



FATAL SINGLE VEHICLE CRASHES STUDY

SUMMARY REPORT

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Abstract:

This report summarises the findings of the **Case-control study of fatal single-vehicle crashes**. The cases in the study were fatal single-vehicle crashes (or crash trips) which occurred during the period from 1 December 1995 to 30 November 1996 within 200 km of Melbourne. The cases have location, driver/rider and vehicle characteristics. The controls were (non-crash) trips which also have location, driver/rider and vehicle characteristics.

The most important risk factors, in terms of magnitude of the odds ratio and fraction of the crashes involved were: alcohol and cannabis, younger drivers, and older drivers. The major factors contributing to the severity of fatal single vehicle crashes were: trees and poles, not wearing seat belts and pre-1978 vehicles.

A number of possible improvements to procedures for the investigation of serious injury crashes are recommended.

Key Words:

(IRRD except when marked*)

Single vehicle accident, fatality, risk, drink driving, marijuana, driver characteristics, vehicle, road environment, pole, vegetation.

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EXECUTIVE SUMMARY

This report summarises the findings of the **Case-control study of fatal single-vehicle crashes**. The cases in the study were fatal single-vehicle crashes (or crash trips) which occurred during the period from 1 December 1995 to 30 November 1996 within 200 km of Melbourne. The controls were (non-crash) trips during the same period.

The characteristics of the cases are described in the report, *Characteristics of fatal single vehicle crashes*. The comparisons of cases and controls to derive relative risk estimates are presented in the companion report entitled *Estimation of risk factors for fatal single-vehicle crashes*.

The aims of the **Case-control study of fatal single-vehicle crashes** study were to:

1. investigate single vehicle crashes to determine the circumstances and factors contributing to them
2. estimate the over-involvement (relative risk) of these factors
3. identify improvements in procedures for the investigation of road deaths and life threatening injuries
4. provide information from which countermeasures can be developed to the agencies responsible for road safety in Victoria

This report summarises work on the first three aims. A report has been provided to the funding bodies which deals with Aim 4.

SUMMARY OF FINDINGS

Driver age and experience

Drivers aged under 25 and those aged 60 and over were at higher risk of being involved in a fatal single vehicle crash than drivers aged 25 to 59. Among these groups the risks were greatest for drivers aged under 21 and 70 and over.

Compared with full licence holders, learner permit and probationary licence holders were at higher risk. Having driven for less than three years and having driven the current vehicle for less than 10,000 km were also associated with increased risk of being involved in a fatal single vehicle crash.

Among drivers with at least five years experience, those who had been involved in a previous crash in the last five years were at greater risk of crashing.

Alcohol and cannabis

Driver BAC levels exceeded .05 in 36% of crashes for which this was known, including 27% of crashes in which BAC exceeded .15. BAC > .05 was associated with significantly increased crash risk. The lack of control drivers with high BAC levels prevented estimation of relative risk for BAC > .15.

Alcohol or cannabis was present in some cases and some controls. Among the cases (but not the controls), cannabis was most commonly present at high levels of alcohol

and very rarely present when there was no alcohol. The lack of alcohol and cannabis together in any controls meant that statistical tests of the effects of the interaction of the two drugs could not be performed. There is a need to focus further research and investigation on the combined effects of alcohol and cannabis.

Differences in data collection methods for cases and controls may have inflated the risk estimate for cannabis. The analysis showed that the presence of cannabis increased the risk of crashing when $BAC \leq .05$. When all BAC data was combined, the presence of cannabis was associated with an increased risk of crashing but it is unclear the extent to which this resulted from an effect of cannabis alone or from an interaction with alcohol.

Passengers

Among the drivers who had passengers, having only male passengers rather than female or male and female passengers was associated with higher crash risk. Having passengers aged 15-24 was also identified as a risk factor.

Vehicle-related factors

Not wearing a seatbelt was associated with significantly increased risk, as was driving a vehicle manufactured before 1978. Driving someone else's car (not the employer's) was also associated with increased crash risk.

Trip factors and activities in the previous 24 hours

Unfamiliarity with the road and reason for the trip did not affect crash risk after adjusting for potentially confounding variables.

Assessment of the crash risk related to excessive speed was restricted by the unavailability of speed data for more than half of the crashes. It is recommended that a future project involve estimation of pre-collision speeds from the scale plans available for most of the crashes followed by a reanalysis of the speed data.

Drivers who had slept for more than ten hours in the previous 24 hours were found to be at higher risk of being involved in a fatal single vehicle crash.

Site factors

The analyses of the site variables were complicated by a number of spurious relationships and the interrelationships of the site variables. In addition, the data set included only 127 crash sites and 100 control sites which meant that an effect would have to be large before it could be detected. Taking into consideration the problems of insufficient statistical power, the following conclusions can be drawn.

The risk of occurrence of a single vehicle crash at a site was found to increase by 3% with every extra 1000 vehicles per day. Relative risk was also higher at sites on curves. The reductions in risk observed with the presence of side drains and traffic controls may have resulted from biases in data collection procedures.

Trees and poles were present in about three-quarters of the crashes. However, the difficulties in identification of control objects prevented the relative risks for trees and poles from being calculated.

While the inability of this study to identify road factors which contribute strongly to the risk of occurrence of fatal single vehicle crashes is somewhat disappointing, it is a similar finding to that of earlier studies.

SUMMARY OF FINDINGS

The adjusted odds ratios for the significant risk factors are summarised in the tables which follow.

Table 1. Matrix of risk factors and their magnitude. Within each category, risk factors are ranked in order of the size of the odds ratio.

Risk factor	% crashes	% controls	Odds ratio
Driver age, licensing, experience			
Learner permit	5	0	10.9
Passengers aged 15 to 24	25	9	8.7
Previous crash in last 5 years ¹	25	4	6.1
Driver aged under 25	41	15	3.9
Driven vehicle less than 10,000 km	53	21	3.7
Driven less than 3 years ¹	31	6	3.5
Probationary licence	22	5	3.4
Driver aged 60 and over ²	17	12	2.3
Unlicensed driver	13	0	undefined
Alcohol and cannabis			
Using both alcohol and cannabis	16	0	118.4
BAC>.05 ³	26	0	95.8
Cannabis only	3	1	9.3
Other driver characteristics			
Depressed	14	4	2.7
Vehicle-related characteristics			
Not wearing seat belt ²	13	2	8.4
Windows closed ¹	78	57	2.4
Pre-1978 vehicle	21	9	2.3
Heater on ¹	53	32	2.2

1 Considerable missing data for cases

2 Percent in drivers with BAC<=.05

3 Percent in drivers without cannabis

Table 2. Matrix of risk factors for which countermeasures are less likely. Within each category, risk factors are ranked in order of the size of the odds ratio.

