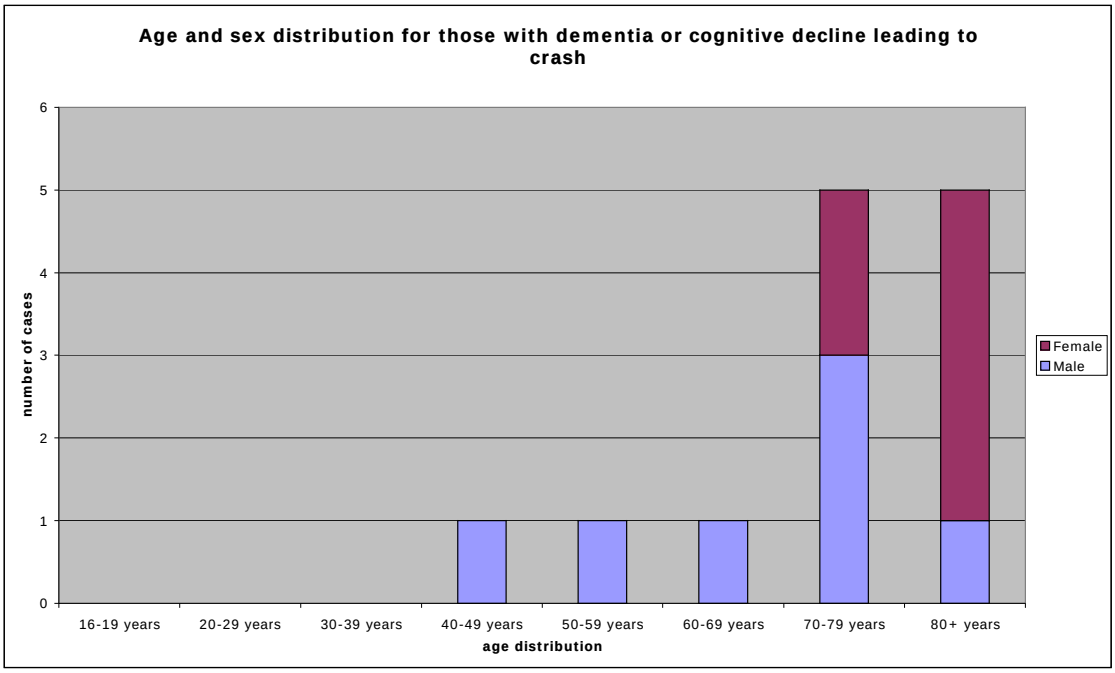

Figure 4.20: Age and sex distribution for those involved in crash as the result of dementia or cognitive decline

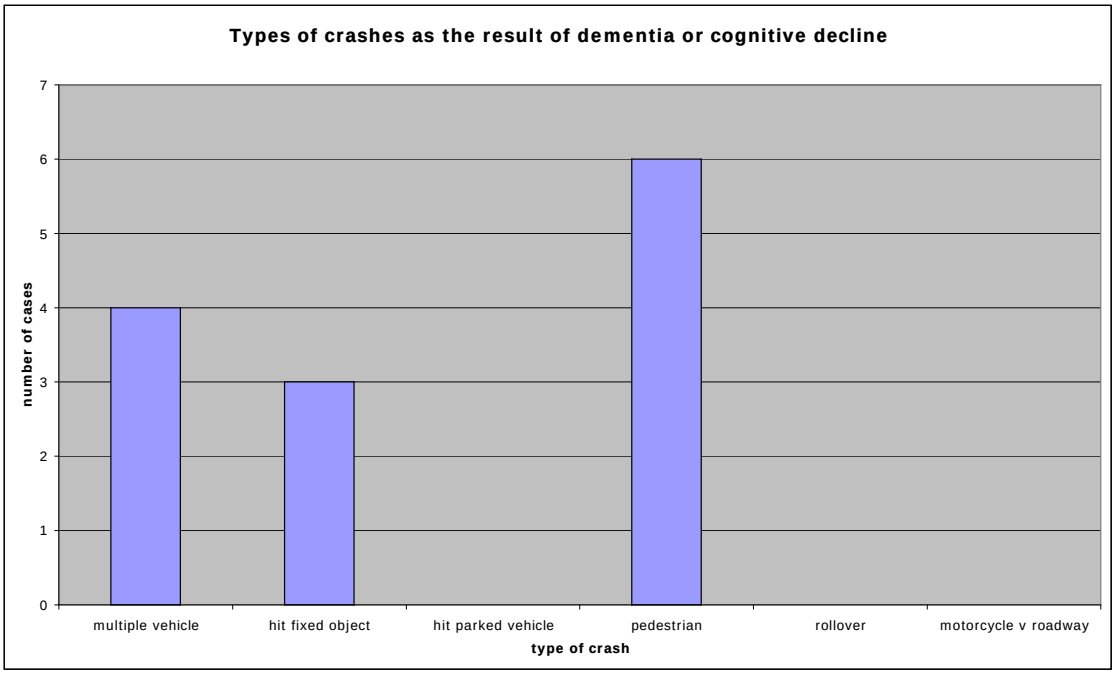

Figure 4.21: Types of crashes as the result of dementia or cognitive decline

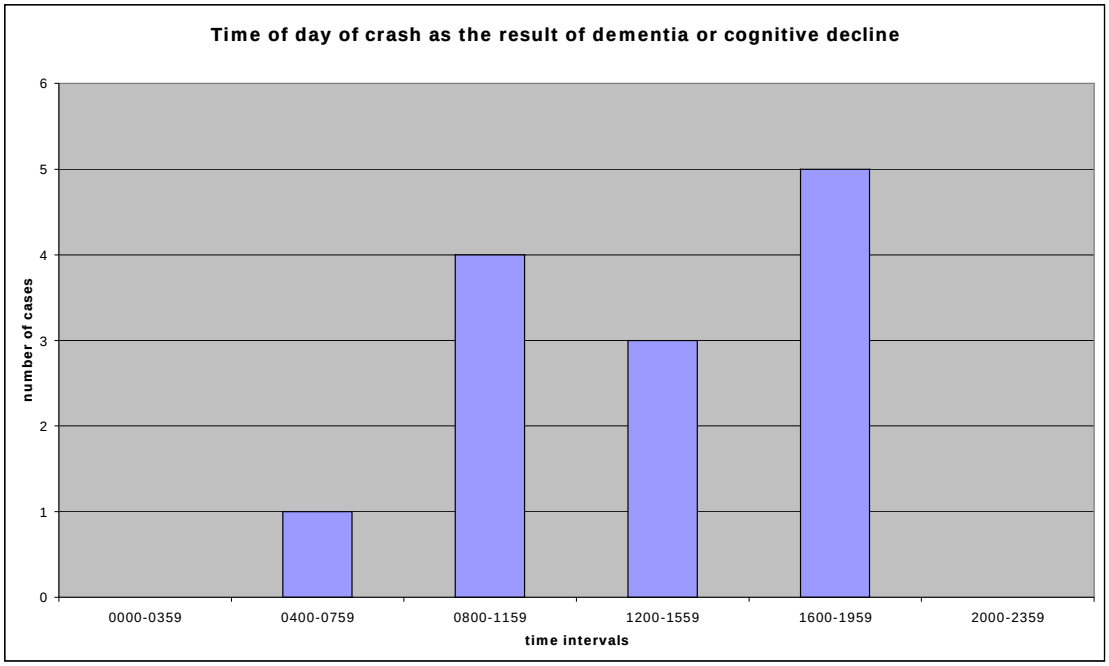

Figure 4.22: Time of day of crash as the result of dementia or cognitive decline

4.7 Hypoglycaemia (low blood glucose) leading to crash

There were seven cases where a participant was identified by the attending medical team as being involved in a crash as a result of a hypoglycaemic event with a high degree of certainty, all of whom were drivers. There was one motorcycle rider involved in a crash where their hypoglycaemic state was deemed as a possible contributor.

In five cases the participant had a previously known history of insulin dependent diabetes. It was understood that the insulin dependent status among these five participants was longstanding but the duration was not explicitly identified in all cases. In four of these cases the person was known to have experienced hypoglycaemic episodes in the past, including one driver who had been experiencing an increase in hypoglycaemic events in the preceding months. Two participants, a driver and a motorcycle rider, had no previous diagnosis of diabetes or any known episodes of hypoglycaemia prior to this presentation.

The crash descriptions for the five cases involving a driver with a known insulin dependent status were very similar, with drivers reportedly demonstrating some alteration in consciousness prior to the crash. In three cases the driver veered left and struck a parked vehicle, one driver travelled over a raised median and into oncoming vehicles and the remaining driver drove into the rear of a vehicle that was stationary at an intersection. The sequence of events for the two drivers who had no history of diabetes, however, did not demonstrate a defined drop in conscious state but were seen to have occurred as the result of inattention secondary to their low blood glucose levels. In one case the driver travelled through an intersection against controls and collided with a vehicle while the motorcycle rider struck a vehicle without evidence of attempts to take evasive action. Blood glucose levels were taken by paramedic staff at the scene and in all cases the drivers and motorcycle rider were administered glucose in the form of glucose paste or glucagon. Blood glucose levels prior to the administration of glucose were documented in four of the seven cases while a blood glucose level following glucose administration was documented in the remaining three cases. The blood glucose levels were recorded as being between 1.5mmol/litre and 2.7mmol/litre in the group known to be tested prior to glucose administration and between 3mmol/litre and 4mmol/litre for those who were tested post administration of glucose. In three

cases the driver reported feeling unwell immediately before or during the driving task but had continued to drive. In two of these cases the driver reported that the hypoglycaemic event was likely to have occurred due to missing a meal.

In four of the seven cases, insulin dependent diabetes was recorded on their conditional licences. One driver held a conditional licence related to heart disease/hypertension only in spite of a known history of insulin dependent diabetes. Six drivers had their licences suspended following the crash on medical grounds, however, one of those suspensions was likely to be related to the extent of the injuries incurred in the crash and not necessarily related to the hypoglycaemic event. Licence suspensions on medical grounds for this group ranged from four weeks to eight months. The crash histories among these eight licence holders generally reflected those seen for other participants in the study, however, the one insulin dependent driver with an unconditional licence had a history of four crashes in the previous ten years. Each of these previous crashes involved striking a fixed object, as was the case in their crash in this study.

In all cases the driver or motorcycle rider was hospitalised as a result of the crash. Drivers and the motorcycle rider involved in these crashes were travelling alone at the time of the crash. No vehicle occupants of the other vehicles involved in the multiple vehicle crashes were injured. The length of stay for this group ranged between one and 29 days with the average length of hospitalisation being ten days.

Those who were involved in a crash as a result of hypoglycaemic event were found across a wide age group. Males were seen to be involved in 38% of cases with females involved in 62%. Figure 4.23 shows the age and sex distribution for those involved in a crash as a result of hypoglycaemia, while Figure 4.24 shows the crash types seen among this group. Figure 4.25 identifies the times of days where crashes occurred for this group. Crashes occurred throughout the day but increased toward the end of the day.

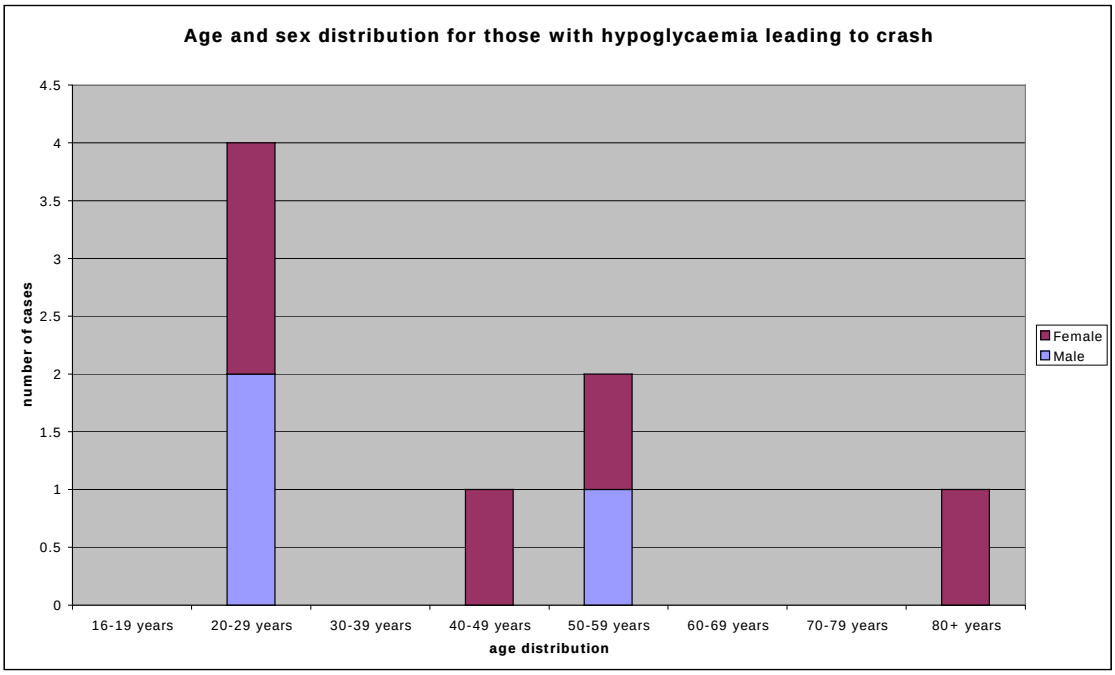

Figure 4.23: Age and sex distribution for those involved in crash as the result of hypoglycaemia

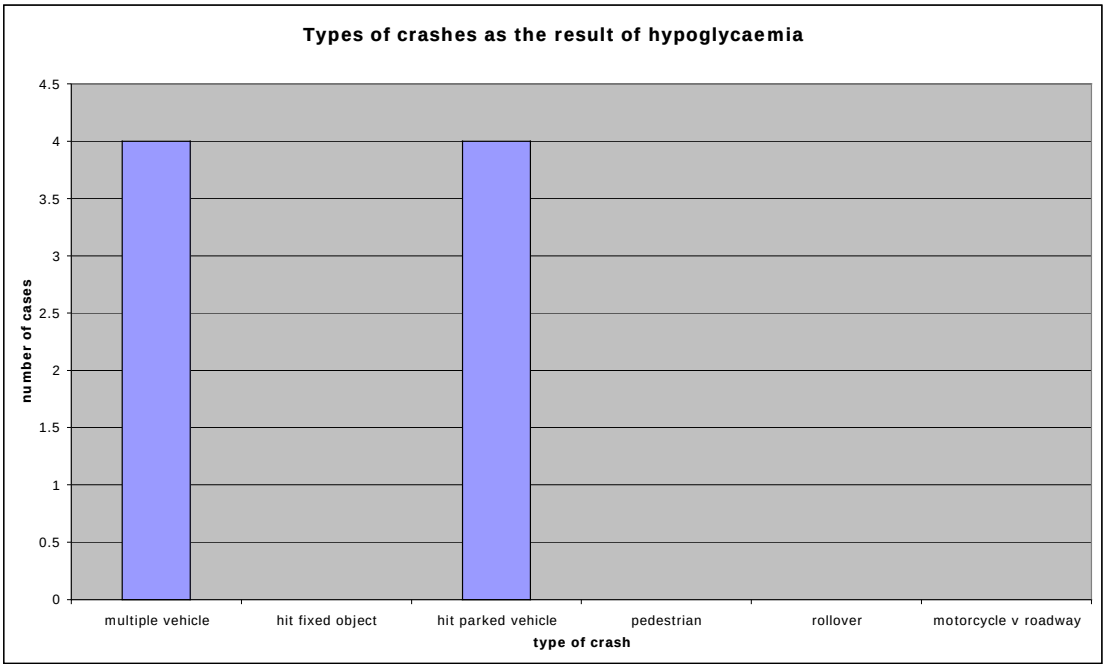

Figure 4.24: Types of crashes as the result of hypoglycaemia

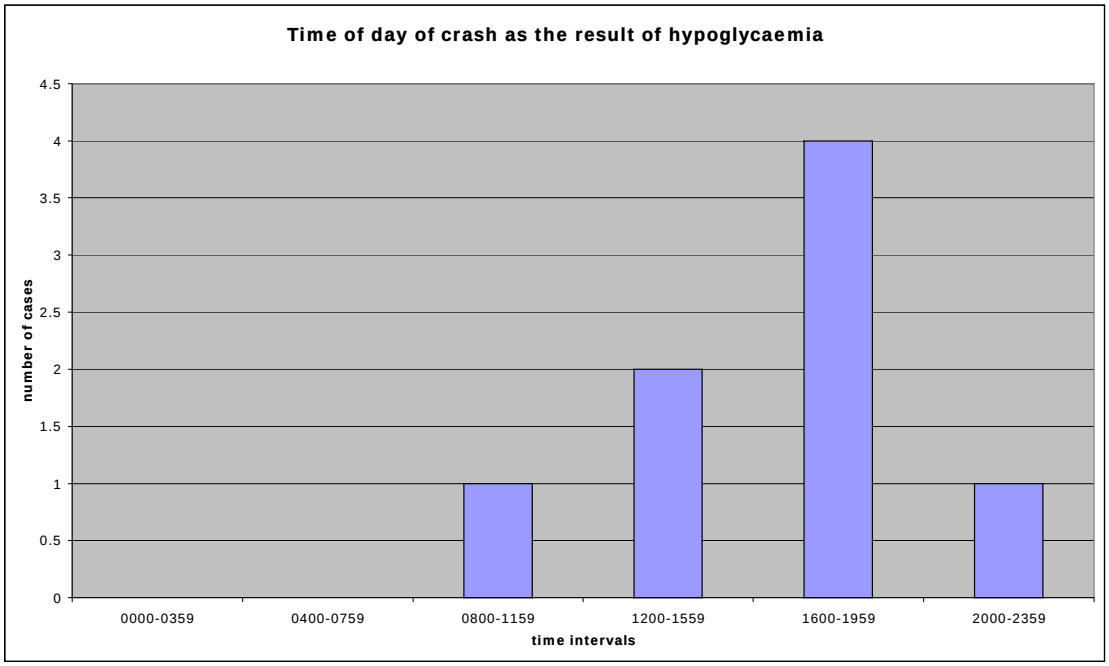

Figure 4.25: Time of day of crash as the result of hypoglycaemia

4.8 Sleep apnoea leading to crash

There were seven cases where a participant was identified by the attending medical team as being involved in a crash as a result of falling asleep secondary to sleep apnoea with a high degree of certainty and one case where a participant was involved in a crash where their sleep apnoea is likely to have contributed. This group of participants were all drivers of cars.

In five cases the participant had a previously known history of sleep apnoea. These five cases include one participant who was involved in two separate crashes that occurred during the study; these two crashes occurring four months apart. In two cases the participant underwent sleep studies during their hospitalisation that confirmed sleep apnoea. In the remaining case the participant was awaiting a sleep study result that was expected to confirm his sleep apnoea status. Those who were not known to have sleep apnoea prior to their crash involvement each described characteristics suggestive of the complaint, including daytime somnolence and excessive snoring. In one of these cases the participant reported falling asleep while driving on one other occasion.

The crash descriptions for the eight cases were very similar, with drivers reporting that they felt tired during the driving task before falling asleep. In four cases the vehicle drifted to the left of the carriageway and struck a fixed object or objects while in the remaining four cases the vehicles were known to cross the carriageway to the right, resulting in striking other vehicles head-on in two cases, a fixed object in one case and a rollover event in the remaining case. In all cases the participant described a poor sleep history in the days leading up to the crash. A typical treatment for sleep apnoea is the use of a continuous positive airway pressure (CPAP) machine. The use or non-use of a CPAP machine was documented only for the one driver involved in two of the crashes. On both presentations to hospital the driver in this case reported that he was currently suffering from a cold and was subsequently unable to use his CPAP machine.

Sleep apnoea was not specifically identified as a condition to licensing in any case, however, there were three cases where drivers were identified as having a conditional licence related to heart disease or a medical condition that was not further specified. In two cases the driver held an interstate licence and so conditions to licensing were not known. Four drivers had their licences suspended following the crash on medical grounds. Licence suspensions on medical grounds were for three months in three cases with the remaining case to be reviewed following the results of a sleep study. The crash histories among the South Australian licence holders were low and reflected those seen elsewhere in the study.

In all cases the driver was hospitalised as a result of the crash. In all but one case the driver was travelling alone. In this one case the passenger also required transport to hospital as a result of injuries incurred in the crash. Two of the drivers of other vehicles involved in the multiple vehicle crashes were injured and transported to hospital. The length of stay for this group ranged between one and 15 days with the average length of hospitalisation being less than six days.

Those who were involved in a crash as a result of sleep apnoea were found across a wide age group. Males were seen to be involved in 62% of cases with women involved in 38%. Figure 4.26 shows the age and sex distribution for those involved in a crash as a result of sleep apnoea, while Figure 4.27 shows the crash types seen among this group. Figure 4.28 identifies the times of days where crashes occurred for this group, showing that most of the crashes occurred in the afternoon.

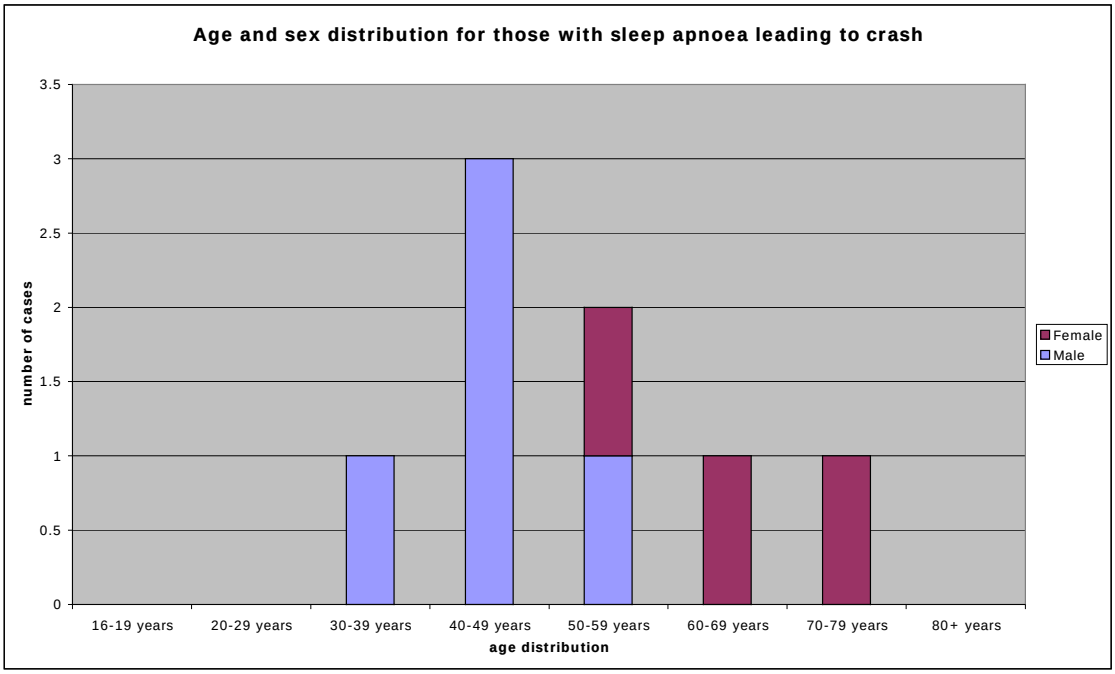

Figure 4.26: Age and sex distribution for those involved in crash as the result of sleep apnoea

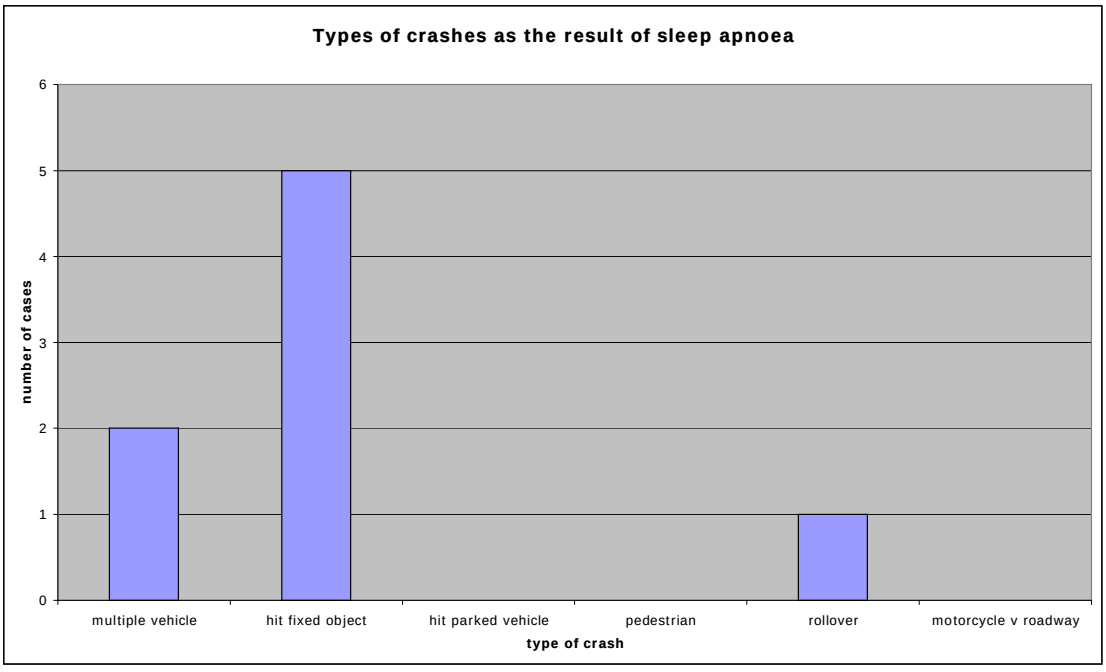

Figure 4.27: Types of crashes seen among those involved in crash as the result of sleep apnoea

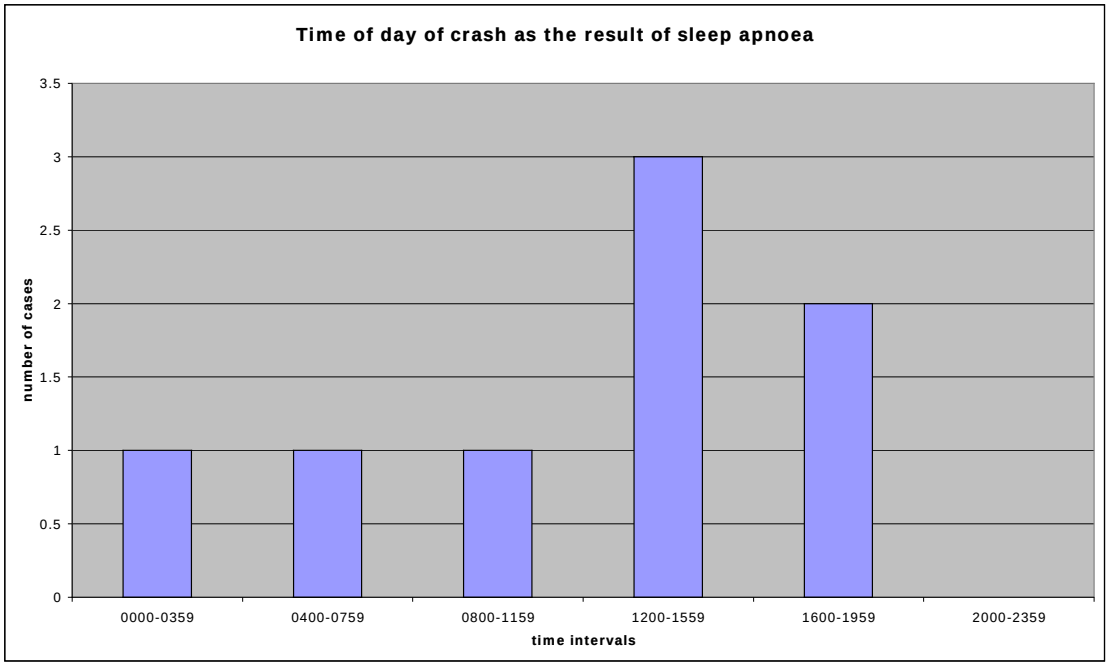

Figure 4.28: Time of day of crash as the result of sleep apnoea

4.9 Cardiac events leading to crash

Seven cases are presented in this section related to a cardiac event that was identified by the attending medical team as a contributing factor to the crash with a high degree of certainty. These seven cases, all involving drivers, need to be considered in conjunction with those ten cases identified in an earlier section under the heading of loss of consciousness leading to crash. In some of the crashes that will be addressed in this section it is possible that the participant may have also had a pre-crash loss of consciousness but this was not explicitly documented.

In six of these seven cases the driver had a previously known history related to cardiovascular disease. These medical conditions were most commonly identified as hypertension, high cholesterol and ischaemic heart disease with one participant known to have a previous history of unexplained unconscious collapse. In one case the driver also had a history of unstable angina in the weeks preceding the crash. Two of the drivers were known to hold a conditional licence related to a reported medical condition. In one case that conditional licence related to their heart disease/hypertension status while the other held a conditional licence as a result of their non-insulin dependent diabetes. In one case it was known that the driver had undertaken three practical driving tests within the two months preceding their crash involvement. This driver had failed those tests and was disqualified from driving at the time of the crash. There was one driver who held a Northern Territory licence and so conditions to licensing were not known.

In four cases the driver veered to the left of the carriageway resulting in collisions with fixed objects including a pole in two cases, a tree and a parked car. There was one case where the vehicle drifted to the left of the carriageway and rolled. In the remaining two cases the collision involved a right angle multiple vehicle collision at an intersection. Of these two multiple vehicle crashes it was known that one driver had travelled through a red light prior to the collision, while the description available for the second case lacked enough detail to determine the pre-crash events.

In three cases the driver described feeling unwell in the days leading to the crash with one driver reporting that they had been having chest pain over a two day period, one who reported experiencing palpitations throughout the night before the crash and the third describing a general

un-wellness and fatigue that was related to periods of angina. The remaining four drivers reported no pre-warning symptoms. In two cases the cardiac event leading to the crash was identified as a myocardial infarction. There were three cases that were identified as occurring as a result of heart block, one case where a driver's crash was related to a new presentation of atrial fibrillation and one case where the medical conclusions drawn were identified as 'related to cardiac issues, including multi focal PVCs, and bigemny'. In four cases the participant had a pacemaker inserted during their post-crash hospitalisation. Those participants identified as having a myocardial infarction underwent stent insertion in one case and multiple coronary bypass grafting in the other prior to being discharged.

Licence privileges were suspended on medical grounds for two drivers following their involvement in the crash. In one case that suspension was for a twelve month period while the other was until further notice. The licence suspension that was already in place for one driver prior to the crash was upheld.

In all cases the driver was hospitalised as a result of the crash. Drivers involved in these crashes were all travelling alone. No vehicle occupants of the other vehicles involved in the multiple vehicle crashes were injured. The length of stay for this group varied considerably with three drivers being hospitalised for six days or less while three others were hospitalised for more than 28 days; the average length of hospitalisation was 21 days.

Those involved in a crash as the result of a cardiac event in this section were between the ages of 37 years and 81 years. Males were seen to be involved in 38% of cases with women involved in 62%. Figure 4.29 shows the age and sex distribution for those involved in a crash as a result of a cardiac event, while Figure 4.30 shows the crash types seen among this group. Figure 4.31 identifies the times of days where crashes occurred, with all crashes found to have occurred during daylight hours.

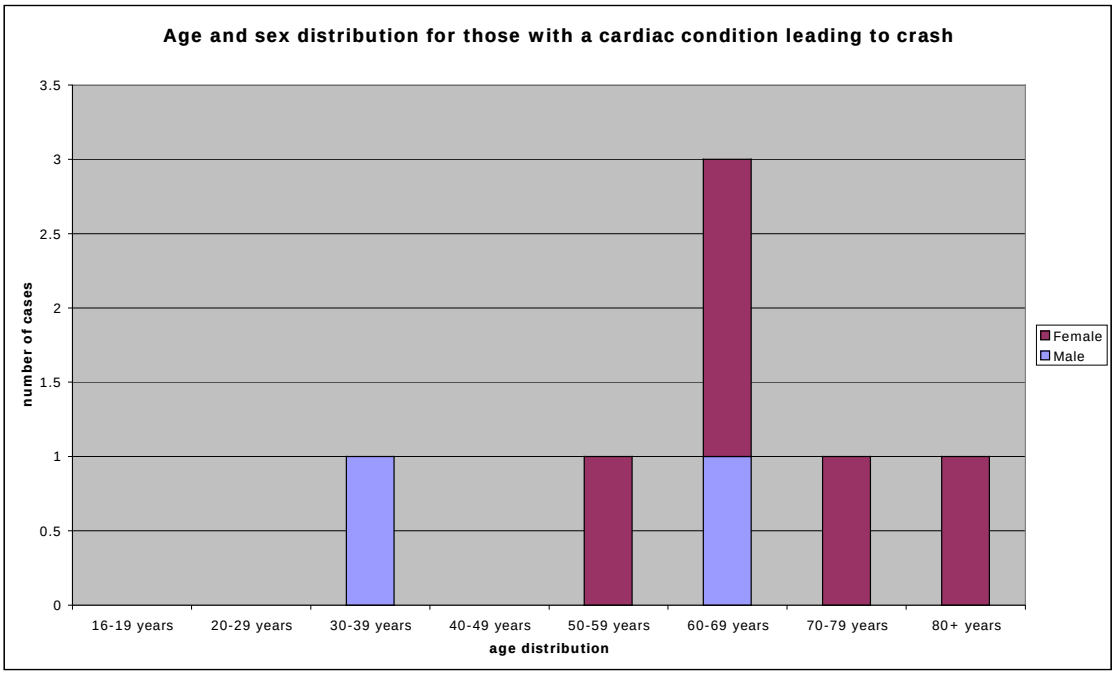

Figure 4.29: Age and sex distribution for those involved in crash as the result of a cardiac event

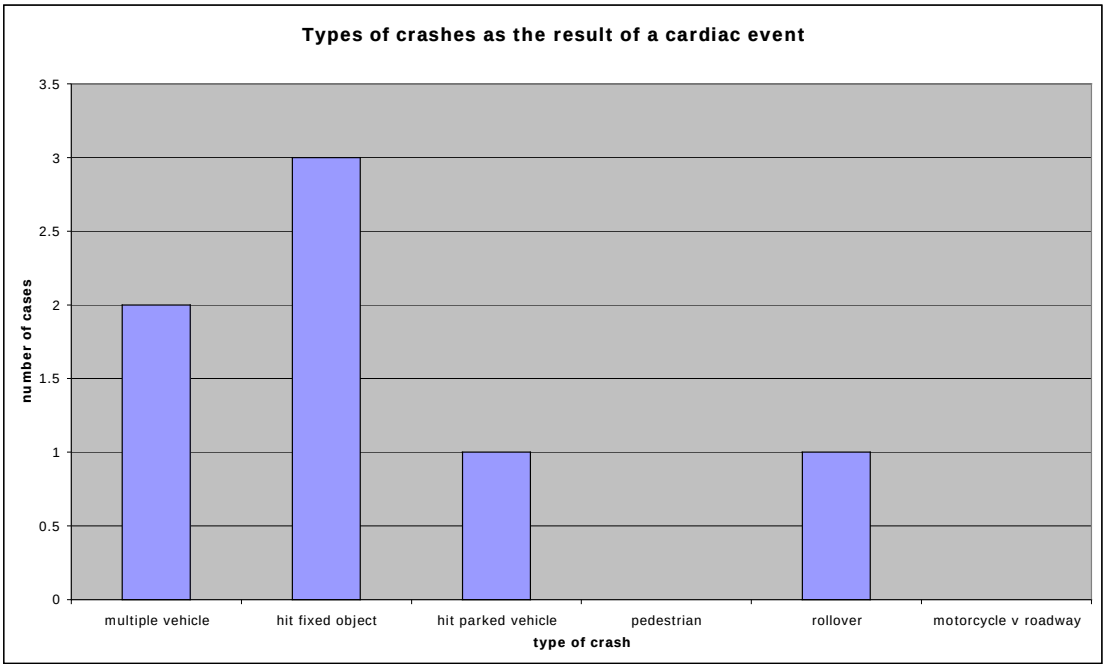

Figure 4.30: Types of crash as the result of a cardiac event

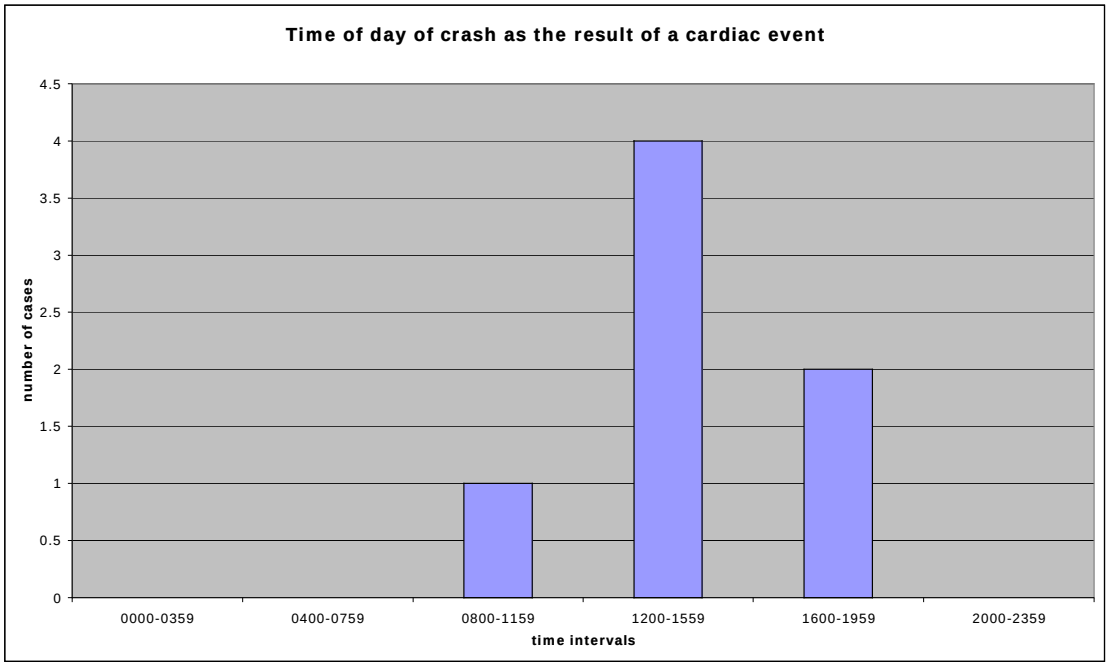

Figure 4.31: Time of day of crash as the result of a cardiac event

There were ten cases identified under the section related to a loss of consciousness leading to a crash that were later identified as occurring in response to a cardiac event. These ten cases were considered again and combined with the above details to provide a better understanding of the age and sex distributions for all cases involving a known cardiac event. The types of crashes they were involved in were also reviewed. The following Figures 4.32 and 4.33 show these characteristics for both groups of cardiac event cases combined.