Risk factor	% crashes	% controls	Odds ratio
Other driver characteristics			
Receiving a benefit	21	10	5.0
Sleeping more than 10 hours in previous 24	19	7	4.4
Having male passengers only	20	11	3.0
Never married	53	23	2.2
Vehicle-related characteristics			
Driving someone else's car	36	7	4.5
Site factors			
Curves	30	16	2.4

POSSIBLE IMPROVEMENTS IN INVESTIGATION PROCEDURES

In order to improve the availability of information about severe crashes, it was recommended that:

1. The availability of toxicological information for drivers who may be charged be investigated and, if necessary, a procedure be developed to incorporate the BAC data into the State Traffic Accident Record at an appropriate time (perhaps after completion of criminal procedures).
2. Given the lack of information on drugs in nonfatal crashes, perhaps testing of all (or a given proportion) of blood samples for drugs should be undertaken for a specified period to increase our knowledge in this area.
3. Blood samples of all drivers in fatal crashes (whether or not injured) be taken and analysed for both alcohol and other drugs. An alternative would be to have blood samples taken and analysed whenever the breath shows alcohol (building on the strong relationship between alcohol and cannabis).
4. The family's right to object to autopsy be maintained but that the authorities have the right to take and analyse a blood sample from the deceased.
5. Testing for the active ingredient, rather than the metabolite, of cannabis be undertaken, at least for fatal crashes, in the short term. Improvements in technology may reduce costs etc and allow this to be extended to nonfatal crashes in the future.
6. Vehicle Identification Numbers (VINs) be recorded to allow better identification of makes and models of vehicles and judgements of the presence of safety features. Currently, VINs could be added to the State Traffic Accident Record routinely by interrogating the registration data, using the vehicle registration number. In the future, automatic capture of VINs at the crash site may replace this method.
7. In addition, for the next couple of years, it would be desirable to record deployment of airbags.

8. It is probably preferable for items regarding the state of the vehicle immediately prior to the crash (e.g. heating and ventilation) to be collected in special studies, rather than to burden the Police with additional workload for every reported crash.
9. While resource limitations are an important issue which needs to be considered, it may be useful from the point of view of training Accident Investigation Section staff and developing a high quality knowledge base for prevention, to have a special focus on particular crash types (or perhaps even locations) for a particular period.

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- Graeme Johnstone, State Coroner
- Isadora Engert - State Coroner's Office
- Bob Wylie, Neil O'Sullivan, Noel Osbourne - Victoria Police
- Ted Vincent, Mike Regan, Mike Tziotis, Bob Gardner, Phillip Jordan - VicRoads
- David Healy - Transport Accident Commission
- Karen McIntyre, Peter Doupé, Anne Harris - RACV
- David Ranson - Victorian Institute for Forensic Medicine

Many of our colleagues at MUARC provided valuable advice during the study. We would like to acknowledge the traffic engineering input of Bruce Corben and the statistical advice of Max Cameron, Lesley Day and Caroline Finch.

Thank you also to the drivers and riders who agreed to be interviewed for the study.

1. INTRODUCTION

1.1 BACKGROUND TO THE STUDY

Single vehicle crashes resulted in 134 deaths and 1898 persons seriously injured in Victoria during 1995 (VicRoads, 1996). The monetary cost to the community of these types of crashes is estimated to be about \$450 million. Overall, single-vehicle collisions comprise approximately 30% of road trauma in Victoria.

The study arose from concern by the Victoria Police and the State Coroner that there was a need for a better understanding of the causative factors in single vehicle run-off-road crashes. Traditionally, Police investigation of these crashes has often been rudimentary when the driver has been killed (and so prosecution is not possible). Since driver-killed crashes comprise about three-quarters of all fatal single-vehicle crashes, the lack of detailed investigation of these crashes has prevented the development of a clear understanding of the factors involved. The Police and Coroner, in consultation with the Transport Accident Commission and Vic Roads, decided that there was a need for a multi-disciplinary approach which would go beyond the attribution of blame. The study was very much a cooperative venture between the State Coroner's Office, Victoria Police Accident Investigation Section, Victoria Police Traffic Operations Group and Monash University Accident Research Centre.

In most past studies, crash types have been studied in a descriptive manner, focussing on in-depth investigation to identify those factors which contribute to crash occurrence or injury severity. The lack of a control group in these studies, however, has made it difficult to test whether the factors identified truly increase crash risk or are merely common characteristics of the road users, vehicles and locations involved. Increasingly, the epidemiological tool of the case-control study is being applied to investigation of road safety problems, as it is in medical research (e.g. cancer). Thus this case-control study aimed to identify the factors which contribute to an increased risk of occurrence of fatal single vehicle crashes, an important step in developing countermeasures to address the problem.

1.2 OUTLINE OF THE STUDY

The **Case-control study of fatal single-vehicle crashes** collected detailed information about cases and controls. The cases are fatal single-vehicle crashes (or crash trips) which occurred during the period from 1 December 1995 to 30 November 1996. The cases have location, driver/rider and vehicle characteristics. The controls are (non-crash) trips which also have location, driver/rider and vehicle characteristics.

The study collected three types of information:

- detailed descriptive information about the crash and the resultant injuries
- comparisons of the features of cases and controls, and
- general exposure information (gathered as part of the control collection process).

1.3 AIMS OF THE STUDY

The aims of the study were:

1. to investigate fatal single vehicle crashes to determine the circumstances and factors contributing to them
2. to estimate the over-involvement (relative risk) of these factors
3. to identify improvements in procedures for the investigation of road deaths and life threatening injuries
4. provide information from which countermeasures can be developed to the agencies responsible for road safety in Victoria

This report summarises work on the first three aims. A report has been provided to the funding bodies relating to the fourth aim of the study.

1.4 STRUCTURE OF REPORTING

This report summarises the results of the **Case-control study of fatal single-vehicle crashes**. The characteristics of the cases are described in the report, *Characteristics of fatal single vehicle crashes*. The comparisons of cases and controls to derive relative risk estimates are presented in the companion report entitled *Estimation of risk factors for fatal single-vehicle crashes*.