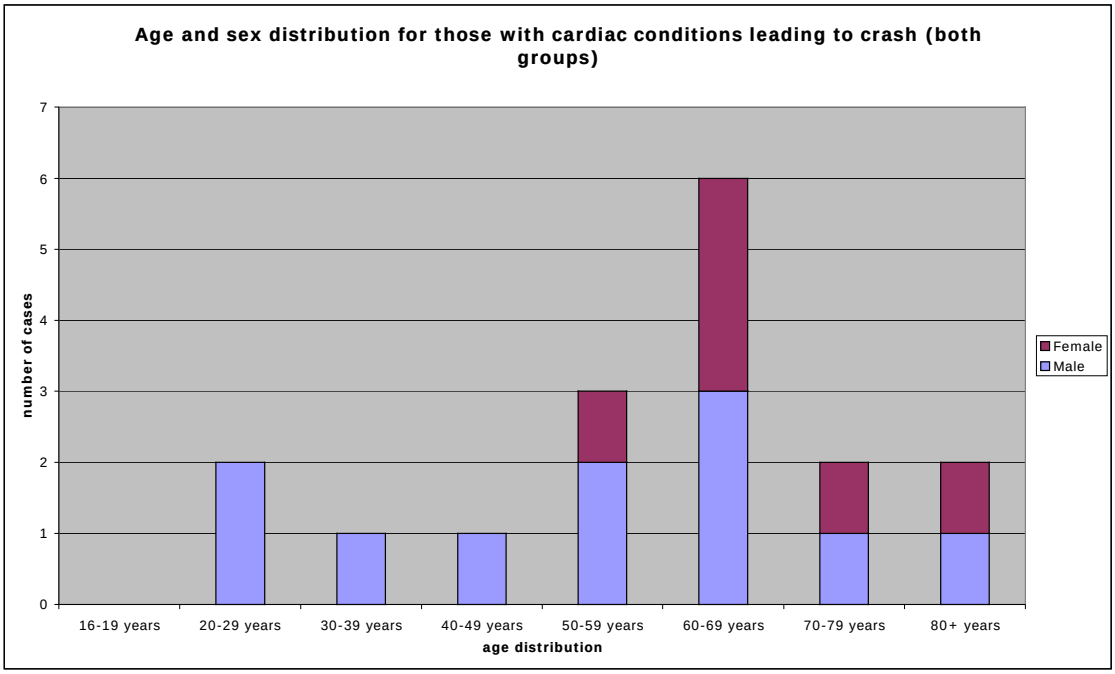

Figure 4.32: Age and sex distributions for crashes due to a cardiac event - including those who had a loss of consciousness prior to the crash

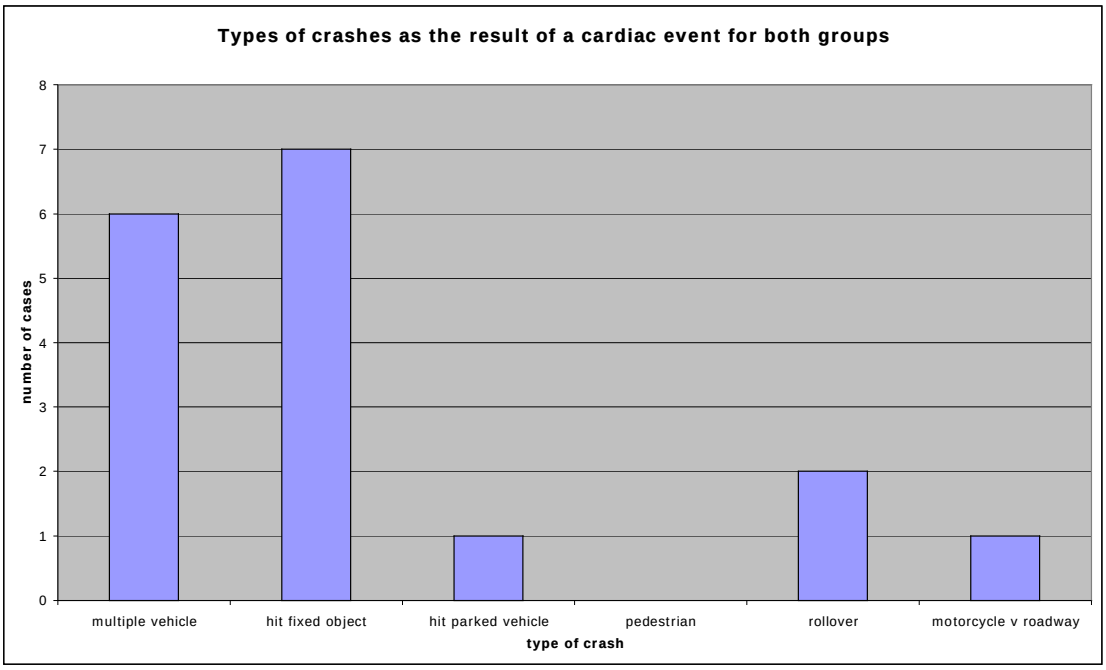

Figure 4.33: Types of crashes as the result of a cardiac event - including those who had a loss of consciousness prior to the crash

4.10 CVA (stroke) leading to crash

There were six cases where a participant was identified by the attending medical team as being involved in a crash as a result of a cerebro-vascular accident (stroke) with a high degree of certainty. All of the participants in this group were drivers of cars.

In four of these six cases the driver had a previously known history related to cardiovascular disease. These conditions were most commonly identified as hypertension, atrial fibrillation and ischaemic heart disease with one participant known to have undergone surgery for cardiac stent insertion in the month preceding the crash. Three of the drivers were known to hold conditional licences related to heart disease/hypertension while the other drivers were found to have unconditional licences.

There were three cases involving a single vehicle hitting a fixed object in close proximity to the road. In two of these three cases the driver veered to the left of the carriageway and struck a pole or tree while the third driver drifted across the carriageway to the right and struck an embankment. The fourth single vehicle crash involved a driver who was known to have continued to drive past his intended destination and travel through the end of a T junction and into a rural property for more than 500 metres before coming to rest against a tree. In two cases the collision involved another vehicle. In one of these cases the driver travelled through an intersection against a red light and struck the side of a through vehicle before continuing into a shop front window, while in the remaining case the driver rear ended a vehicle that was stationary at an intersection. Alcohol intoxication in the context of alcohol dependence was believed to have played a contributing role in one case, however, there was no objective alcohol reading to support this assertion.

In all cases the driver was found to be demonstrating evidence of a neurological deficit on arrival of witnesses and paramedics at scene; including unilateral weakness, inability to communicate and confusion. The drivers underwent computerised tomography (CT) examination on hospital admission that confirmed a diagnosis of stroke and medical documentation supported a determination that the stroke event preceded the drivers crash involvement in all cases. This documentation also provided information related to the specific type of stroke experienced. In three cases the driver was found to have had a Middle Cerebral Artery (MCA) Territory Infarction, two cases were identified as the result of a large intra-cerebral bleed and one cases was identified as an embolic stroke.

Licence privileges were suspended on medical grounds for all surviving drivers following their involvement in the crash, with two drivers electing to surrender their licences permanently. In one case that suspension was for a four week period but all others were for periods between three and six years.

In all cases the driver was hospitalised as a result of the crash with one driver having a fatal outcome in the hours following admission as a result of a continued untreatable cerebral bleed. Drivers involved in these crashes were travelling alone in all but one case. The passenger in this instance was also hospitalised as a result of injuries incurred in the crash. No vehicle occupants of the other vehicles involved in the multiple vehicle crashes were injured. The length of stay for the surviving drivers in this group ranged between eight and 38 days with the average length of hospitalisation being 20 days. In three cases the hospitalisation was followed by transfer to other facilities for either stroke rehabilitation or convalescent care. In one case the driver was transferred to a residential care facility that was expected to be a permanent placement.

Those who were involved in a crash as the result of a stroke event were generally older and between the ages of 69 and 87 years; however the driver who experienced the embolic stroke was significantly younger at 43 years. Males were seen to be involved in 67% of cases with women involved in 33%. Figure 4.34 shows the age and sex distribution for those involved in a crash as a

result of a stroke, while Figure 4.35 shows the crash types seen among this group. Figure 4.36 identifies the wide range of times of days where crashes occurred for this group.

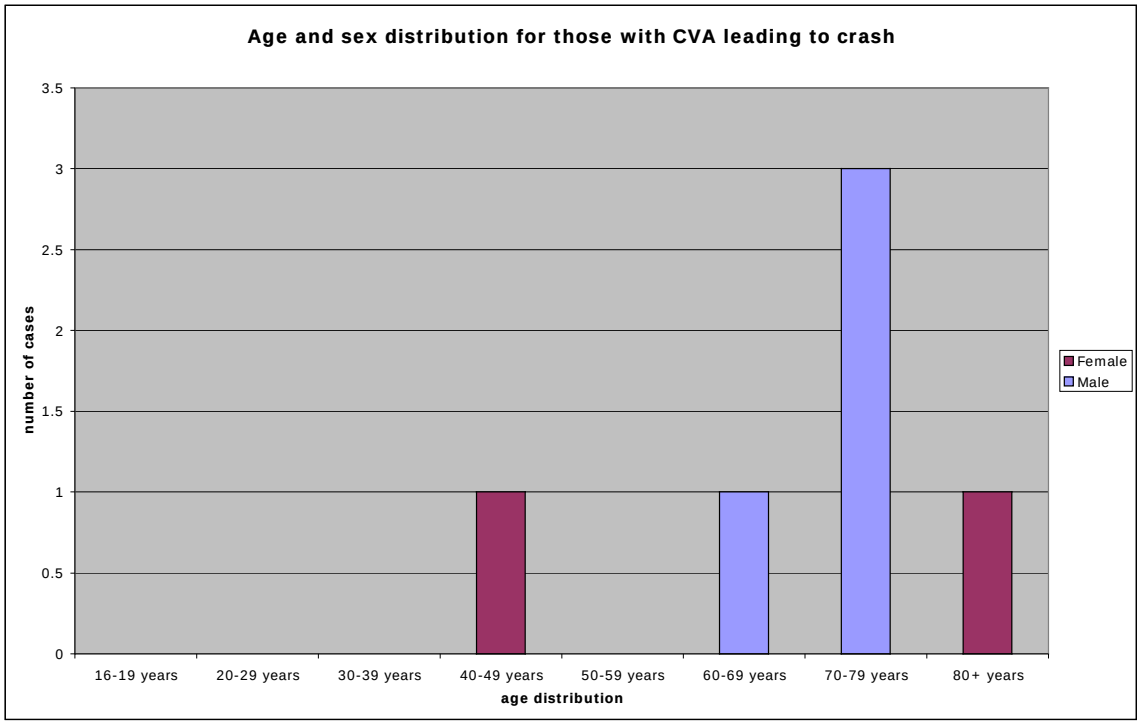

Figure 4.34: Age and sex distribution for those involved in a crash as the result of a CVA (stroke)

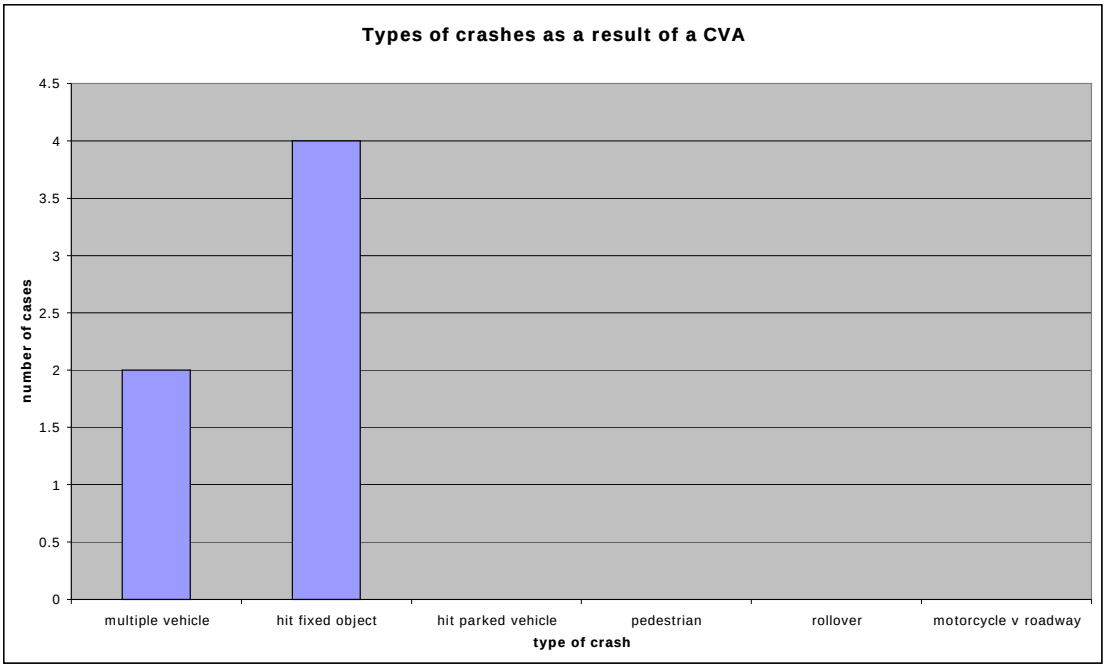

Figure 4.35: Types of crashes as the result of experiencing a CVA (stroke)

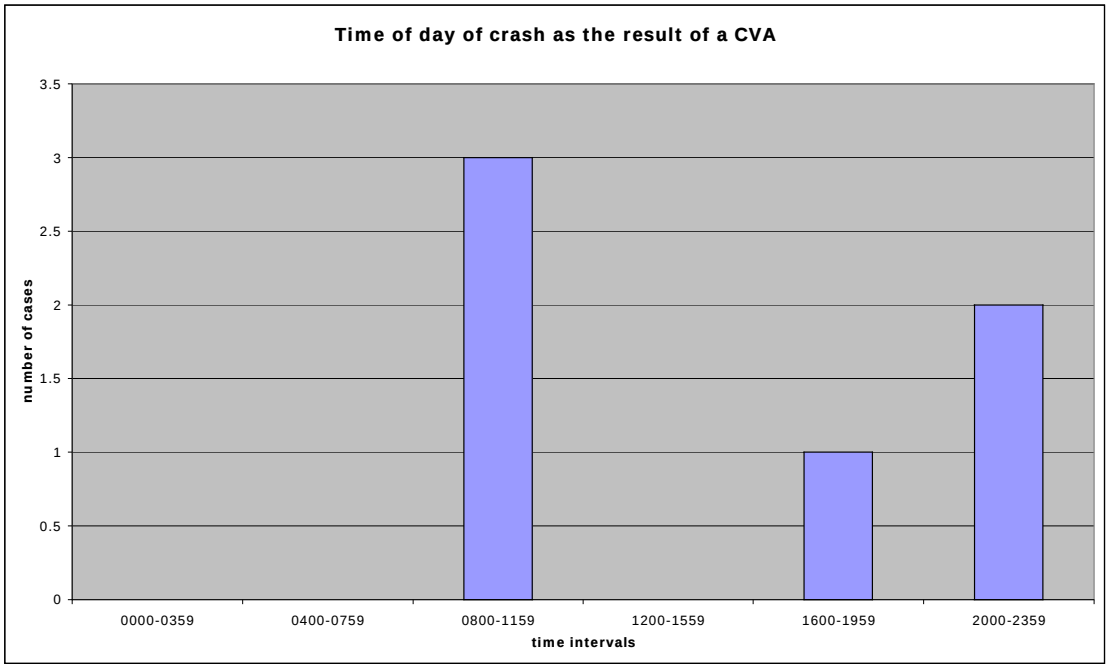

Figure 4.36: Time of day of crash as the result of a CVA (stroke)

4.11 Other neurological condition or event leading to crash

There were five cases where a participant was identified by the attending medical team as being involved in a crash as a result of a neurological condition or event with a high degree of certainty and one case where a person was involved in a crash where a neurological event is likely to have contributed. All of the participants in this group were drivers of cars. In four of these six cases the driver had no pre-existing health concerns that were predictive of a neurological event while the remaining two were presenting with changes in behaviour or personality prior to the crash. In four cases the driver held conditional licences relating to heart disease/hypertension or a limb condition.

The drivers in this group were involved in single vehicle crashes in five cases and there was one case where the driver struck another vehicle before becoming involved in a second single vehicle crash. Unusual driving behaviours or circumstances surrounded each of these crashes. In two witnessed crashes the driver was seen to be driving in an erratic manner before striking a fixed object or other vehicle and then continuing to travel some distance from the primary impact and striking another object that brought their vehicles to a stop. In one case a driver left their home for no specific purpose and uncharacteristically travelled for more than an hour to a destination of no consequence before being involved in a crash. The drivers in at least three cases were reported to have been behaving in a normal manner prior to undertaking the driving task while the behaviours of the remaining three were not known.

In all six cases the person presented at scene in a confused state with agitation and an inability to obey commands observed. In four cases the clinical presentation prompted diagnostic tests that included computerised tomography (CT) scans, magnetic resonance imaging (MRI) and in one case a craniotomy. A metastatic malignancy was identified in two cases while a large meningioma and hypertensive encephalitis were identified in two cases. In the two remaining cases medical documentation was less definitive and were reported as being involved in a crash as the result of ‘unspecified neurological cause’.

In all cases the driver was hospitalised as a result of the crash. Two drivers died in the days following admission and a third driver died while in hospice care within two weeks of the crash. Drivers involved in these crashes were travelling alone in all cases. No vehicle occupants of the other vehicle involved in the multiple vehicle crash were injured. The length of stay for the surviving drivers in this group ranged between one and 25 days. Licence privileges were suspended on medical grounds for two of the surviving drivers following their involvement in the crash. These suspensions were for a period of six months pending medical review.

Those who were involved in a crash as the result of a neurological condition or event were between the ages of 65 and 82 years. Males and females were equally involved in these crashes. Figure 4.37 shows the age and sex distribution for those involved in a crash as a result of a neurological condition or event, while Figure 4.38 shows the crash types seen among this group. Figure 4.39 identifies the times of days where crashes occurred for this group. In most cases the crash occurred during daylight hours.

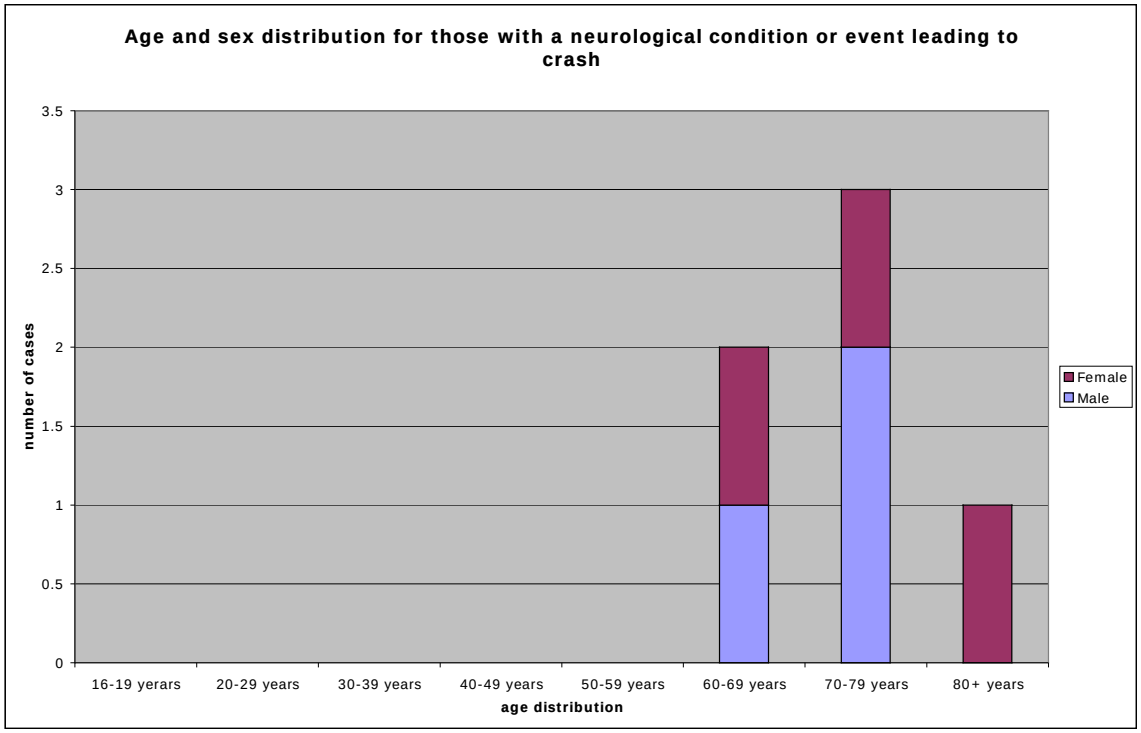

Figure 4.37: Age and sex distribution for those involved in crash as the result of a neurological condition or event

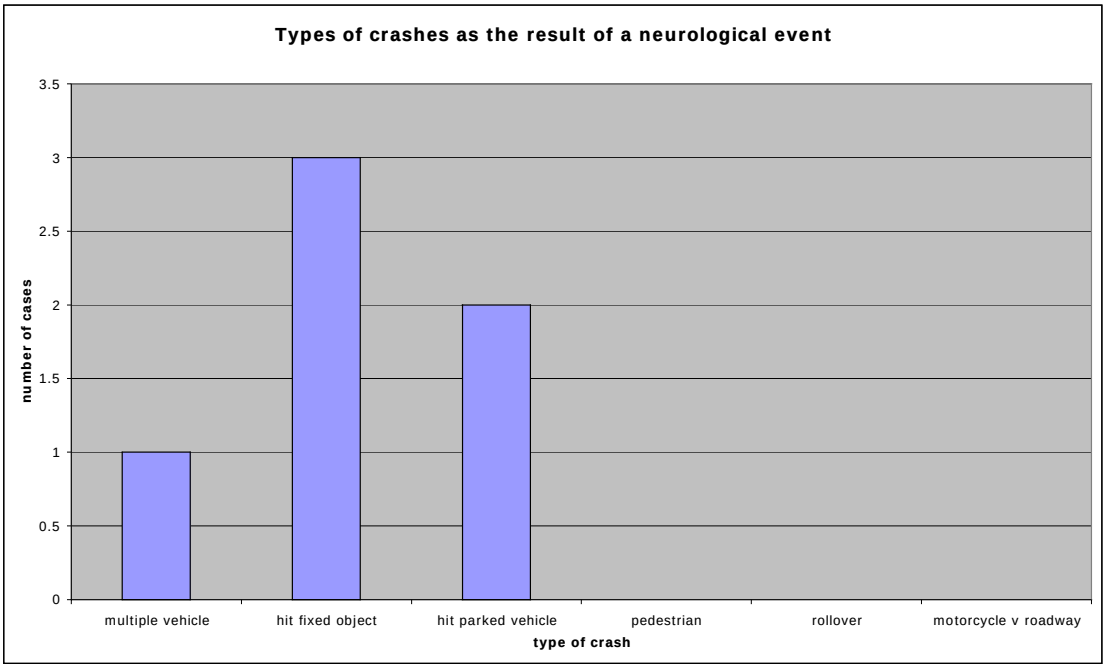

Figure 4.38: Type of crash as the result of a neurological condition or event

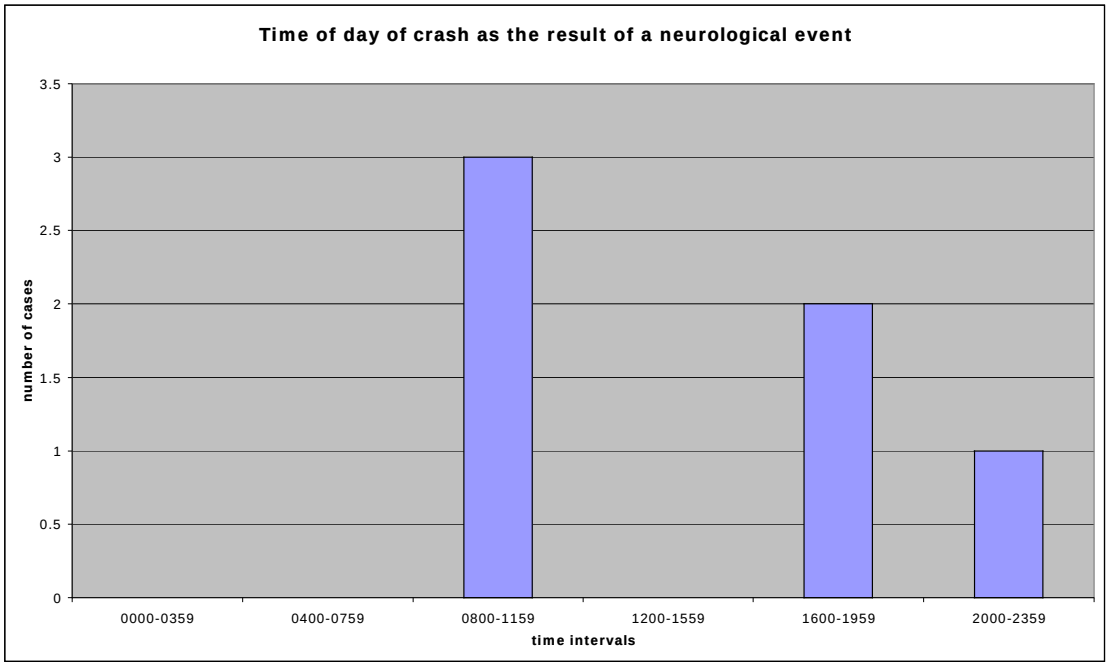

Figure 4.39: Time of day of crash as the result of a neurological event

4.12 Visual deficits leading to crash

There were three cases where a participant was identified by the attending medical team as being involved in a crash as a result of identified visual deficits with a high degree of certainty and one case where a person was involved in a crash where a visual deficit is likely to have contributed to the crash but with less certainty. The participants in this group consisted of two pedestrians and two drivers of cars.

The drivers in this group were involved in multiple vehicle crashes. In one case the driver travelled through an intersection on a red signal and struck a large four wheel drive vehicle and in the other case a driver attempted a U turn and was struck by a tram. The two pedestrian cases involved participants who were considered in poor health with multiple health issues including alcohol dependence, however in both cases the pedestrian was found not to be intoxicated at the time of the crash. In both of these cases the pedestrian walked onto the carriageway into the path of vehicles that were travelling in a platoon of vehicles that would be expected to have been seen by a person with sound vision.

On presentation to hospital these four participants were all identified as experiencing visual deficits. In one case involving a driver it was found that the participant had been experiencing visual impairment related to left hemianopia that was deemed secondary to a stroke in the months preceding the crash. The second driver was known to have undergone scleral banding two weeks prior to the crash following retinal detachment and lens displacement. In this case a vitreous haemorrhage and infection were detected, leading to a further reduction in their visual abilities. In both cases it was concluded by the medical team that the visual deficits played a role in the drivers crash involvement. The pedestrians were reported to have visual deficits related to bilateral cataracts in one case and poor visual fields secondary to diabetic retinopathy and cataracts in the second case.

In all cases the driver or pedestrian was hospitalised as a result of the crash. Drivers involved in these crashes were travelling alone in both cases. No vehicle occupants of the other vehicle involved in the crashes were injured. The length of stay for the drivers and pedestrians in this group ranged between two and 15 days. Licence privileges were suspended on medical grounds for the driver experiencing hemianopia for a period of one year while the driver in the second case was instructed not to drive until further ophthalmic review was undertaken.

Those who were involved in a crash as the result of a visual deficit were seen to be older and ranged between the ages of 69 and 78years, all of whom were male. Figure 4.40 shows the age and sex distribution for those involved in a crash as a result of a visual deficit, while Figure 4.41 shows the crash types seen among this group. Figure 4.42 identifies the wide distribution of times of days where crashes occurred for this group.

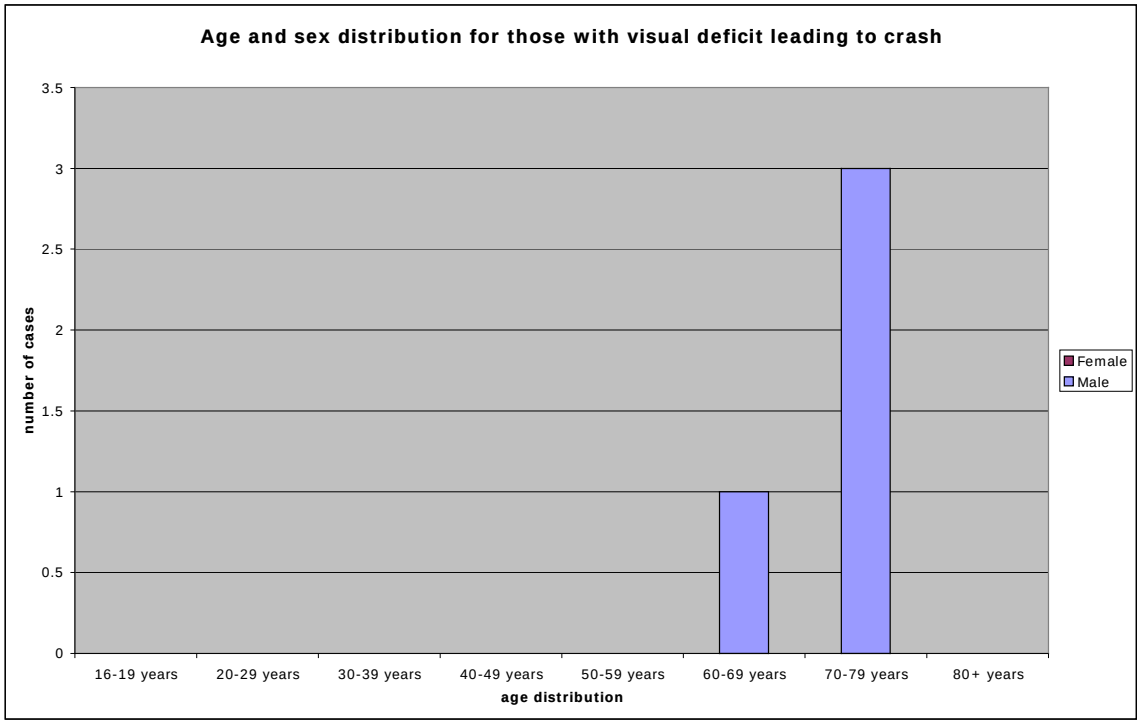

Figure 4.40: Age and sex distribution for those with visual deficits leading to crash

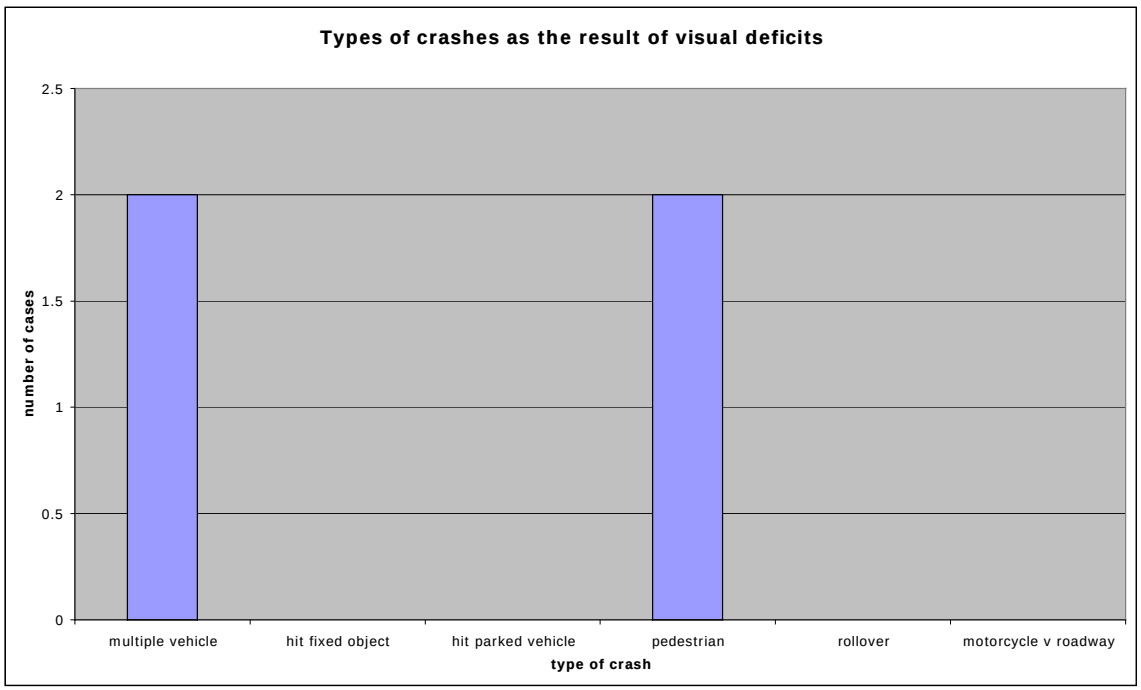

Figure 4.41: Types of crashes involving those with visual deficits

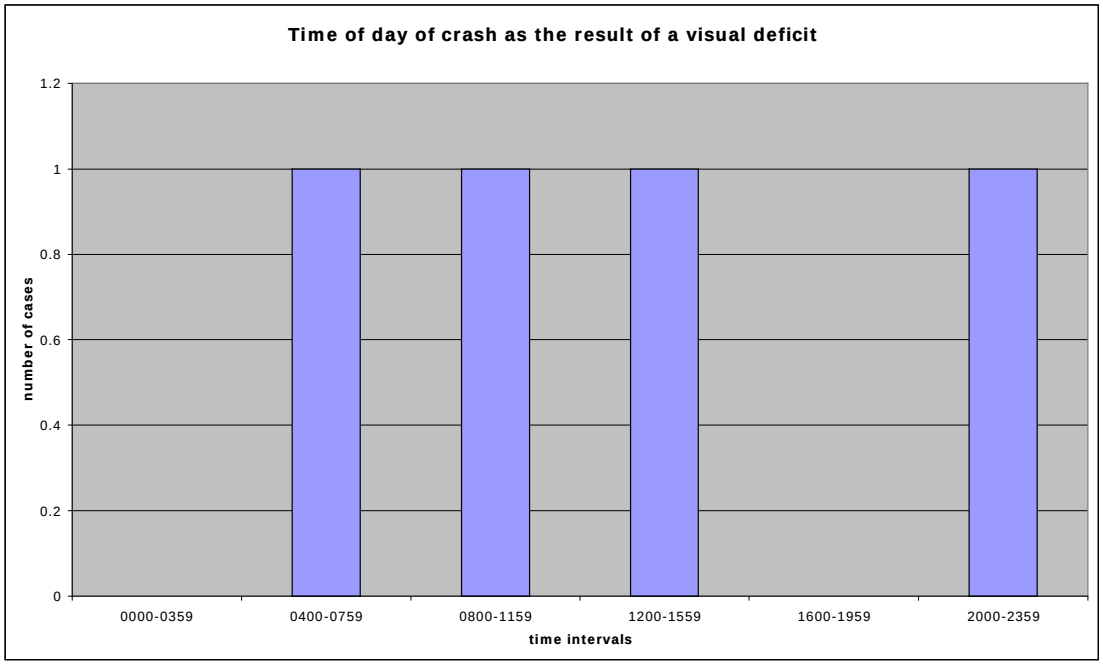

Figure 4.42: Time of day of crash as the result of a visual deficit

4.13 Other medical conditions leading to crash

There were seven cases where a participant was identified by the attending medical team as being involved in a crash as a result of a medical condition or event that has not been addressed in the above categories. In five of these cases the participant was involved in the crash as a result of a medical event with a high degree of certainty, and there were two cases where a person was involved in a crash that is likely to be related to a medical event but with less certainty. In six of these cases the participants were drivers of cars and there was one case involving a motorcyclist.

In three of these seven cases, all involving drivers, the participant was seen to be involved in the crash secondary to excessive fatigue and general un-wellness with subsequent misjudgement that was deemed to be directly related to a medical condition. In two of these cases the driver was known to be experiencing an acute febrile illness, in one case related to pneumonia and in the other to tonsillitis. In both of these cases the driver demonstrated an elevated temperature in the vicinity of 39 degrees Celsius. In a third case an elderly driver also reported excessive fatigue, in this case the fatigue was related to considerable health issues centred around recently diagnosed cancer for which they were undergoing treatment. In all three cases the participant's illness and fatigue impacted on their abilities to perform the driving task resulting in a loss of control of the vehicle and a collision with a fixed object.

There were two cases of drivers who had taken large doses of analgesics for chronic pain management resulting in an over-sedated effect. In both cases the driver had a history of mental health deficits, however, it was deemed that the over-administration of medication was not related to an intentional suicide act in either case. Both drivers lost control of the vehicle resulting in collisions with a fixed object in one case and a parked vehicle in the other.

The two cases that were deemed possibly occurring as the result of a medical event involved a motorcyclist and one driver. In one case an elderly driver approached a signalised intersection where they reportedly had a brief episode of unexplained confusion before travelling through a red signal and colliding with opposing vehicles. This driver had no history of confusion in the past and there was no residual confusion following the crash. Medical assessment suggested that a

transient episode is likely to have contributed to the crash but no definitive conclusions were drawn. The motorcyclist among this group had a longstanding history of attention deficit-hyperactivity disorder (ADHD) that was known to impact on all aspects of their behaviour including violent outbursts and expressions of that in the context of their driving performance. In this case the rider lost control of the motorcycle and collided with another vehicle.

In all cases the drivers and motorcycle rider were hospitalised as a result of the crash. In one case hospitalisation occurred as a result of the febrile illness rather than as a result of the injuries resulting from the crash. Drivers and the motorcycle rider involved in these crashes were travelling alone in all cases. No vehicle occupants of the other vehicle involved in the crashes were injured. The length of stay for the drivers and motorcycle rider in this group ranged between one and 29 days with the average length of stay being nine days. Licence privileges were suspended on medical grounds for the motorcycle rider, however, this suspension was likely to be in response to the injuries incurred in the crash.

Those who were involved in a crash as the result of a these conditions were seen over a wide age distribution between 18 and 79 years. Males were involved in 43% of the crashes for this group and females 57%. Figure 4.43 shows the age and sex distribution for those involved in a crash as a result of a these conditions, while Figure 4.44 shows the crash types seen among this group. Figure 4.45 identifies the times of days where crashes occurred for this group. No time pattern was identified amongst this group.

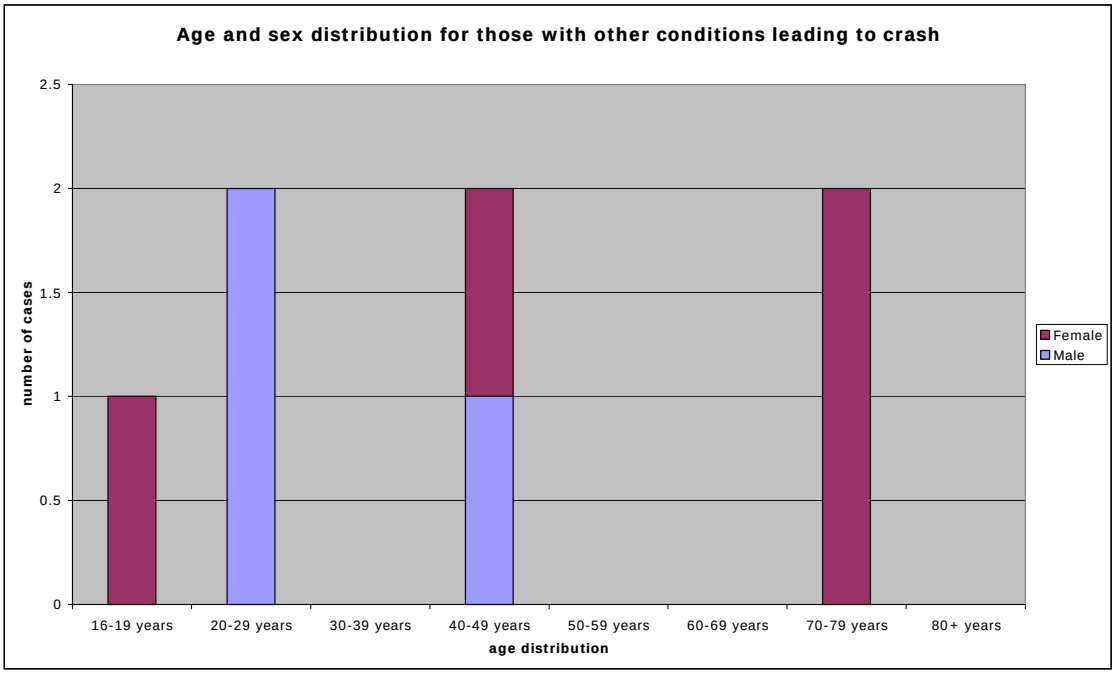

Figure 4.43: Age and sex distribution for those involved in a crash as a result of medical condition categorised as other