2. STUDY DESIGN AND PROCEDURE

2.1 STUDY DESIGN

Fatal single-vehicle crashes were defined in the following terms for the purposes of this study - “where a collision occurs involving a single vehicle, resulting in the death of occupants of that vehicle, in either (sic) of the following circumstances:

1. collision with a fixed object (on/off road)
2. collision with parked vehicle
3. rollover collisions”.

The study region comprised the area in Victoria within a 200 km radius of Melbourne. It stretched from Sale in the east, to Wangaratta and Echuca in the north, to Ararat in the west (see Figure 2.1) and included most of the major population centres in Victoria.

Figure 2.1. The study region.



The study included all fatal single-vehicle crashes in the study region, regardless of the type of vehicle involved. Controls were only collected for car and motorcycle crashes, however, because of the relatively small number of fatal crashes of other vehicle types. Thus, descriptive information is available for crashes involving all vehicle types whereas case-control and exposure information is available for only car and motorcycle crashes.

2.1.1 Selection of control sites

An interest in relative risks for road factors means that a study design in which control drivers are stopped at the crash sites (ie complete matching on site) was not appropriate. If this was done, then a comparison of crash sites with the rest of the road system would not be possible.

A sample of 100 control sites was generated to compare with the expected 100 crash sites. The sample of control sites was structured according to location, road class and time of day.

2.2 PROCEDURE

The study was very much a cooperative venture between the State Coroner's Office, Victoria Police Accident Investigation Section, Victoria Police Traffic Operations Group and the Monash University Accident Research Centre. The roles played by these agencies in the research are outlined below.

2.2.1 Collection of case information

Members of the Victoria Police Accident Investigation Section (AIS) attended the scene of the crash and conducted the investigations necessary to complete the crash questionnaire. This included conducting inspections of the site of the crash. The AIS Coordinator collected questionnaires from attending officers and forwarded them to MUARC.

The questionnaire was developed based on questionnaires used in the University of Auckland Case-Control Study of Motorcycle Crashes and input from the Project Steering Committee. MUARC designed and produced the questionnaires (case and control) and undertook data entry and analysis.

The State Coroners Office coordinated information for fatalities. This included the supply of toxicology reports and autopsy reports when available.

While some post mortems were conducted in the country, all country autopsies were overviewed by a pathologist at Victorian Institute of Forensic Medicine.

2.2.2 Collection of control information

The AIS Coordinator notified the Victoria Police Traffic Operations Group of times and places where their assistance was needed in the collection of controls (random breath testing and licence checking). Members of the Victoria Police Traffic Operations Group (TOG) stopped the control motorists and undertook breath tests and recorded licence details. Roadside interviews and telephone follow-up interviews were conducted by MUARC staff who also inspected control sites.

Four sets of information were collected for control motorists: licence data, roadside observations, roadside interviews and follow-up telephone interviews. Follow-ups were completed for 70% of motorists stopped.

During the 12 months of the study, 865 drivers or riders were stopped at 100 control sites. The majority of vehicles stopped were cars (90%). There were also 19 motorcycles (2%) and 72 light commercial vehicles (8%) stopped.

3. CHARACTERISTICS OF THE CRASHES

There were 127 single vehicle crashes in which 133 persons were killed. The crashes had the following characteristics:

Type of crash

- almost 75% of crashes involved an impact with a tree or pole or both (71% metropolitan, 78% of rest of study area crashes)
- tree crashes were more common outside the metropolitan area
- 53% of trees and 36% of poles impacted were on the right-hand side of the road
- 31% of crashes involved impact with a tree or pole located within the desirable clear zone outlined in VicRoads policy

Temporal characteristics

- were most common from midnight to 6 am and midday to 6 pm and least frequent from 6 am to midday
- were most common on Saturdays and Sundays
- were more common in February, April and September than in other months

Persons killed

- five crashes were multiple fatalities
- the driver was killed in 81% of crashes
- almost half the persons killed were aged under 25

Drivers and riders

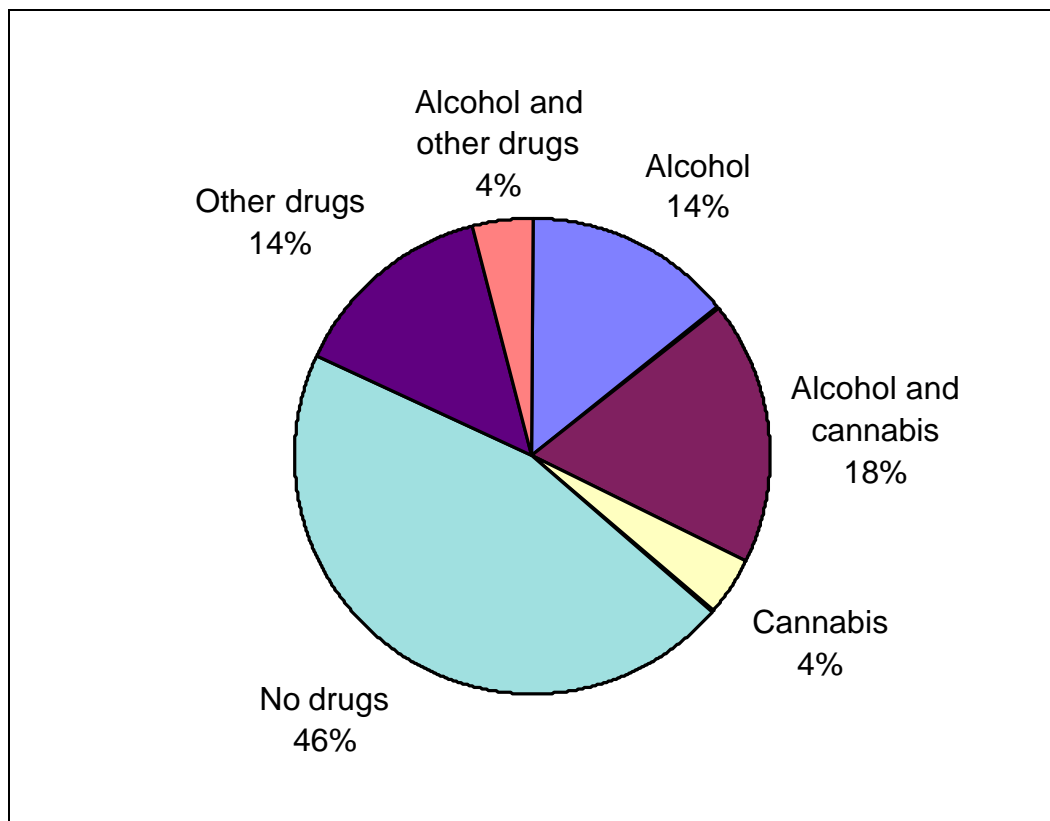
- 80% of the drivers and riders were male
- more than 40% of the drivers and riders were aged under 25
- 13% of the drivers had been severely depressed in the previous six months
- 13% of drivers or riders did not hold a current licence (6% never held a licence, 2% licence lapsed, 6% licence disqualified)

Alcohol and other drugs

- BAC was known for 95% of crashes and cannabis use known for 83% of crashes. The percentages in this section are percentages of known cases. All of the cases of cannabis were in deceased drivers where it was detected as the metabolite, carboxy-THC. This substance may be detected some weeks after cannabis use and therefore its detection does not prove that the driver was under the influence of cannabis at the time of the crash.
- results are summarised in Figure 3.1
- BAC>.05 in 36%, BAC>.15 in 27% of crashes
- cannabis was most commonly found in conjunction with alcohol:
 - for BAC>.05, cannabis was present in 49%
 - for BAC>.15, cannabis was present in 52%
 - but cannabis was present in only 6% for BAC<.05
- males were twice as likely as females to have BAC>.05 but the proportions of these groups with BAC>.15 were similar
- no alcohol or cannabis was found in drivers aged 60 and over
- drivers aged 25 to 59 were more likely to have BAC>.15 than those under 25

- higher levels of education were related to fewer drivers with BAC>.05 or cannabis for 25 to 59 year olds but not under 25s
- proportions of crashes with BAC>.05 or cannabis were similar in metropolitan and rural areas
- BAC>.05 occurred more often on major roads than freeways, highways or minor roads
- cannabis was detected for 23% of male drivers and 11% of female drivers
- cannabis was detected in 21% of drivers under 25 and 25% of drivers aged 25 to 59
- cannabis-involved crashes were less common on highways than freeways, major roads or minor roads
- information about consumption of prescription and nonprescription drugs was available for 78% and 73% of drivers, respectively
- 17% of drivers had taken prescription drugs in the 12 hours prior to the crash (14% of under 25s, 18% of 25 to 59s and 27% of those aged 60 and over)
- 3 drivers or riders had taken nonprescription drugs in the 12 hours prior to the crash

Figure 3.1. The prevalence of alcohol, cannabis and other drugs in the 98 deceased drivers and riders for whom toxicology reports were available. In this figure, persons with BAC less than .050 and no other drug are classified drug-free.



Passengers

- there were 74 passengers of whom 30 were killed
- passengers were more likely to be of the same sex as the driver than to be of the opposite sex or a mixture of males and females
- young drivers were more likely to have passengers than other drivers
- most passengers were in the same age group as the driver of the vehicle (particularly for under 25s)
- in four of the 24 crashes for which BAC of both driver and (killed) passenger were known, the BAC of the driver was greater than that of the passenger.

Vehicles

- 10 crashes involved motorcycles, 7 involved light commercial vehicles and 3 involved trucks
- six of the 10 motorcycles had an engine capacity of greater than 500 cc but none of the motorcycles with an engine capacity greater than 260 cc was ridden by a learner or probationary rider
- almost 20% of the vehicles involved in crashes were manufactured before 1978 and so were not required to comply with some of the current safety standards
- age of the vehicle was not related to age of the driver

Locations of crashes

- 60% of crashes occurred in the Melbourne metropolitan area, 40% in the remainder of the study region
- most crashes occurred on highways (42%)
- a larger proportion of crashes occurred on highways and a smaller proportion on minor roads in the metropolitan area compared to the rest of the study area
- two-thirds of the crashes occurred on undivided roads (58% of metropolitan, 77% of rest of study area)
- half of the crashes occurred where the speed limit was 100 km/h or 110 km/h (23% of metropolitan, 82% of rest of study area)
- about one-third of the crashes occurred on curves (27% of metropolitan, 36% of rest of study area)
- 20% of metropolitan and 8% of rest of study area crashes occurred at intersections (most commonly T intersections)
- traffic controls were present at the site of 13% of crashes (18% of metropolitan, 6% of rural)
- mud, oil or loose material was present on the road surface for 10% of crashes in the rest of the study area
- the road had a shoulder for 62% of metropolitan crashes and 96% of rural crashes. In the metropolitan area, 49% of shoulders were sealed compared with 20% of rural shoulders

4. CRASHES INVOLVING TREES AND POLES

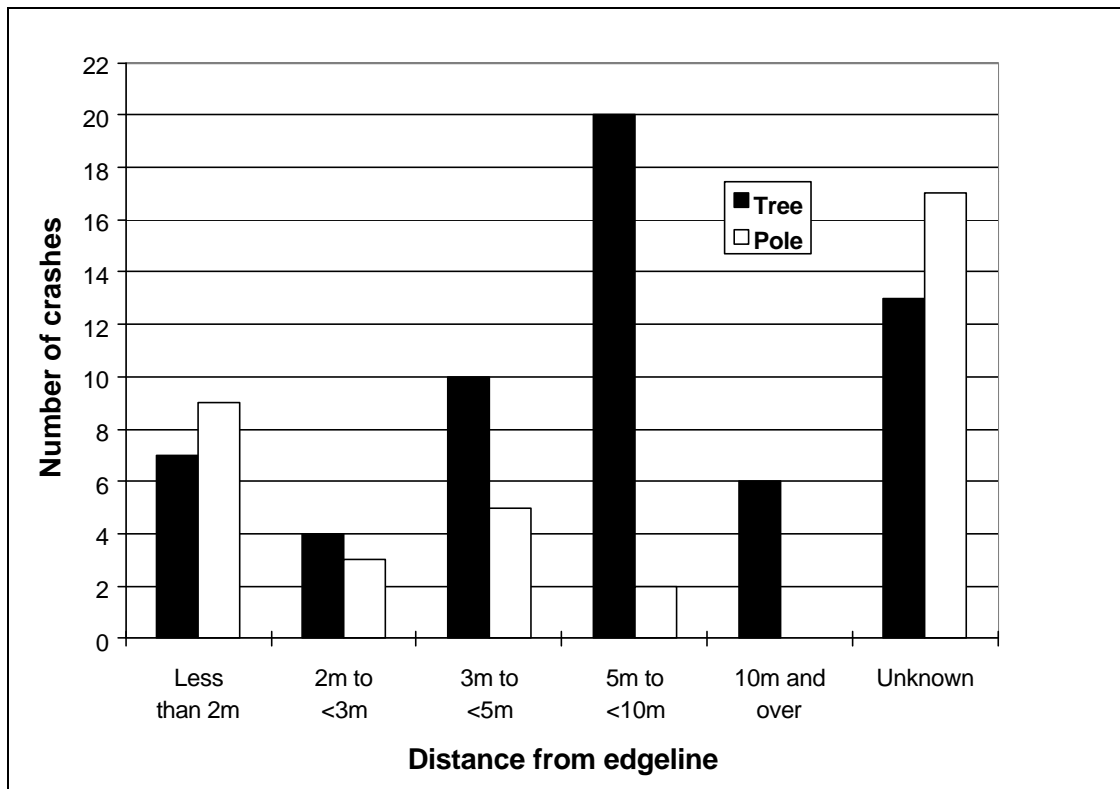
Almost 75% of the crashes involved an impact with a tree or pole or both (71% of metropolitan crashes, 78% of crashes in the rest of the study area). Trees and poles were involved to the same extent in metropolitan crashes but trees were much more common in crashes in the rest of the study area. Overall, 53% of the trees and 36% of the poles impacted were on the right of the direction of travel of the vehicle.