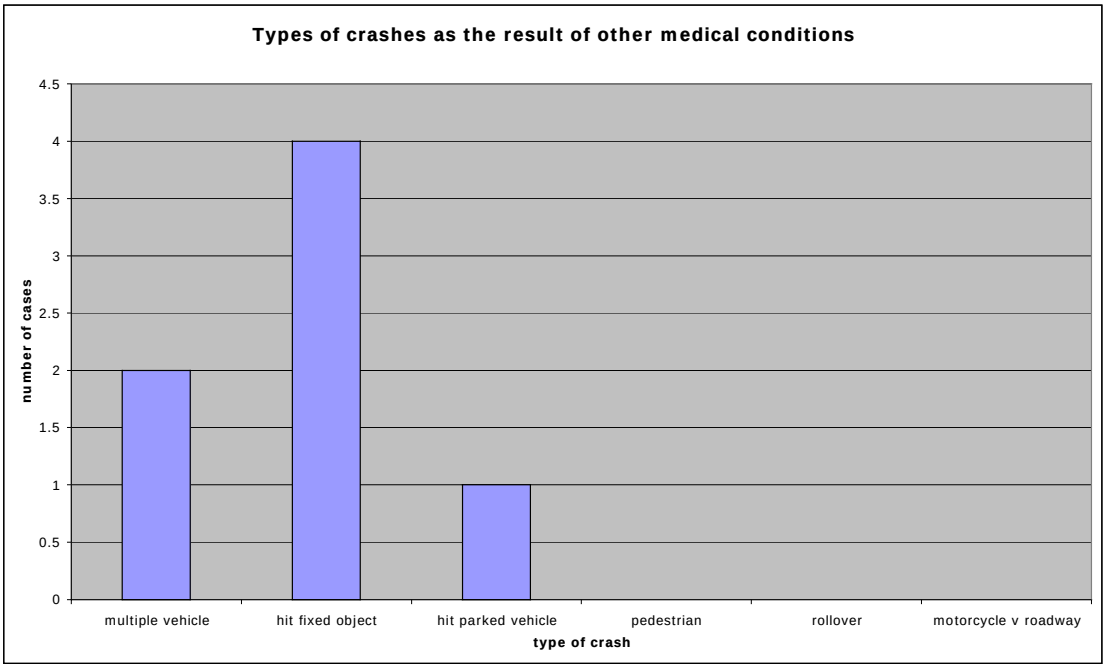

Figure 4.44: Type of crash as the result of medical conditions categorised as other

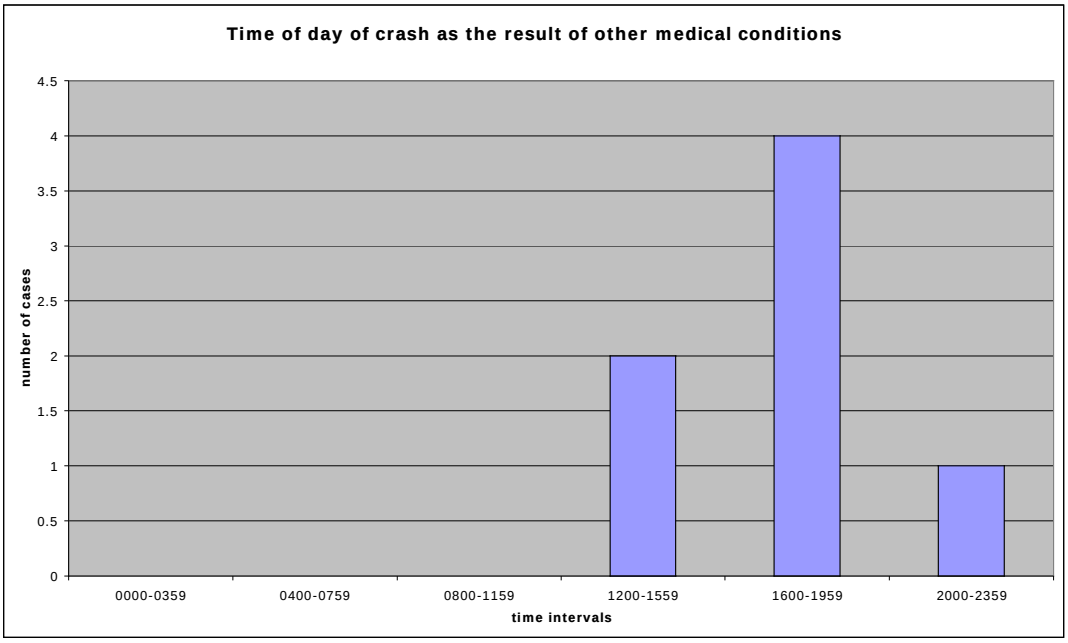

Figure 4.45: Time of day of crash as the result of other medical conditions

5 IMPAIRED DRIVING AS THE RESULT OF ALCOHOL AND ILLICIT DRUGS

5.1 Impairment as the result of alcohol in crash

Impairment as a result of alcohol intoxication was identified as the leading contributing factor to crash causation in this study. Although testing for blood alcohol concentration (BAC) is mandatory for those who attend hospital as a result of crash involvement in South Australia, there were 238 cases where a sample appears to have either not been taken or not tested within the eight hour time frame. This was particularly the case for pedestrians where it was found that a Forensic Science blood alcohol level was identified in only 50% of cases. In addition there were 48 cases overall where a blood sample was taken but the sample was found to have denatured and was unable to be analysed. Of the 1204 cases where a BAC was known from this source, there were 232 cases where the blood alcohol concentration was found to be above 0.05gm/100ml.

A secondary source of objective information related to alcohol levels was the Emergency Department records. These records frequently provided alcohol readings from breath testing undertaken on presentation to the department. In the 286 cases where no Forensic Science data was available these breath alcohol test results were sourced in an attempt to gain a more complete understanding of the involvement of alcohol in the crashes in the study. Among the 286 cases where no Forensic Science BAC data was available there were 42 cases where a breath alcohol result above 0.05 was identified in the Emergency Department records. The results in these 42 cases were included with those from the Forensic Science data, bringing the total of known cases of alcohol levels above 0.05 to 274 cases. These 274 cases represent 18.4% of all cases in the study.

Given the number of cases that were unable to be matched with a reliable source it is expected that the real impact of alcohol is greater than that presented here. For example, there were at least 40 other cases where the medical documentation provided anecdotal evidence that a participant was intoxicated at the time of the crash. This evidence included statements such as ‘been drinking all day, consumed three litres of wine’, ‘patient intoxicated on alcohol at time of MVA’. However, due to a lack of a supporting blood or breath alcohol result, these cases have not been included in any analysis of alcohol impairment. Table 5.1 shows the blood and breath alcohol results found amongst all participants where an objective alcohol reading was available.

Table 5.1: Blood and breath alcohol levels for all participants in the study

Alcohol level distribution	Number of cases
Negative	908
Less than 0.05	22
0.05-0.079	22
0.08-0.099	18
0.1-0.149	63
0.15-0.199	79
0.2-0.249	51
0.25-0.299	26
0.3-0.349	9
0.35-0.399	6
Unknown	286
Total	1490

Those with an alcohol level above 0.05 were found across all age groups and all road user types, with those between the ages of 20 and 50 years making up close to 80% of the total. An alcohol level above 0.05 was noted most strongly amongst pedestrians and car drivers with 25.6% of all pedestrians and 21.5% of all drivers who were tested, found to have an alcohol level of 0.05 or more at the time of their crash involvement. Motorcyclists were found to have an alcohol level above 0.05 in 11% of cases while 4.9% of cyclists had an alcohol level in this range. Males were found to be more likely to have an alcohol level over 0.05, accounting for more than 75% of all cases. Figure 5.1 shows the age and sex distributions for those found to have an alcohol level above 0.05 while Figure 5.2 shows the levels of alcohol concentration found and Figure 5.3 show this group by road user type.

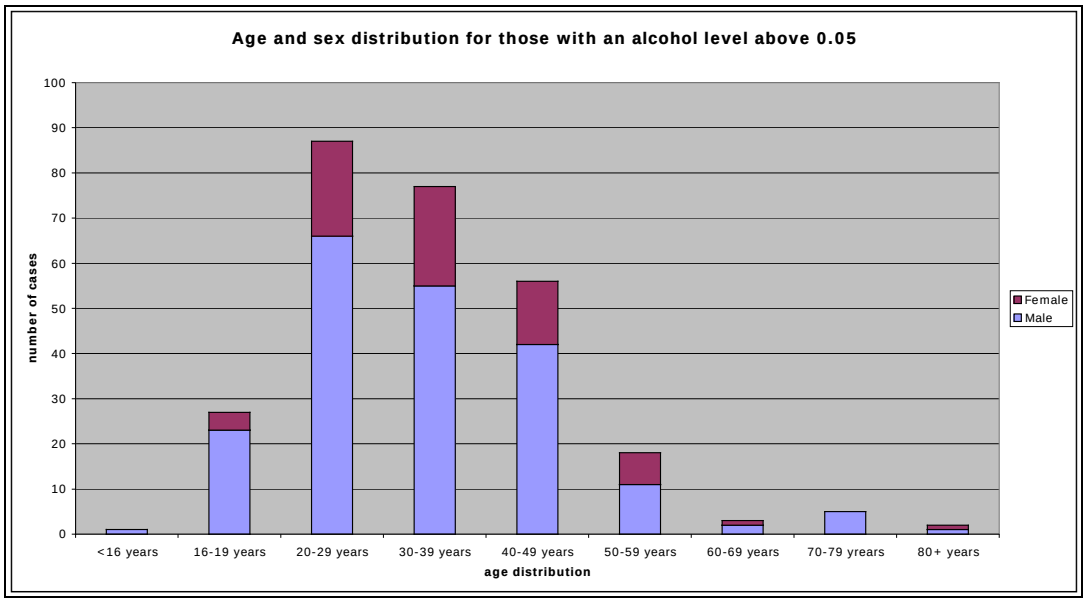

Figure 5.1: Blood and breath alcohol concentration above 0.05 by age and sex

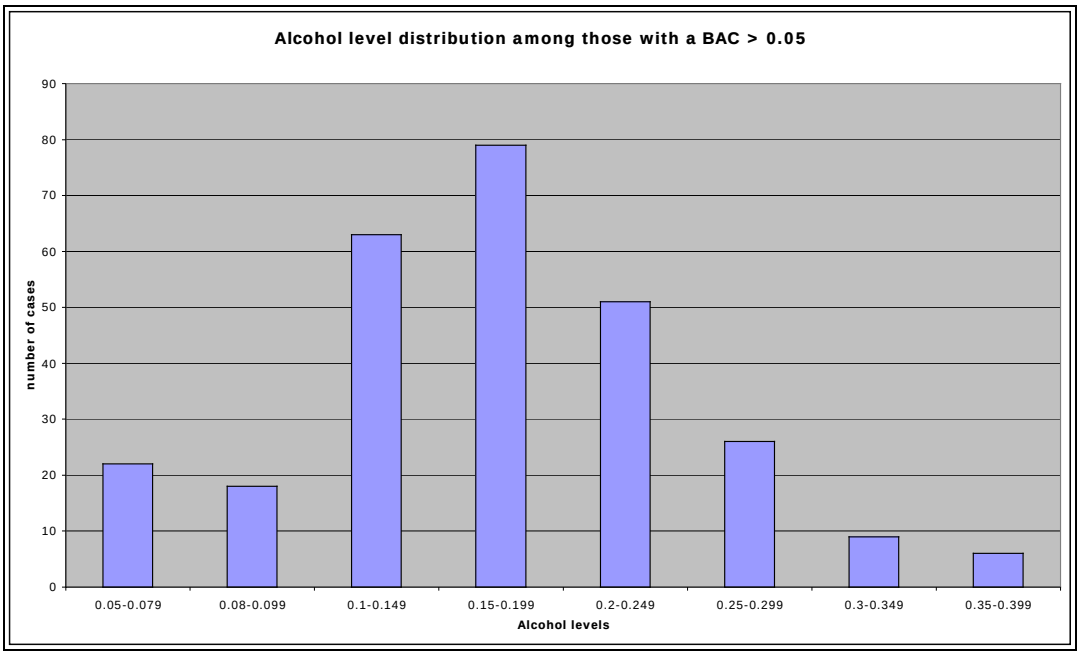

Figure 5.2: Numbers of participants found to have an alcohol level above 0.05 and the level distributions

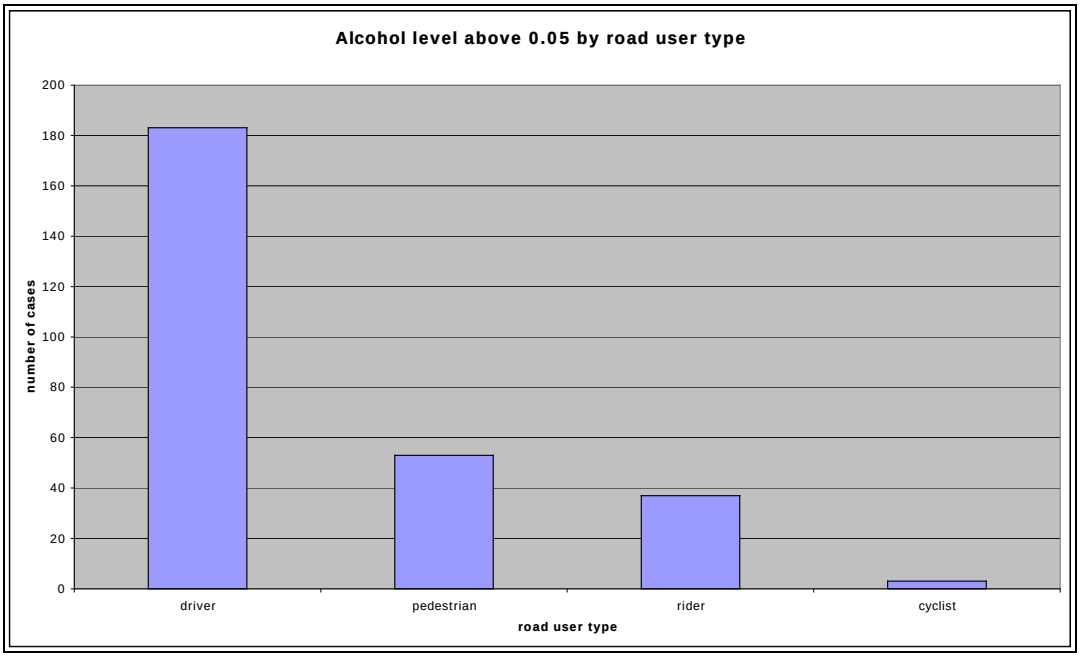

Figure 5.3: Number of participants with an alcohol reading above 0.05 by road user type

The types of crashes involving a participant impaired as a result of alcohol can be seen in Figure 5.4. Single vehicle crashes were the most common crash type seen among drivers and motorcycle riders impaired by alcohol, with more than half (52.4%) of these single vehicle crashes involving the vehicle striking a fixed object and 19% involving a single vehicle rollover.

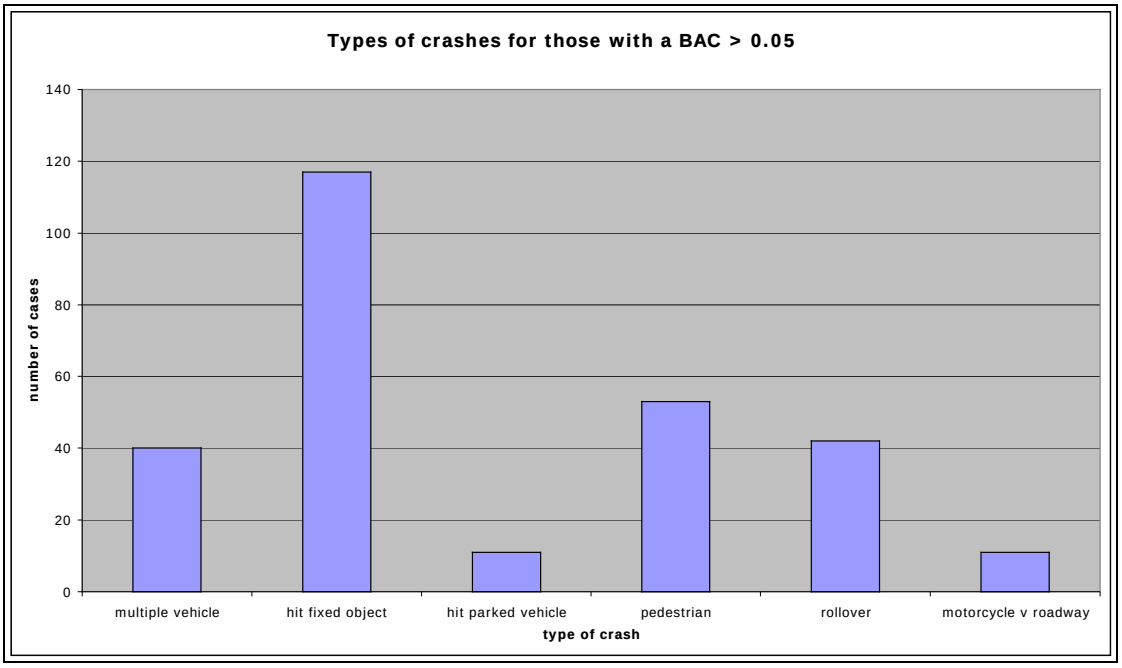

Figure 5.4: Type of crash for those intoxicated on alcohol

5.1.1 Medical condition cases confounded by alcohol intoxication

Alcohol intoxication was found to be a confounding factor in 19 of the 189 medical condition cases. In 16 of these cases the identified condition or event was related to mental illness and/or deliberate suicide attempts; with alcohol intoxication being a co-contributor in eleven cases where a participant undertook a deliberate suicide act and five cases where a participant was involved in a crash due to a mental illness alone. In almost 60% of these cases the alcohol concentration was found to be 0.15 or above. The alcohol levels found amongst those participants involved in the crash as the result of a mental illness or a deliberate suicide attempt can be seen in Figure 5.5. Included in Figure 5.5 are two participants that were described by the medical team as being highly intoxicated on presentation to hospital but no reading related to alcohol level could be found. There was one driver involved in a crash as the result of a loss of consciousness who was also intoxicated on alcohol at the time of their crash involvement, however, the blood alcohol sample result in this case was at a low level of 0.053gm/100ml.

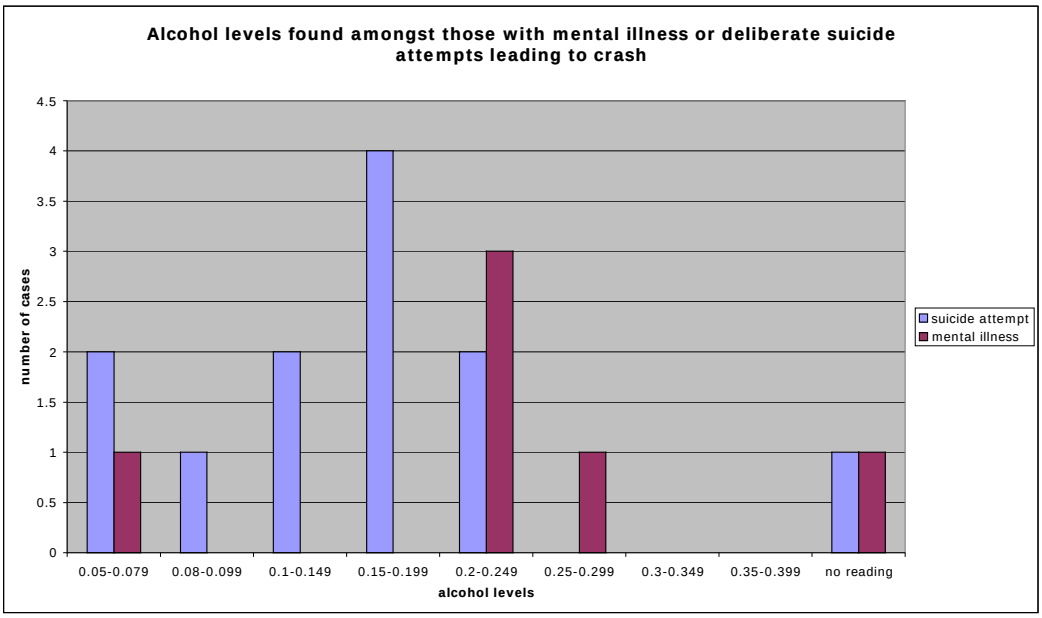

Figure 5.5: Alcohol levels found amongst those involved in a crash as the result of mental illness or a deliberate suicide attempt

5.1.2 Acute alcohol intoxication in the context of known alcohol dependence

While acute alcohol intoxication is not considered a medical condition as such, the involvement of acute intoxication in a climate of alcohol dependence is less clear. Alcohol dependence was identified in the medical records to be a pre-existing medical condition for 146 of the participants in the study. The incidence of alcohol dependence was found to be highest amongst the pedestrians in this group, with 23.2% of all pedestrians in the study known to be alcohol dependent. The incidence of known alcohol dependence was found to be much lower in drivers (68 cases or 8% of all drivers), motorcyclists (25 cases or 6.6% of all riders) and cyclists (5 cases or 8.2%). Of these 146 participants who were known to be alcohol dependent, 74 (50%) were known to have an alcohol level above 0.05 at the time of the crash. An alcohol reading was not recorded for 31 (21%) of the participants known to be alcohol dependent. This group of 31 participants consisted of 17 pedestrians, six motorcycle riders, five drivers and two cyclists. Given that these 31 participants did not undergo testing for alcohol, it is proposed that the 50% figure quoted above is conservative. Figure 5.6 shows the age and sex distribution for those identified as being alcohol dependent while Figure 5.7 shows the alcohol levels found amongst this group.

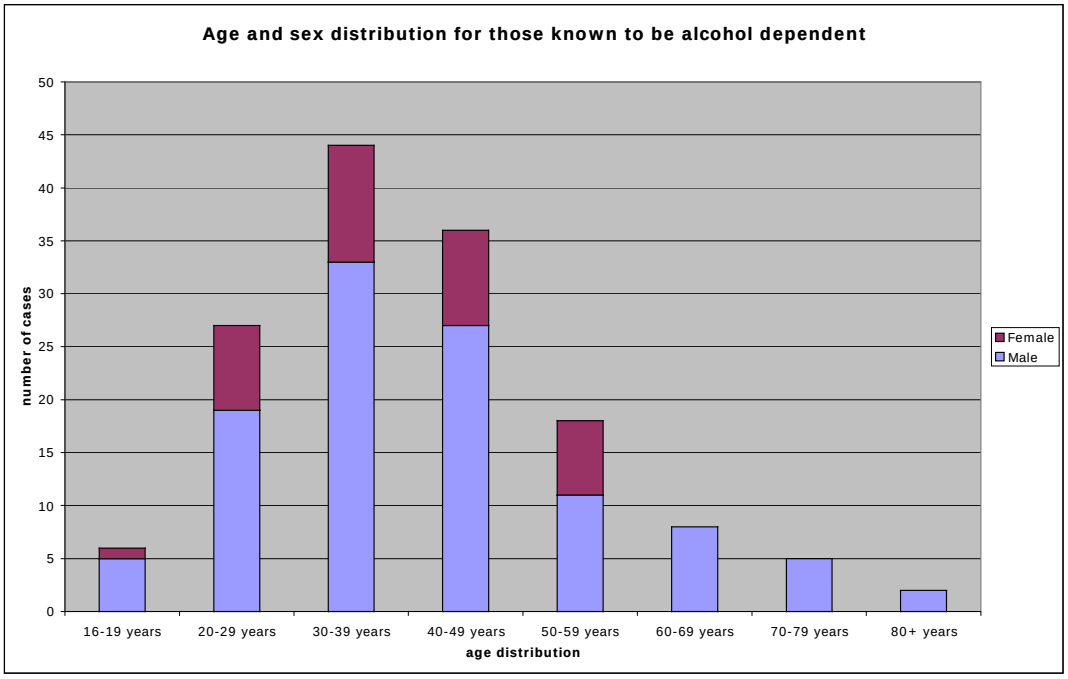

Figure 5.6: Age and sex distribution for those known to be alcohol dependent

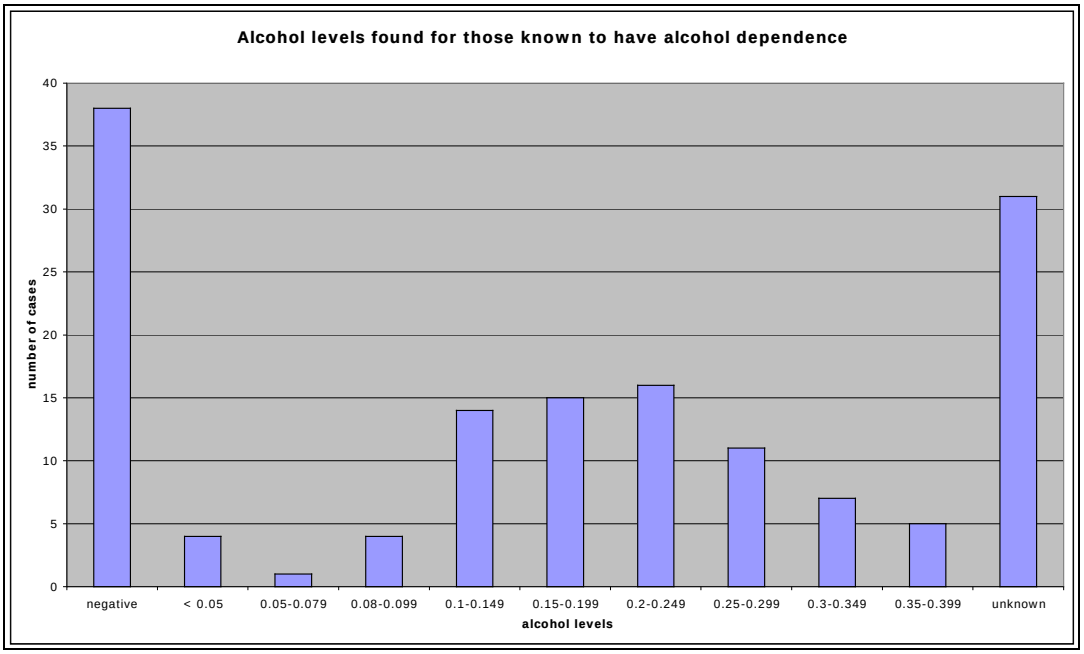

Figure 5.7: Alcohol levels among those with known alcohol dependence

There were 93 drivers and motorcycle riders who were identified as being alcohol dependent. Almost 60% of these drivers and riders had a prior history of at least one drink driving offence, with one driver having a history of nine offences related to drink driving. Figure 5.8 shows the number of previous drink driving offences for the 93 drivers and motorcycle riders in the study with known alcohol dependence. Alcohol dependence was identified as a condition to licence holding in only one of these 93 cases.

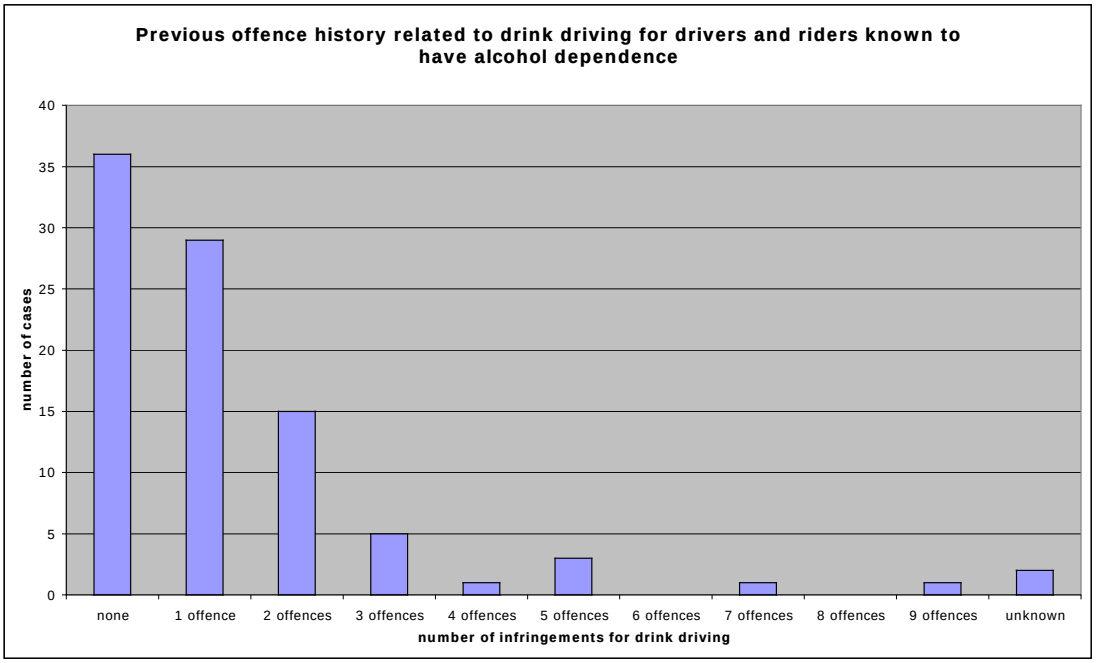

Figure 5.8: Previous drink driving offences for the 93 drivers and riders known to have alcohol dependence

While the medical records identified 93 drivers and motorcyclists as being alcohol dependent, there is a likelihood that this figure does not reflect the true nature of the problem. For example, a review of the infringement records for those drivers and motorcycle riders who were known to have an alcohol reading above 0.2, but not known to be alcohol dependent, at the time of the crash was undertaken. It is not suggested that an alcohol reading of 0.2 is diagnostic of alcohol dependence, but rather that a participant with a reading of this level may more closely reflect those who at least have a problem with alcohol. The review found that 21 (34.4%) of the drivers and motorcycle riders who had an alcohol reading of 0.2 or above in this crash, had a history of at least one previous infringement related to driving whilst intoxicated. In five of these cases the driver or motorcycle rider had a history of between three and five previous drink driving infringements.

5.2 Impairment as the result of illicit drugs in crash

There were 109 participants in the study who were identified in medical records as being a current frequent user of illicit drugs. These 109 participants consisted of 63 drivers, 24 pedestrians, 20 motorcycle riders and two cyclists. The most common drug identified as being used among this group was marijuana. Since July 2008 the Forensic Science Centre of South Australia has undertaken mandatory drug screening for those attending hospital as the result of involvement in a motor vehicle crash. These drug screenings test for three illicit drugs: THC, methamphetamine and MDMA. Among the cases that were tested for drugs by the Forensic Science Centre there were 62 participants (4.2% of all cases) identified as having a positive result for at least one of these three drugs at the time of the crash. Males were found to constitute 87% of this group with females accounting for 13%. THC and methamphetamine were the most commonly detected drugs with 28 participants identified as being positive for THC and 24 participants identified as being positive for methamphetamine. There were ten participants found to have a combination of two or more drugs, including MDMA that was found to be positive for three participants. Figure 5.9 shows the age and sex distribution for those with a positive drug screening.

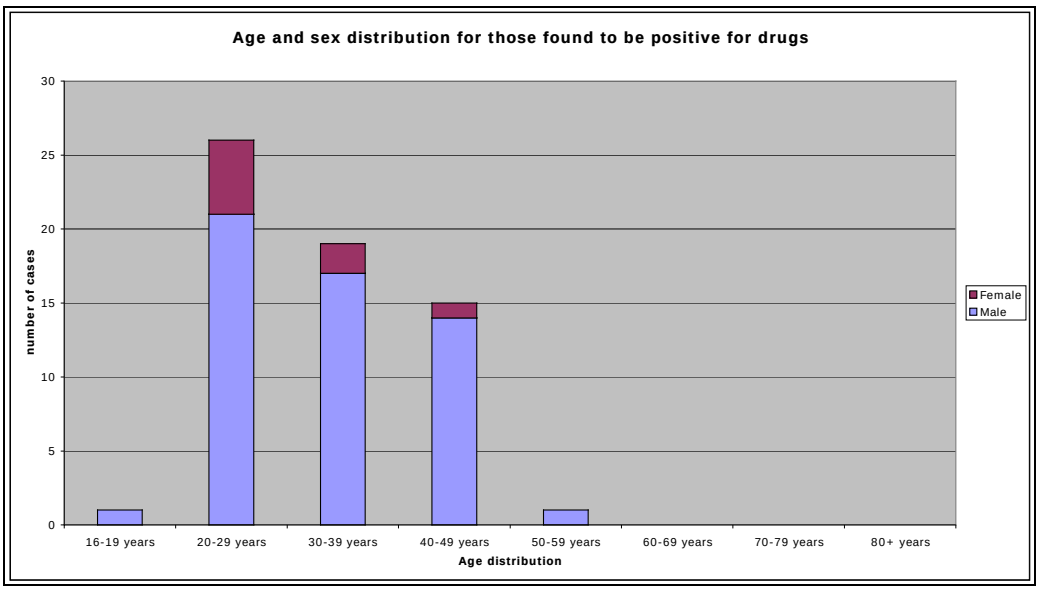

Figure 5.9: Age and sex distribution for those found to have a positive drug screen

5.2.1 Medical condition cases confounded by illicit drug use

A positive drug screening for methamphetamine and/or THC was found amongst ten of the 189 medical condition cases. In five of these ten cases the drug involvement was seen among those identified as being involved in the crash as the result of mental illness or deliberate suicide attempt. The drug found amongst this group was THC in four cases and methamphetamine in one case. There were four cases where a participant who was identified as being involved in a crash as the result of a seizure was found to have a positive drug screen. In three of these seizure related cases the drug detected was THC with one participant being detected as having a positive screen for methamphetamine. The remaining case involved a participant involved in a crash as the result of a cardiac event. In this case the participant was found to be positive for THC.

6 COMPARING MEDICAL CONDITION GROUP WITH REMAINING SAMPLE

The participant, licensing and crash characteristics of those identified as being involved in the crash as the result of a medical condition or acute medical event were compared to those where no medical condition was identified. For ease of reading, those participants identified as being involved in the crash as the result of a medical condition or acute medical event will be referred to as the medical condition group.

6.1 Person characteristics

6.1.1 Road user type

Participants in the study were identified by road user type. Drivers of cars or trucks formed the largest group of road user across the whole sample at 56.7%, followed by motorcycle riders at 25.3%, pedestrians 13.9% and cyclists 4.1%. Those in the medical condition group were even more likely to be involved in the crash as a driver (80.95%) compared to all other participants (53.1%) and almost four times less likely to be motorcycle rider. Figure 6.1 shows the percentage of participants involved by road user type, comparing those who were identified in the medical condition group to all other participants.

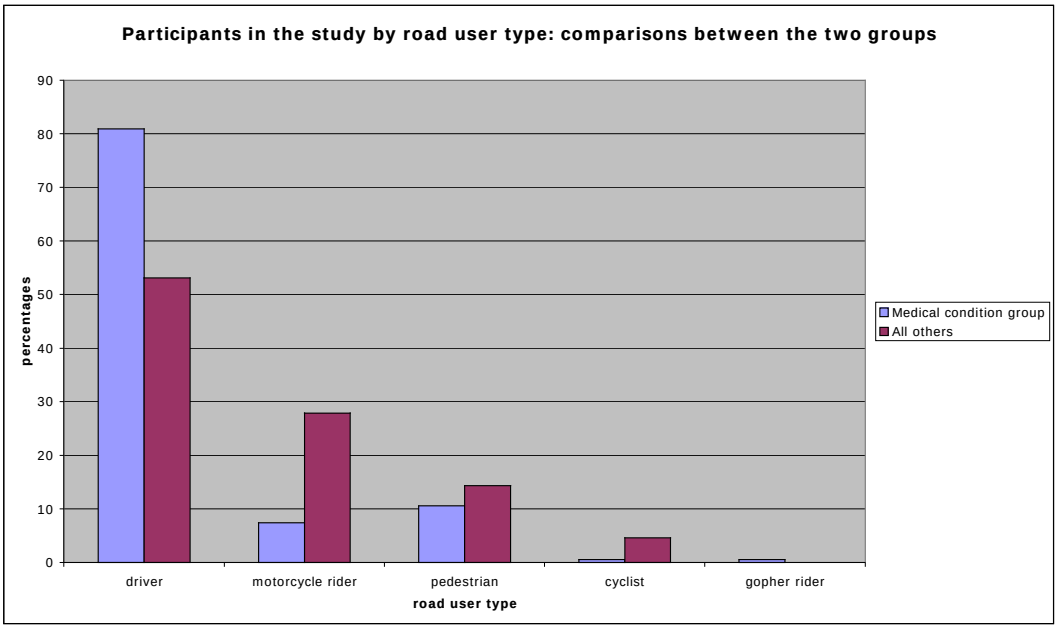

Figure 6.1: Road user type comparisons between the medical condition group and all other participants

6.1.2 Age distribution

Age was seen to be an important factor when looking at those involved in the crash as the result of medical conditions. A medical condition or acute medical event was found to be a contributing factor in 9.17% of the crashes for participants 50 years of age or less. However, those participants 70 years of age or more were found to have a medical condition or acute medical event as a contributor in 34% of the crashes they were involved in. For those over 80 years of age this figure increased to 40.8% and those 90 years of age or more to 66.6%. Comparisons of the age distribution for those in the medical condition group and all other participants can be seen in Figure 6.2.

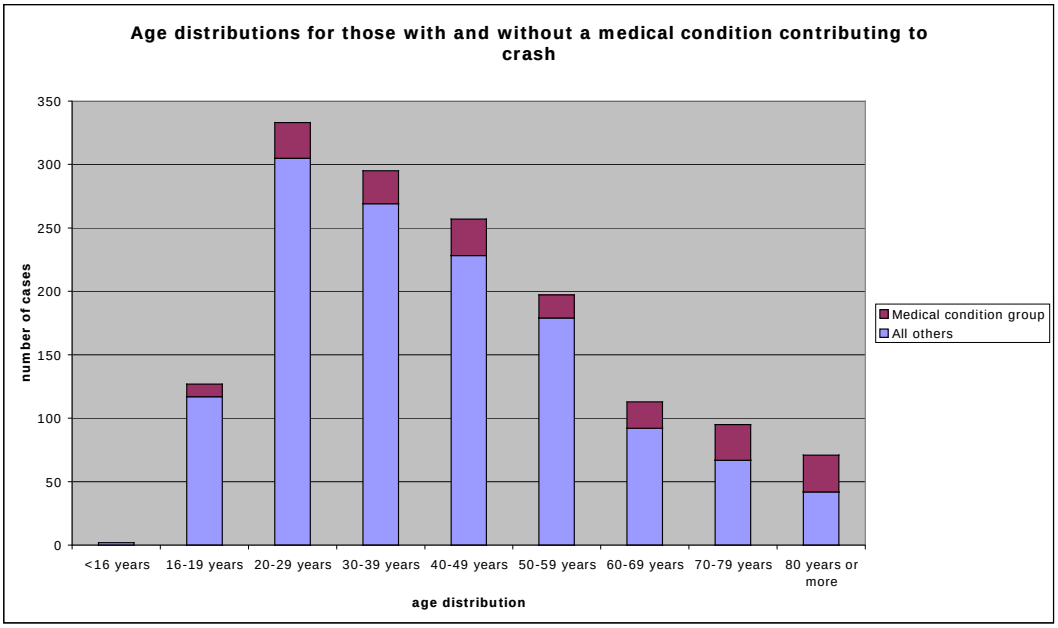

Figure 6.2: Age distribution of participants comparing those with a medical condition or event to all other participants

6.1.3 Injury severity and length of hospitalisation

The length of hospitalisation as the result of injuries incurred in the crash were compared between those active participants identified as being involved in the crash as the result of a medical condition and those where no medical condition was identified. Those identified in the medical condition group were more likely to be hospitalised for at least one day when compared to all other participants. In most cases the length of hospitalisation following the crash was longer for those in the medical condition group. Figure 6.3 compares the length of hospitalisation between the two groups of participants.

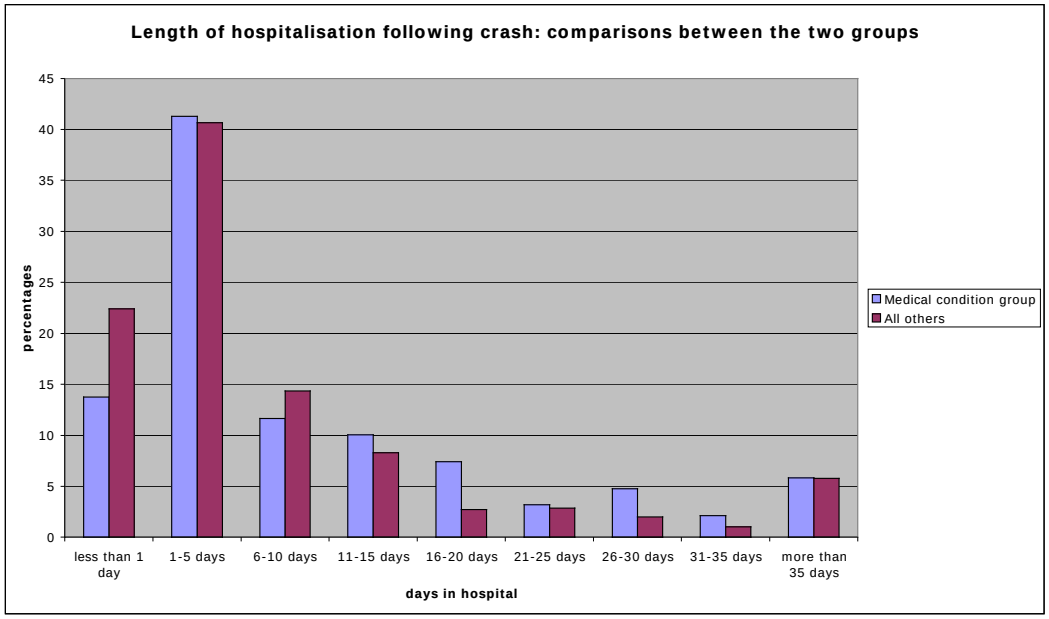

Figure 6.3: Length of hospitalisation: comparisons between those in medical condition group and all other participants

In 45 cases (3%), the active participant who presented to hospital as a result of injuries incurred in the crash, died as a result of those injuries. Ten of these cases involved a participant who was identified as having a medical condition or acute medical event that contributed to the crash while the remaining thirty-five were not related to a medical condition.