4.1 DISTANCES TO IMPACTED TREES AND POLES

Figure 4.1 summarises the distances from the closest edgeline to impacted trees and poles. It shows that many of the trees impacted were between 3m and 10m from the travel lane. Eleven trees and twelve poles were less than 3m from the edgeline. Seven trees and nine poles were less than 2m from the edgeline.

In the metropolitan area, crashes involving poles were more frequent. Poles were often less than 2m from the edge of the road. The distances to trees varied. In the rest of the study area, many more crashes involved trees than poles. Most trees were within 3 to 10m of the edgeline. In 65% of crashes where a tree was impacted, it was on the right.

Figure 4.1. Distances to impacted trees and poles.



4.2 COMPARISONS WITH VICROADS CLEAR ZONE POLICY

The VicRoads clear zone policy (Road Design Note 3-1a, March 1995) outlines desirable widths for clear zones according to speeds, traffic volumes and road curvature. The minimum desirable clear zone width is 3m and this increases to 9m for 85th percentile speeds of 95 km/h and over with approach volumes of greater than or equal to 5,000 vehicles/day.

Application of the clear zone policy to the crash data was complicated by the lack of traffic volumes for the crash sites and the lack of 85th percentile speeds. A conservative comparison was undertaken, which assumed the lowest traffic volume and that the 85th percentile speed was the speed limit. A summary of this comparison is presented in Table 4.1. It shows that 22 trees and 14 poles were located within the desirable clear zone. The numbers in the table are underestimates because they do not include the 13 trees and 17 poles for which the distances were unknown.

Table 4.1. Numbers of crashes involving trees and poles within the desirable clear zone for that speed. The distances are from the edgeline of the road closest to the tree or pole.

Speed limit (km/h)	Clear zone width	Impacted trees within clear zone	Impacted poles within clear zone
60	3.0 m	6	5
70	3.4 m	0	4
80	4.2 m	1	1
100	6.0 m	14	3
110	6.0 m	1	1
Total		22	14

The clear zone policy notes that “in urban areas it is often not practical to provide even three metres because of poles and trees. In these circumstances, a clear zone of one metre may have to be adopted. Any clearances less than one metre could adversely affect both the safety and operating conditions of traffic” (p.2). In the sample of crashes analysed here, one tree and four poles were less than one metre from the edge of the traffic lane.

4.3 CRASHES WITH TREES AND POLES ON CURVES

Of the 94 crashes involving trees and poles, 25 (27%) occurred on a curve. For comparison, 36/118 (31%) crashes in total occurred on a curve. For four of the seven crashes where the tree or pole was outside the clear zone for a straight section of road, it was within the clear zone calculated according to the radius of curvature and speed limit.

Thus, a total of 40 crashes (31%) in the study occurred when the tree or pole impacted was within the recommended clear zone.

5. RISK FACTORS IDENTIFIED

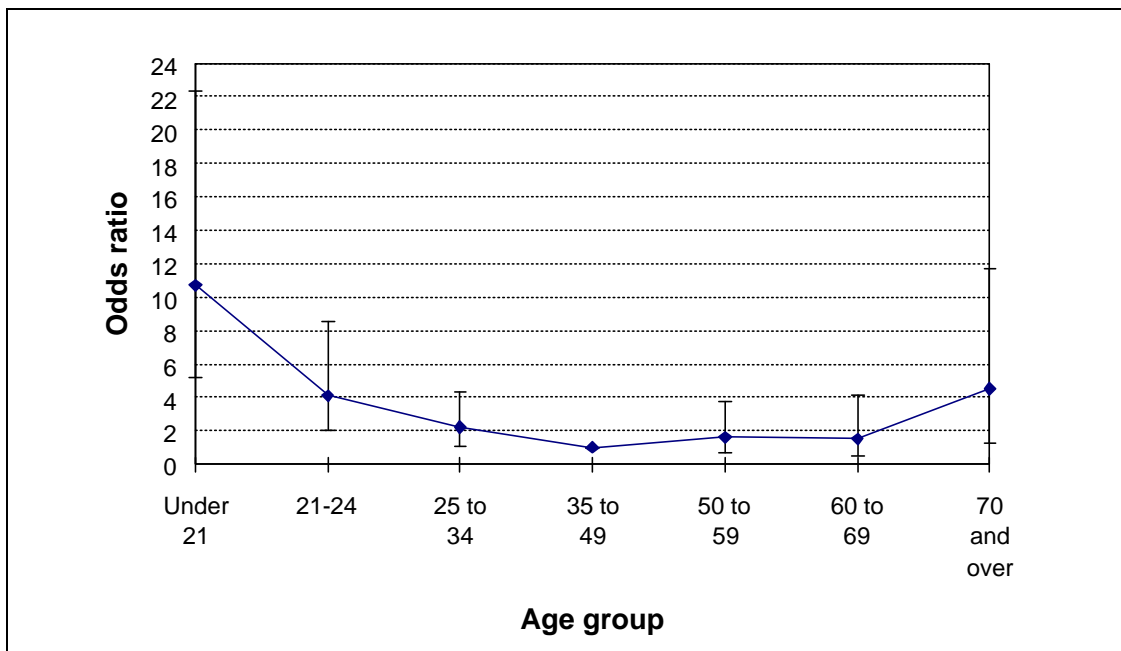
Case-control comparisons were conducted for cars and light commercial vehicles. In this study, the controls were not involved in a crash, so the relative risks relate to both crash involvement and crash severity, rather than to crash involvement alone.

Preliminary analyses showed that the effects of age of the driver and BAC level on risk of crashing were very strong. These effects masked or accentuated the true effects of factors which were correlated with age or BAC level. Therefore logistic regression was used to calculate the odds ratios adjusted for the effects of age and BAC level, and other variables where appropriate.

5.1 DRIVER AGE AND EXPERIENCE

The unadjusted odds ratios and confidence intervals for involvement in a fatal single vehicle crash, compared to drivers aged 35 to 49 is presented in Figure 5.1.

Figure 5.1. Unadjusted odds ratios and confidence intervals for involvement in a fatal single vehicle crash. Drivers aged 35 to 49 were the reference group.



5.1.1 Younger drivers

Drivers aged under 25 comprised 41% of those in crashes and only 15% of control drivers. Compared with drivers aged 25 to 59, the odds of the younger group crashing were 4.3 times greater. The odds of crashing for drivers aged under 21 were even higher (see Figure 5.1).

Part of this age effect is related to the risk-taking factors of use of alcohol and cannabis. Yet after adjustment, the under 25s still have a statistically significant odds ratio of 3.3.

The data suggest that under 25s do more night driving. These drivers comprised 25% of night-time controls but only 12% of daytime controls. The ratio of night to day young driver crashes was similar (54% night time to 26% daytime), suggesting that while night-time driving was more common for younger drivers, it was no more dangerous for them than for the other drivers.

That the age effect may be due to inexperience is supported by the significantly elevated odds ratios for learner drivers (20.4) and probationary drivers (6.6), and drivers who have driven less than three years (6.5).

These odds ratios found in this study seem to be higher than for young drivers in multi-vehicle crashes. Earlier, Macdonald, Bowland and Hancock (1994) concluded from analyses of Australian and US mass crash databases that there was relatively higher involvement in single vehicle than multi-vehicle crashes.

5.1.2 Older drivers

Drivers aged over 60 comprised 13% of those in crashes and 12% of those in controls. This unadjusted odds ratio is not significant, although that for drivers aged 70 and over is significant (see Figure 5.1).

Whether drivers aged 60 and over are at greater risk depends on the interpretation of the adjusted and unadjusted odds ratios. This group of drivers are not operating at higher risk overall, but once the lower prevalence of other risk factors in this group (e.g. alcohol, cannabis, inexperience) is considered, then they are at higher risk.

Reading of the Coroners' briefs showed that the cause of death was related to natural disease, rather than injuries sustained in the crash, for more than half of the drivers aged 60 or over.

Prescription drugs were more commonly taken by members of this age group (27% of cases, 47% of controls) than younger drivers but none of the unadjusted or adjusted odds ratios for prescription drugs were significant.

5.1.3 Previous crash involvement

Among drivers with at least five years experience, those who had been involved in a previous crash in the last five years were at greater risk of crashing.

5.2 ALCOHOL AND CANNABIS

5.2.1 Alcohol

Blood alcohol concentrations of above .05 were present in 37% of crashes. In 27% of crashes, the BAC was .15 or above. Less than 1% of control drivers had BAC>.05 and none were >.15. The odds of crashing were 120 times greater with BAC>.05 than with BAC<.05.

Alcohol use was associated with cannabis use (at high BAC levels), being aged under 60 and being male. However, adjustment for these factors only reduced the odds ratio to 96.

Alcohol was also associated with other risk factors. Drivers with BAC>.05 were more likely to be unlicensed, to have had a crash in the previous five years, to have passengers and to not wear seat belts.

The nature and existence of an interaction between the presence of cannabis and BAC level could not be addressed with the current data because there were no controls with both BAC>.05 and cannabis present. The need to investigate this interaction has been identified by the Victorian Parliamentary Road Safety Committee Report into Drugs (Other than Alcohol) in Driving (1996) who recommend further research in this area.

5.2.2 Cannabis

Cannabis was present in 19% of crashed drivers in this study, compared with 1% of control drivers. The odds of crashing with cannabis present were estimated as 38 times greater than that with cannabis absent.

Cannabis use in crashed drivers was most common at high BAC levels - two-thirds of those drivers who had cannabis present had BACs of .15 or above. Drivers aged 25 to 59 were somewhat more likely to have cannabis present than drivers aged under 25.

There were differences in the methods of collecting information about cannabis for cases and controls. For controls, the only feasible method of collection of information about use of illicit drugs was self-report. Drivers were asked whether they had used marijuana in the previous 12 hours. It is possible that some drivers in the control group deliberately under-reported their use of marijuana. For cases, cannabis was coded as present if the toxicology report stated that the metabolite was found in blood or urine. This could result in cannabis being coded as present which may have been taken more than 12 hours before the crash. Both factors could contribute to an overestimation of the odds ratio for cannabis.

The analysis showed that the presence of cannabis increased the risk of crashing when BAC<=.05. When all BAC data was combined, the presence of cannabis was associated with an increased risk of crashing but it is unclear the extent to which this resulted from an effect of cannabis alone or from an interaction with alcohol.

Concern has been expressed in recent years that drink driving enforcement may be encouraging the use of cannabis instead of alcohol by drivers who wish to avoid detection. The data for the controls shows that about 1% of driving occurred when cannabis had been used in the previous 12 hours (and so is likely to have had a behavioural effect). Within this very small sample (n=5), all drivers had no detectable alcohol. For those who crashed, however, alcohol and cannabis were commonly both present.

5.3 PASSENGERS

Among the drivers who had passengers, having male passengers rather than female or male and female passengers was associated with higher crash risk. Having passengers aged 15-24 was also identified as a risk factor.