6.2 Crash characteristics

6.2.1 Time and day and day of week of crash

The time of day and day of week of crashes in the study sample were compared between the medical condition group and all other participants. These distributions can be seen in Figures 6.4 and 6.5. Although crashes involving the medical conditions group can be seen across most times of the day there were peak times where they were more likely to have occurred when compared to all other cases, this was particularly the case for daytime crashes between 8am and 4pm. Those involved in a crash as the result of mental illness or as the result of a deliberate suicide attempt, however, were more likely to have occurred later at night or early morning. Those in the medical condition group were found to have more crashes in the earlier part of the week than all other participants.

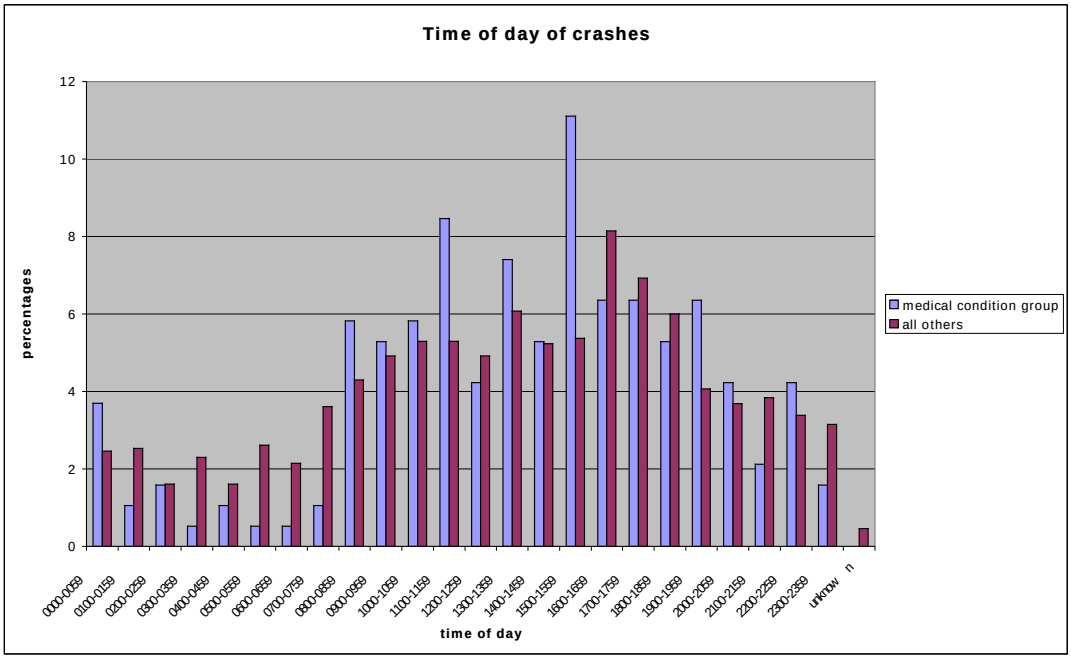

Figure 6.4: Comparisons between the medical conditions group and all other participants related to time of day of crash

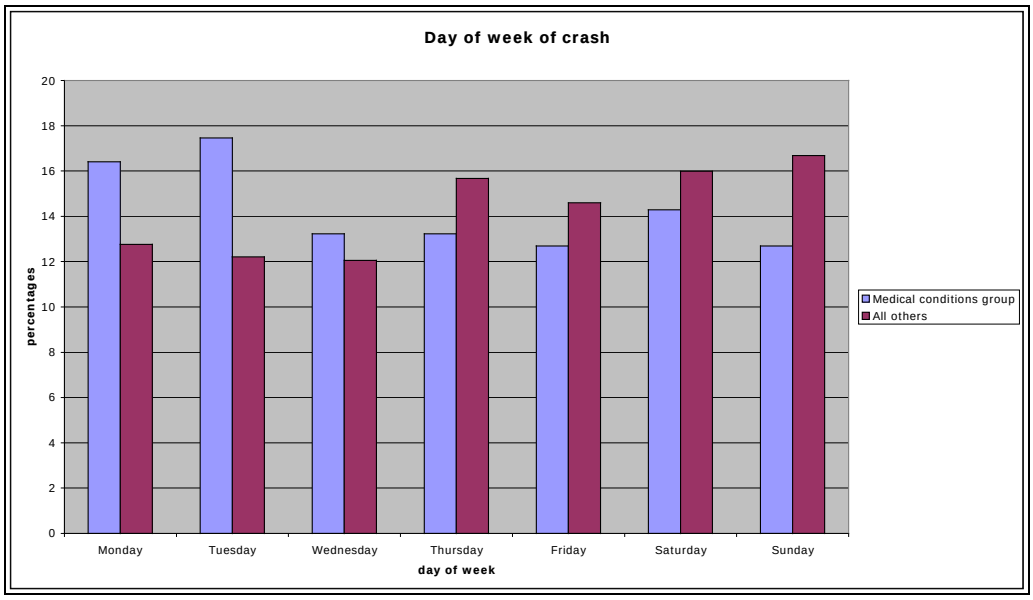

Figure 6.5: Comparisons between the medical conditions group and all other participants related to day of week of crash

6.2.2 Location of crash

Crashes in the study were categorised by three distinct locations: metropolitan area, rural areas within a 100km radius of Adelaide and those occurring in areas greater than 100km from Adelaide. Those participants in the medical condition group were involved in more crashes in the metropolitan areas when compared with all other participants. Figure 6.6 shows the location distribution for those in the medical condition group and compares these with all other participants in the study.

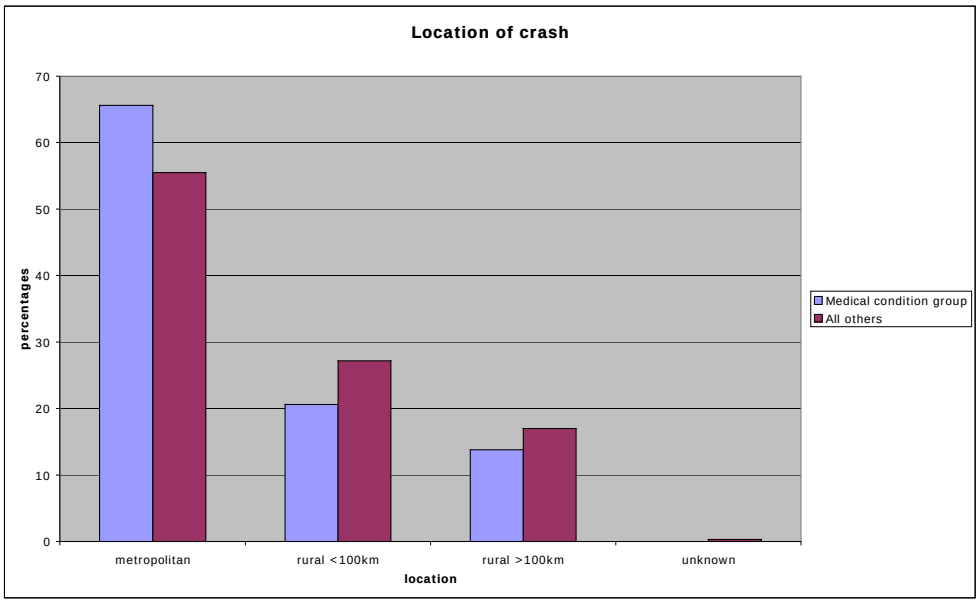

Figure 6.6: Comparisons between the medical conditions group and all other participants related to crash location

6.2.3 Crash site speed zones

Those involved in the crash as the result of a medical condition or event were seen to occur across all speed zones, but were found predominantly to have occurred in 50 and 60 kilometre per hour zones when compared to all participants in the study. Figure 6.7 compares the percentages of road users in each group involved in crashes within the known speed zones.

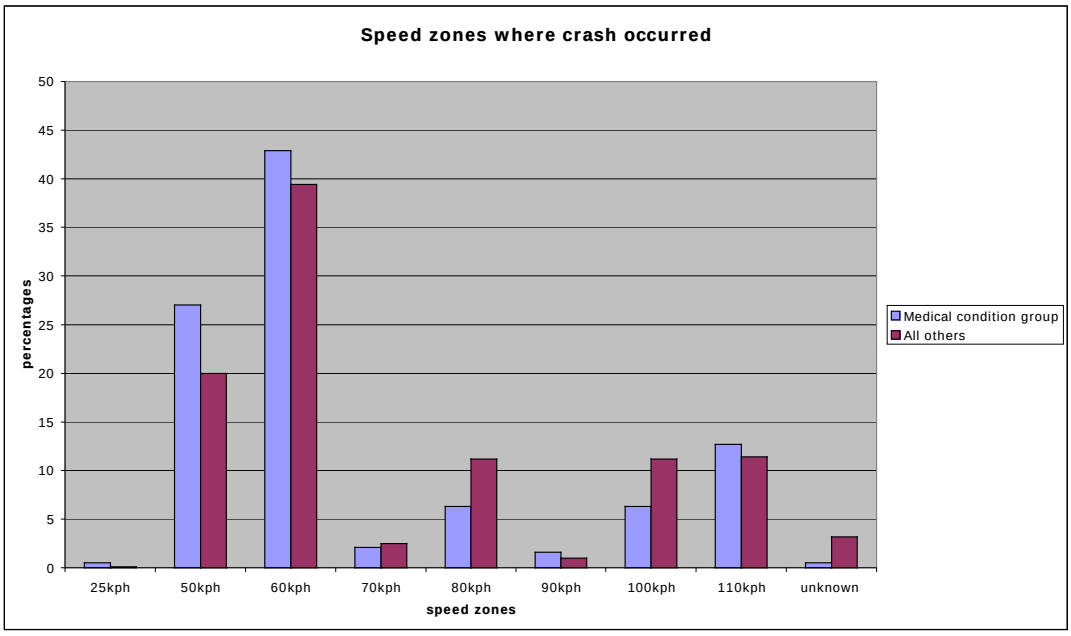

Figure 6.7: Comparisons between the medical conditions group and all other participants related to speed zones at crash sites

6.2.4 Site of crash

Those involved in the crash in the medical condition group were found to have had more crashes at a mid-block site compared to all other participants, and to be involved in less crashes at T-

junction sites. The incidence of crashes at intersections were similar for both groups. Figure 6.8 compares the crash site between the medical condition group and all other participants.

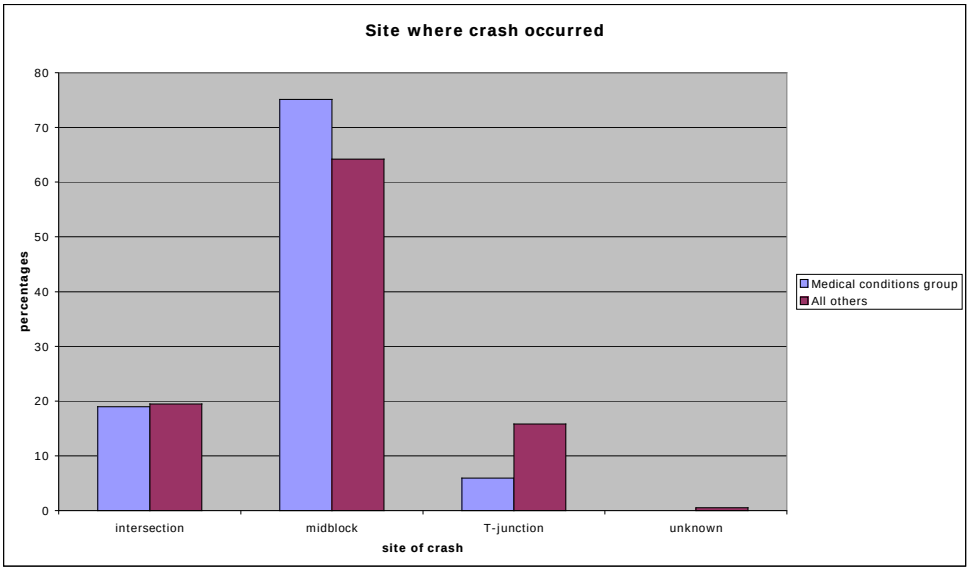

Figure 6.8: Comparisons between groups related to crash site

6.2.5 Type of crash

The types of crashes were categorised under ten broad headings. The most common crash types for all participants in the study related to hitting a fixed object or collisions between two or more motorised vehicles. Those in the medical condition group were more likely to be involved in these types of crashes than other participants in the study, with almost 40% of all participants in the medical condition group striking a fixed object, compared to 22.4% of all other participants. Hitting a parked vehicle was also a common occurrence among those in the medical condition group, with 9% of those in the medical condition group involved in this type of crash compared to 1.2% of all other participants. Those among the medical condition group were involved in less than half as many rollover crashes, 4.8% compared to 9.1% of all others. Figure 6.9 compares the crash types seen for the medical condition group with all other participants.

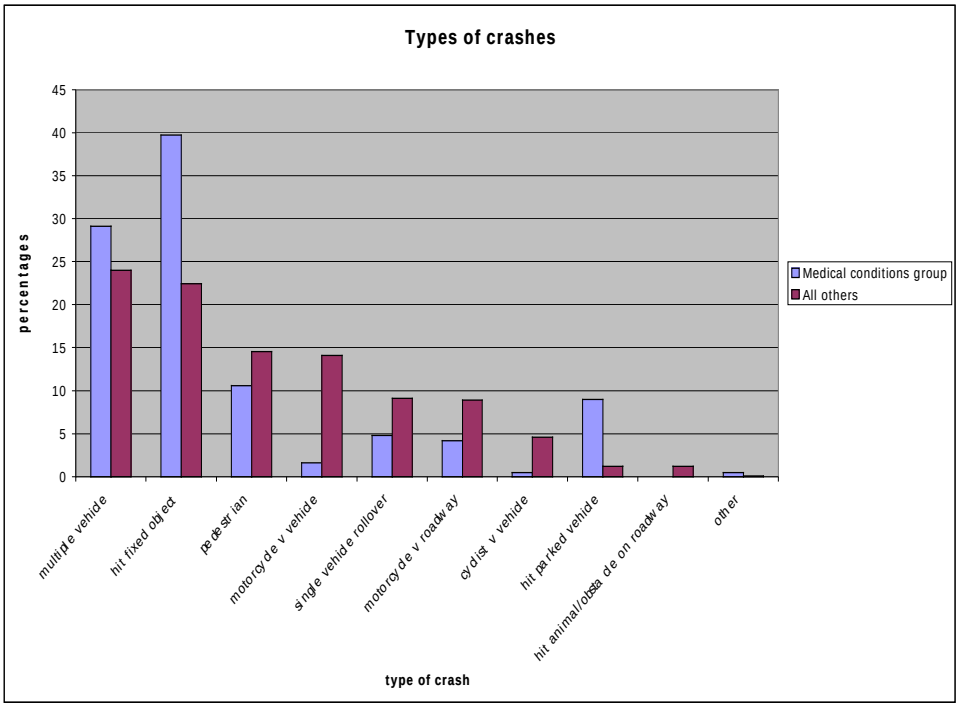

Figure 6.9: Comparisons between the medical conditions group and all other participants related to crash type

6.2.6 At-fault status for crash

Those in the medical condition group were identified by Police (SAPOL) as at-fault in more than 95% of the crashes they were involved in. This compared to 68.4% for all other participants. The most commonly identified fault for both groups was inattention with 48.2% of the medical condition group and 38.7% of all other participants identified by SAPOL as at-fault under this category.

One of the categories used by SAPOL in allocation of at-fault status is ‘sick, asleep or dead at the wheel’. This category of at-fault was used in Police records in less than 12% of those cases identified in the study as occurring as the result of a medical condition or event. Figure 6.10 compares the SAPOL allocation of at-fault status between those in the medical condition group and all other participants.

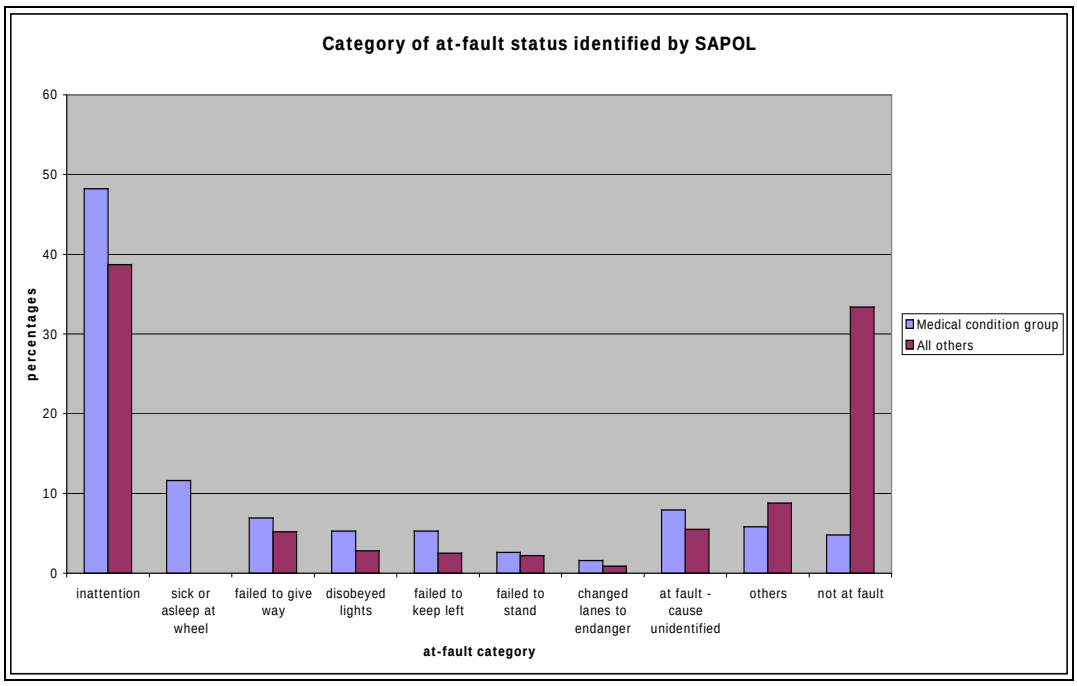

Figure 6.10: Comparisons between the medical conditions group and all other participants related to at-fault status allocated by police

6.2.7 Crash experience

Those in the medical condition group were found to be involved in more previous crashes than all other participants, however, the differences between the two groups is not statistically significant. A lack of corresponding information related to length of driving experience and exposure detail make this information less useful. This is particularly relevant for those in the medical condition group who tended to be older and, therefore, potentially having a longer exposure history. Figure 6.11 compares the crash histories of those drivers and riders in the medical condition group to all other participants. These figures include the crash in the current study.

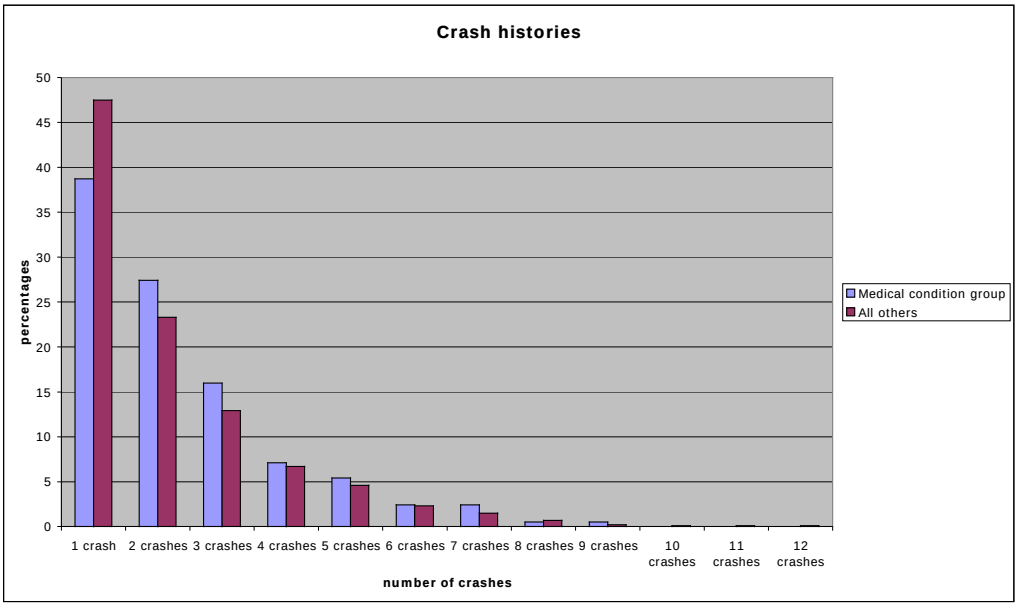

Figure 6.11: Comparisons between the medical conditions group and all other participants related to crash history

6.3 Licensing characteristics

6.3.1 Conditions to licence holding

Of the 167 drivers and riders identified as being involved in the crash as the result of a medical condition or acute medical event, 157 held a South Australian drivers licence. The remaining ten cases consisted of drivers or motorcycle riders who were un-licenced or disqualified from driving and those who held an interstate or international licence. In 66 (42%) of these 157 cases the driver or motorcycle rider was found to hold an unconditional licence. There were 21 drivers who held conditional licences related to reported medical conditions, 19 of whom had two reported medical conditions identified and two whom had three reported medical conditions. The most common conditions to licence holding was the wearing of corrective lenses (22.9%) and heart disease/hypertension (21.7%). In 7% of cases the driver or rider was identified as having a conditional licence related to seizures. This 7% relates to those identified with seizures prior to the crash and does not include those where seizure was added to their conditional licence status following the crash.

Conditional licence holding for those in the medical condition group were compared with all other participants. These comparisons could only be undertaken for those holding a South Australian licence. Table 6.1 compares the percentage of drivers and motorcycle riders who held a conditional licence for the two groups. A conditional licence related to heart disease/hypertension was identified for 21.7% of licence holders in the medical condition group compared to 5.6% of all other drivers and riders. A conditional licence related to seizures were identified for 7% of the medical condition group compared to less than 1% (0.5%) of all other drivers and motorcycle riders in the study. Those in the medical condition group were four to five times more likely to hold a conditional licence as a result of their insulin dependent and non-insulin dependent diabetes status compared to all other participants. Although alcohol dependence was noted as a pre-existing condition in 93 cases in the study, a conditional licence related to alcohol dependence was identified in only one case.

Table 6.1: Comparisons of the types of conditions to holding for those in the medical conditions group and all other participants who were drivers or riders

Condition to licence holding	Percentage of medical group	Percentage of all other participants
corrective lenses	22.9%	13.4%
heart disease/hypertension	21.7%	5.6%
seizures	7.0%	0.6%
medical condition (NFS)	7.0%	5.7%
non-insulin depend diabetes	5.1%	1.7%
nervous/psychiatric disorder	3.2%	1.5%
insulin dependent diabetes	3.2%	0.6%
limb condition	0.6%	0.7%
automatic vehicle only	1.3%	1.0%
arthritis	-	0.6%
alcohol interlock	-	0.09%
night time curfew	-	0.5%
alcohol dependence	0.6%	-

limit of15km radius	0.56%	-
respiratory disease	-	0.09%

7 DISCUSSION

This study involved the examination of the circumstances surrounding the crash events for 1490 drivers, motorcycle riders, pedestrians and cyclists who required hospitalisation as the result of a crash. The main purpose of the study was to determine the extent to which a pre-existing medical condition or acute medical event was a contributing factor in casualty crash causation. It was not the primary purpose of this report to generate countermeasures for reducing the incidence or impact of medical conditions that result in crash involvement but rather to provide a new understanding of the types of medical conditions or acute medical events that are likely to contribute to a persons involvement in a crash.

The detailed examination of the medical records was an invaluable tool that provided insights into both the physiological and psychological factors that impacted on the participants' abilities to perform in the road environment at the time of the crash. Included among these were an understanding of their pre-existing medical conditions, but also included insights related to behaviours and other extraneous factors. Examination of the primary source medical records data provided a more complete understanding of the circumstances surrounding the participants' involvement in the crash that would not be possible from summarised hospital separation data alone.

The study incorporated information from the medical records with linked data related to each participant's licensing and crash history from the licensing and police data; and also with objective data related to drug and alcohol use at the time of the crash. This linkage of data allowed for a more holistic picture of the events surrounding the participant's involvement in the crash that are often not considered in other approaches to crash investigation.

In the 1490 cases examined in the study it was found that a medical condition or acute medical event was a contributing factor in the crash events with a high degree of certainty in 165 cases, 11.1% of all cases. There were a further 24 cases where the possibility of a medical condition contributing to the crash could not be ruled out, giving a total of 189 cases or 12.7%. These conditions or events were seen among all road user groups. However, drivers were found to be more likely than all other road users to be identified as being involved in a crash because of these; with a medical condition or acute medical event found to be a contributing factor in crash causation for 18.1% of the drivers in the study.

This percentage was considerably higher than that found in earlier studies, such as the recent findings of Hanna [2]. There are a number of possible explanations for this. These may include: study methodology, case selection criteria and the data collection source:

1. Some studies have used hospital separation data or police records to determine the extent of medical conditions in crashes. These sources have limitations; for example the current study found that police data identified a medical condition as a cause for the crash in only 12% of the 189 cases identified here. This study involved extensive review of the primary source medical data. This data provides much more detailed information that is not available when using police or hospital separation data alone; and as a result provides more evidence to support the impact of a medical condition or event in the crash.

2. Case selection for this study was based on identification of patients through the ICD-10AM medical record coding system. This coding process only occurs following hospital admission and those crash involved persons who spend less than four hours in hospital are not coded in this way. This resulted in a group of participants who were potentially more seriously injured or required more extensive care than those who spend less time in hospital. There is at least a possibility that those who are hospitalised for longer periods are more likely to have been assessed for factors that led them to be involved in the crash. There is also the

possibility that those who were not admitted may have been less likely to have had a medical condition or event that led to their crash involvement, though this can not be assumed.

3. As discussed earlier, the Royal Adelaide Hospital is one of the two major trauma centres in South Australia. As such, the hospital provides care for the local community of Adelaide but also care for those across the state requiring specialist care that may not be available elsewhere. It is possible that some participants in this study who required a higher level of care may also be more likely to have a medical condition that contributed to their crash.

The medical conditions and acute medical events identified in this study were categorised under thirteen broad headings as:

1. loss of consciousness leading to a crash, some of which were related to cardiac events,
2. seizure events,
3. mental illness,
4. deliberate suicide attempt,
5. dementia and cognitive decline,
6. hypoglycaemic events,
7. sleep apnoea,
8. cardiac conditions,
9. CVA (stroke),
10. other neurological conditions and events,
11. visual deficits,
12. general poor health and declining functional abilities, and
13. others.

The role of alcohol in the context of alcohol dependence was also identified within this report as contributing to crash causation but has been considered in isolation from the more intrinsic medical conditions identified above.

The medical conditions and acute medical events identified in this study reflect those found by others, including Charlton et al (2004), Marshall and Sagberg (2006); and compliment those identified in the Austroads Fitness to Drive Guidelines (2003). One unexpected observation found amongst those with a medical condition, however, related to those experiencing a cardiac event. Although cardiac conditions have been identified in all previous studies, the most commonly cited disorder identified has been related to myocardial infarctions. While myocardial infarction did play a role in the cases in this study, there was a higher incidence of conduction disorders among those experiencing a cardiac event in this study.

The medical conditions and events identified in this report were for the most part identified with a high degree of confidence, and were based on medical documentation that supported the medical condition or event as a contributing factor in the crash events. It is possible that more subtle medical deficits, for example visual decrements, neck and other mobility limitations, that may be less likely to have been documented in the medical records also contributed to crashes for some

participants, but this possibility was either not explored, or at least not documented by the medical team in enough detail to be included.

While it is not the purpose of this report to develop countermeasures, there are a number of observations worth highlighting. These observations relate to those aspects that proved to have the most impact on the road user's involvement in a crash, in particular age, predictability of crash occurrence, injury to other road users and the involvement of alcohol and mental health in crash causation.

Age

Age was found to be an important factor in crashes in the study, particularly for those aged 70 years or more. This age group were most likely to be involved in crashes as a result of a loss of consciousness, dementia/cognitive decline or as a result of general poor health. While participants aged 70 years or more accounted for 11.4% of all case participants in the study, they were found to constitute more than 30% of those participants involved in a crash as the result of a medical condition or acute medical event. The proportion of participants involved in a crash as the result of a medical condition increased in proportion to their age; for example 37.5% for all participants between the ages of 80 and 89 years were found to have had a medical condition or event as a contributing factor to their crash, increasing to 66.6% of those who were 90 years or more.

Injury outcomes for this group were also found to be poor, with those 70 years or older almost three times more likely to have a fatal outcome as the result of the crash when compared to those who were 40 years or less. Among those participants who were 70 years or older there were ten cases where the participant was discharged from hospital to an aged care facility due to their inability to live independently, many of whom had their licences suspended on medical grounds. It is at least suspected that those medical grounds for suspension and their inability to provide self care were relevant before their involvement in the crash. Although the importance of mobility is recognised as a key component of health for older people it is suggested that closer monitoring regarding fitness to drive among those with demonstrable health deficits needs to occur.

The evidence based recognition of the role of age in increased crash risk that is presented in this report adds weight to the debate centred on the appropriateness of regular medical assessment of drivers over the age of 70 years for fitness to hold a licence, as outlined in the Austroads Assessing Fitness to Drive guidelines [14]. This is particularly the case for those older drivers who demonstrate declines in their functional abilities and those impaired as the result of multiple co-morbid medical conditions.

Predictability of crash occurring for drivers and riders

There were a number of cases where the participant had some event or incident in the weeks preceding the crash that eventually played a role in their crash. This was seen particularly among those who were involved in the crash as the result of a loss of consciousness and those involved in a crash as the result of a seizure event. Among the 41 drivers and riders who experienced a loss of consciousness in the lead up to the crash there were ten drivers who had a reported history of two or more episodes of unconscious collapse in the weeks and months preceding the crash. Similarly, among those who had a seizure there were at least ten drivers who had a history of unexplained unconscious collapse or episodes of unresponsiveness. In these cases the episodes had not been medically investigated until the person was involved in the crash in this study. The reasons why these cases were not investigated prior to the crash event are not available in most cases, but it is likely that there were some cases involving the participant not seeking earlier medical attention and some where medical investigation was not undertaken. There is a need to explore these aspects further.

In addition to these there was a considerable number of cases involving those participants experiencing mental health issues; this was found amongst pedestrian participants as well as drivers. In many of these cases there was documentation that described a demonstrable escalation in either their mental illness status or suicidal ideation before the crash event. These escalations in behaviours were noted by family members in some cases but also included medical documentation in those cases where the person presented to hospital in the days and weeks prior to the crash involvement. The medical management protocols related to mental health and analysis of specific areas of health care are beyond the scope of this project, however, at least in the case of drivers, closer consideration of the fitness to drive at periods of reduced capacity secondary to acute mental illness is one aspect that could benefit from further consideration. This is particularly the case with those individuals experiencing an acute escalation in their illness who may be less likely to consider the implications of their illness on driving.

Alcohol

Alcohol was the leading contributor to crashes accounting for at least 18.4% of cases. While acute alcohol intoxication is not a medical condition as such, most would agree that intoxication in a climate of alcohol dependence is. There were 146 participants identified as being alcohol dependent in this study. It is suspected that the true figure is likely to be higher. These 146 participants included 93 participants involved in the crash as a driver or motorcycle rider. In 50% of cases involving these drivers and riders the alcohol level at the time of the crash was known to be above the legal driving limit of 0.05, most of these had alcohol readings above 0.150. In 21% of these 93 drivers and riders there was no alcohol reading available and so these figures are likely to be conservative. In almost 60% of these drivers and riders there was a prior history of at least one drink driving offence, with one driver having a history of nine offences.

In spite of the well identified risks of alcohol intoxication and alcohol dependence in road crashes only one of these 93 drivers and riders had a conditional licence related to reporting of their alcohol dependence status to the driver licensing authority. As with individuals with other medical conditions, it is the responsibility for the licence holder to inform the licensing authority of any medical condition that may impact on driving or pose a risk to others in the driving context [14]. As with those experiencing mental illness, it is at least possible that those with alcohol dependence may be a group less likely to fulfil this responsibility, as evidenced by the low level of alcohol dependence reporting found here. It is suggested that there may be a case for those medical officers responsible for the care of patients with alcohol dependence to take a more active role in advising patients regarding their legal obligation to notify licensing authorities of their alcohol dependent status, or giving further consideration to their own role in notification.

Other persons injured

A common belief regarding medical conditions and driving is that those who experience a medical event run off the road and injure only themselves. It is clear from the study that drivers and riders who experience a medical event leading to a crash do involve other road users, both within their vehicles and those of other vehicles. It was found that those crashes involving a driver or motorcycle rider with a medical condition or experiencing an acute medical event resulted in 36 others being transported to hospital as a result of injuries incurred in the crash. These others included 17 occupants who were passengers of the driver experiencing a medical event and 19 occupants, drivers and passengers, of other vehicles.

The results from this study have identified that particular groups are at risk of crash involvement as a result of their medical condition status. These groups were found to be generally consistent with those identified in the 2003 Assessing Fitness to Drive Guidelines [14]. The study findings provide further evidence that may be considered by health care professionals when assessing the fitness to drive among their patients.

8 STUDY LIMITATIONS

Participants in this study were drawn from those who were identified by ICD10-AM coding processes which are only undertaken following admission to hospital. As a result, those who attended the hospital for less than four hours are not included in this study. This may have created a bias toward more seriously injured participants, though this can not be confidently asserted. As stated earlier, The Royal Adelaide Hospital is one of the two major adult trauma centres in South Australia. As such, the hospital provides care for the local community of Adelaide but also care for those across the state requiring specialist care that may not be available elsewhere. It is at least possible that some participants in this study who required a higher level of care may also be more likely to have a medical condition that contributed to their crash.

In many cases those who have a pre-existing medical condition are more likely than not to be prescribed a therapeutic medication in the management of that condition. Although data collection for the study included recording of prescribed medications taken by participants in most cases, it was found that the information that was able to be gathered was commonly limited to a list of drugs prescribed. Dose of the prescribed medication, whether the medication had been taken as prescribed in the lead up to the crash and general medication adherence or non-adherence data was commonly not provided with any consistency. This led to the researchers being unable to provide any meaningful analysis of the impact of medication usage or non-usage on the crash events.

Risk ratios for specific medical conditions were considered beyond the scope of this report. However, it would appear that those with some medical conditions are at greater risk of being involved in a crash as a result of their condition; included among these are those who experienced a seizure. It is proposed that this limitation could be addressed with an extension of the study that incorporates licensing data for the entire South Australian licensed driver population so as to yield a better understanding of the risk ratios for all of the medical condition identified in the study. This extension work would be of value to those revising future fitness to drive guidelines.

9 CONCLUSION

This study has shown, through detailed consideration of the medical records of road users admitted to hospital following a crash, that medical conditions are associated with the occurrence of 11-12% of their crashes. This is a larger proportion than reported in other studies. Loss of consciousness from undetermined causes, seizures, mental illness and deliberate suicide attempts were identified as being important. Highly elevated blood alcohol levels were found particularly in persons with alcohol dependence. Alcohol played a role for those involved in the crash as a result of mental illness and deliberate suicide attempts but did not play a role for other medical condition cases. The occurrence of multiple co-morbid medical conditions increased with increasing age with a corresponding increase in being involved in a crash as the result of a medical condition or acute medical event.

The findings of this study have implications for licensing authorities and for the management of licence holders with medical conditions by the treating medical personnel. The study findings also have implications for road safety practitioners in developing strategies to address an aging population. Some of the suggested implications from this study include:

- continuation of regular assessment of older drivers for medical fitness to drive, particularly for those demonstrating age related functional decline and those at increased risk as the result of the effects of multiple co-morbid medical conditions
- closer monitoring of those with medical conditions where self reporting to the driver licensing authority is less likely to occur, including those with alcohol dependence and those experiencing mental illness
- improved evidence based information available to licence holders, and the medical practitioners responsible for their care, that identifies the increased risks of driving with particular medical conditions.

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APPENDIX 1 - Reasons for exclusion from study

There were 788 cases that were excluded during the data collection period.

Reasons for these exclusions:

- crash occurred on private property or driveway: 257 cases (89 in car, 168 on motorcycle)
- crash of bicycle to roadway, no other vehicle involved: 210 cases
- crash occurred on racetrack during organized race event or activities: 65 cases
- crash occurred in another Australian state or overseas: 64 cases
- incorrectly coded as driver or rider but were found to be passenger or pillion: 57 cases
- incorrectly coded - medical event not related to a motor vehicle crash: 45 cases
- crash occurred on non-public road, car park, cycle way, skate park or golf course: 40 cases
- crash occurred in 2007, prior to study commencement date: 24 cases
- admitted for corrective surgery related to injuries incurred at an earlier date: 21 cases
- fall of pedestrian on pavement, no vehicles involved: 5 cases

APPENDIX 2 - Identified pre-existing medical conditions found for all participants

Type of condition	Number of cases	Type of condition	Number of cases
ADHD	6	hypercholesterolaemia	123
alcohol dependence	146	hypertension	245
anxiety disorder	68	hyperthyroidism	3
asthma	129	hypothyroidism	25
binge/problem drinker	13	IDDM	29
cancer	31	joint replacement	25
cardiac condition	134	myocardial infarction	21
cardiac surgery	39	morbid obesity	33
cataracts	8	NIDDM	91
closed head injury	28	osteoarthritis	52
COAD/emphysema	35	osteoporosis	21
cognitive impairment	24	personality disorder	29
current illicit drug use	108	psychiatric (other)	56
CVA (stroke)	25	psychosis	7
dementia	13	rheumatoid arthritis	7
depression	168	schizophrenia	23
epilepsy/seizure	58	shoulder injury	21
eye sight deficit (other)	19	sleep apnoea	28
glaucoma	9	spinal/back injury	101
GORD	85	suicide attempts	49
gout	21	unconscious collapse	26
hepatitis	43	other	242

INFORMATION RETRIEVAL

Austroads (2011), **Medical Conditions as a Contributing Factor in Crash Causation**, Sydney, A4, 92pp, AP-R389-11

Keywords:

Medical conditions, impairment, crash causation, casualty crashes, conditions to licence holding, fitness to drive.

Abstract:

Impairment as the result of a medical condition or acute medical event and the role that impairment takes in crash causation has been recognised as a road safety issue for more than three decades. Their contribution to the overall crash problem, however, have frequently been over-shadowed or seen as less important when compared to the risks posed by other road user groups including young drivers and those who are impaired as the result of alcohol.

Between 2008 and 2010 a study was undertaken to determine the proportion of casualty crashes resulting in admission to hospital that were directly associated with the effects of a medical condition or an acute medical event. The study involved examination of the hospital medical records for drivers, riders, pedestrians and cyclists involved in crashes on public roads in South Australia who presented to the Royal Adelaide Hospital for four hours or more during the three year period. A total of 1,490 medical records were accessed.

These records were matched with a number of other data sources including Vehicle Collision Records generated by South Australian Police, licensing records from the SA Department of Motor Registration and drug and alcohol screening records generated by the Forensic Science Centre of SA. This detailed examination of the circumstances surrounding each person's involvement in a crash enabled identification of those crashes that occurred as the direct result of a medical condition or acute medical event, as opposed to those for which a crash participant's pre-existing medical condition(s) were unrelated.

The report outlines the major findings of the study including the medical conditions found to have directly contributed to the crash, licensing considerations before and after crash involvement and the crash types commonly observed.