5.4 VEHICLE-RELATED FACTORS

5.4.1 Not wearing a seat belt

The odds of being involved in a fatal single vehicle crash were almost 15 times greater for drivers who were not wearing a seat belt. While there was a strong association with BAC level and country driving, even after adjusting for these factors the odds of being involved in a fatal single vehicle crash were more than seven times greater for drivers not wearing seat belts. Adjustment for other driver factors such as age and sex had little effect on the results. Therefore it is likely that much of the effect of seat belts was on the severity of the crash, rather than non-wearing being a proxy for some other variable related to crash involvement.

5.4.2 Older vehicles

Vehicles manufactured before 1978 comprised 21% of crashed vehicles and 9% of control vehicles. Thus the odds of being involved in a fatal single vehicle crash were 2.5 times greater for a driver of a pre-1978 vehicle than a newer vehicle. Adjustment for a number of driver-related variables (BAC level, sex, age) and characteristics of the driving pattern (metropolitan/rural, distance per week) had little effect on the odds ratio. This suggests that the effect of the age of the vehicle reflects its crashworthiness, rather than another factor related to its driver or pattern of use.

These results are consistent with those of Newstead, Cameron and Le (1997) who demonstrated that both the crashworthiness (probability of severe injury given crash involvement) and injury risk (probability of injury given crash involvement) were poorer for vehicles manufactured before 1978 than later vehicles.

Driving someone else's car (not the employer's) was also associated with increased crash risk.

5.5 TRIP FACTORS AND ACTIVITIES IN THE PREVIOUS 24 HOURS

Unfamiliarity with the road and reason for the trip did not affect crash risk after adjusting for potentially confounding variables.

Assessment of the crash risk related to excessive speed was restricted by the unavailability of speed data for more than half of the crashes. It is recommended that a future project involve estimation of pre-collision speeds from the scale plans available for most of the crashes followed by a reanalysis of the speed data.

Drivers who had slept for more than ten hours in the previous 24 hours were found to be at higher risk of being involved in a fatal single vehicle crash.

5.6 SITE FACTORS

The analyses of the site variables were complicated by a number of spurious relationships and the interrelationships of the site variables. In addition, the data set included only 127 crash sites and 100 control sites which meant that an effect would have to be large before it could be detected. Taking into consideration the problems of insufficient statistical power, the following conclusions can be drawn.

The risk of occurrence of a single vehicle crash at a site was found to increase by 3% with every extra 1000 vehicles per day. Relative risk was also higher at sites on curves.

The reductions in risk observed with the presence of side drains and traffic controls were likely to have resulted from biases in data collection procedures.

Trees and poles were present in about three-quarters of the crashes. However, the difficulties in identification of control objects prevented the relative risks for trees and poles from being calculated. Nevertheless, the relative risks associated with poles at varying distances from the road have been clearly demonstrated by Joubert and his colleagues (e.g. Good, Fox and Joubert, 1987).

While the inability of this study to identify road factors which contribute strongly to the risk of occurrence of fatal single vehicle crashes is somewhat disappointing, it is a similar finding to that of earlier studies.

6. DISCUSSION AND CONCLUSIONS

The aims of the **Case-control study of fatal single-vehicle crashes** study were to:

1. investigate fatal single vehicle crashes to determine the circumstances and factors contributing to them
2. estimate the over-involvement (relative risk) of these factors
3. identify improvements in procedures for the investigation of road deaths and life threatening injuries
4. provide information from which countermeasures can be developed to the agencies responsible for road safety in Victoria

6.1 RISK FACTORS IDENTIFIED

The risk factors identified are summarised in Chapter 5. The most important risk factors, in terms of magnitude of the odds ratio and fraction of the crashes involved were:

- alcohol and cannabis
- younger drivers, and
- older drivers.

The major factors contributing to the severity of fatal single vehicle crashes were:

- not wearing seat belts
- pre-1978 vehicles
- trees and poles

6.2 INTERPRETATION OF THE RESULTS

In this study, a case-control methodology was used in order to test whether the factors found in the crashes truly were associated with increased crash risk or are merely common characteristics of the road users, vehicles and locations involved.

The interpretation of the odds ratios is determined, however, by the nature of the controls. It was noted earlier that because the controls were not involved in a crash, then the odds ratios relate to a mixture of crash involvement and crash severity.

There is another important issue of interpretation: whether the risk factors identified are specific to fatal, single vehicle crashes. Due to the control definition, some of the risk factors identified in this study may also be associated with increased risk for other types of crashes and subsequent injury. For example, alcohol is also a risk factor for multi-vehicle crashes. This means that the countermeasures identified in this study may also prevent or reduce the severity of other types of crashes.

6.3 APPLYING THE RESULTS TO TARGET ENFORCEMENT AND OTHER COUNTERMEASURES

In using the information provided in this report to target enforcement and other countermeasures, it is necessary to examine not only the adjusted odds ratios but the unadjusted odds ratios and the percentages among cases and controls.

For example, there was no significant increase in relative risk related to being a male driver after adjustment for age group and BAC. This means that being male did not lead to an increased risk of involvement in a single vehicle crash. Yet it remains true that almost 80% of the drivers in single vehicle crashes were male and almost 90% of crashed drivers with BAC>.05 were male. Thus, there are characteristics (like being male) which can be used to target countermeasures to a group who are highly involved in crashes, despite the fact that the characteristic itself does not directly increase crash risk.

There are also some adjustment factors that do not change the odds ratios but are certainly associated with changes in percentages for both cases and controls. For example, seat belt non-use was more common among cases and controls on major and local roads than on freeways and highways. Adjustment for road type did not change the odds ratio, i.e. not wearing a seat belt was equally risky on both types of roads. Yet, the possible benefits of targeting seat belt enforcement or education efforts at travel on major and local roads is suggested.

In deciding what action to take, there is a need to consider both the dimensions of how dangerous the characteristic is (as shown by the magnitude of the odds ratio) and the prevalence of the characteristic. For example, the odds ratio associated with driving a pre-1970 car might be quite high but only account for less than 1% of fatalities and less 1% of total travel. It might be more profitable to address the use of pre-1978 cars for which the odds ratio is lower but the involvement in crashes and usage is considerably greater.

6.4 CONCLUSIONS

In conclusion, the major factors contributing to the risk of occurrence of fatal single vehicle crashes were:

- alcohol and cannabis
- young drivers (under 25)
- older drivers (60 and over)
- curves

In crashed drivers, cannabis was most commonly found in conjunction with high levels of alcohol. The combined effects of alcohol and cannabis require further investigation, as recommended by the Report of the Parliamentary Road Safety Committee Inquiry into Drugs (Other than Alcohol) in Driving.

Assessment of the crash risk related to excessive speed was restricted by the unavailability of speed data for more than half of the crashes. It is recommended that

a future project involve estimation of pre-collision speeds from the scale plans available for most of the crashes followed by a reanalysis of the speed data.

The available data shows higher median speeds for crash than control vehicles. Factors associated with higher speed in crashes were drivers aged under 25 and BAC>.050.

The major factors contributing to the severity of fatal single vehicle crashes were:

- trees and poles
- not wearing seat belts
- pre-1978 vehicles

7. POSSIBLE IMPROVEMENTS IN INVESTIGATION PROCEDURES

The third aim of this study was to identify improvements in procedures for the investigation of road deaths and life threatening injuries. This study arose from concern by the Victoria Police and the State Coroner that there was a need for a better understanding of the causative factors in single vehicle run-off-road crashes. Traditionally, Police investigation of these crashes has often been rudimentary when the driver has been killed (and so prosecution is not possible). Since driver-killed crashes comprise about three-quarters of all fatal single-vehicle crashes, the lack of detailed investigation of these crashes has prevented the development of a clear understanding of the factors involved.

Improvements are suggested in procedures relating to alcohol, other drugs, recording vehicle information and estimation of driver fatigue. Implementation of some of these improvements will require not only changes to procedures but legislative change or improved resourcing. Such changes may be possible in the context of the proposed review of the Road Safety Act, the Parliamentary Road Safety Committee's Report into Drugs (Other Than Alcohol) In Driving and the review of the State accident data system. Despite potential difficulties, it is felt that the improvements are needed to make data collection procedures more effective from both the legal and injury prevention frameworks.

7.1 ALCOHOL

Despite advances made in recent years, alcohol remains the most significant driver impairment factor in road crashes. Yet, availability of alcohol data for crashes in general suffers from such a degree of missing data that most analyses are conducted using a surrogate measure (the so-called "high" and "low alcohol hours") rather than recorded BAC values.

Availability of BAC information for the 24 surviving drivers in the current study was complicated somewhat by ongoing criminal investigations. While the information was supplied for the study upon request, it is unclear whether this information would be available for the State Traffic Accident Record in the short term or the long term.

We would propose that this issue be investigated and, if necessary, a procedure be developed to incorporate the BAC data into the State Traffic Accident Record at an appropriate time (perhaps after completion of criminal procedures).

Even in the current study, BAC information was missing for 5% of drivers or riders. Each of these drivers was deceased. The State Coroner's Office stated that the information was unavailable because the family had objected to autopsy. While the wishes of the families are understandable, the prevention of further, similar deaths would be assisted by some changes to the current procedures.

It is suggested that the family's right to object to autopsy be maintained but that the authorities have the right to take and analyse a blood sample from the deceased.

7.2 OTHER DRUGS

The issues relating to drugs other than alcohol in crashes continue to be of concern. One of the major issues is the lack of information about the drugs consumed by drivers in crashes.

Current legislation requires that blood samples be taken for testing for alcohol when injured drivers and riders present at hospital. These blood samples may also be tested for other drugs. None of the blood samples from surviving drivers in the current study appeared to be tested for other drugs and it is assumed that testing for other drugs is infrequent.

Given the lack of information on drugs in nonfatal crashes, perhaps testing of all (or a given proportion) of blood samples for drugs should be undertaken for a specified period to increase our knowledge in this area.

This recommendation is in line with the recommendations of the Parliamentary Road Safety Committee Inquiry into Drugs (Other than Alcohol) in Driving.

While it was not a major issue in this study, the legislation does not require that drivers who are uninjured in fatal crashes have a blood sample taken. In some particular types of fatal crashes (e.g. those involving trucks and those involving pedestrians), the driver is often uninjured and so blood samples are generally not taken. While breath alcohol may be measured, this does not supply any information about the role of other drugs in these crashes.

It is recommended that blood samples of all drivers in fatal crashes (whether or not injured) be taken and analysed for both alcohol and other drugs.

An alternative would be to have blood samples taken and analysed whenever the breath shows alcohol (building on the strong relationship between alcohol and cannabis).

While cannabis was detected in 17% of drivers and riders in the current study, this was most commonly by means of the metabolite, carboxy-THC. As mentioned earlier in the report, this does not show that the driver or rider was influenced by cannabis at the time of the crash, only that they had smoked it some time in the past several weeks.

It is recommended that testing for the active ingredient, rather than the metabolite, of cannabis be undertaken, at least for fatal crashes, in the short term. Improvements in technology may reduce costs etc and allow this to be extended to nonfatal crashes in the future.

7.3 RECORDING VEHICLE DATA

Monitoring of the primary and secondary safety performance of vehicles would be enhanced if sufficient details of crashed vehicles were recorded to infer if particular features are present (e.g. airbags).

It is recommended that Vehicle Identification Numbers (VINs) be recorded to allow better identification of makes and models of vehicles and judgements of the presence of safety features. Currently, VINs could be added to the State Traffic Accident Record routinely by interrogating the registration data, using the vehicle registration number. In the future, automatic capture of VINs at the crash site may replace this method.

In addition, for the next couple of years, it would be desirable if deployment of airbags could be recorded.

Difficulty exists in determining the transitory characteristics of the vehicle, the most important of which is the speed profile prior to the crash. Others which may be less important to crash causation but should be easier to assess are related to ventilation and heating, use of cruise control etc which can be inferred from examination of the vehicle (settings of knobs etc) after the crash. Unfortunately this information was not recorded for many crashes in the current study. It is unclear whether this resulted from difficulty in ascertaining the information or a perceived lack of importance of the information.

It is probably preferable for such items to be collected in special studies, rather than to burden the Police with additional workload for every reported crash.

7.4 AIS ATTENDANCE CRITERIA

The AIS attended and investigated every fatal single vehicle crash within the study area for the purposes of this study. Normally, they would have only investigated those crashes which fell within their attendance criteria. These criteria include crashes in which:

- culpability may be involved
- three or more people are killed
- a Police officer is involved
- a truck or bus is involved

While resource limitations are an important issue which needs to be considered, it may be useful from the point of view of training staff and developing a high quality knowledge base for prevention, to have a special focus on particular crash types (or perhaps even locations) for a particular period.

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