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An In-Depth Study of Rural Road Crashes in South Australia

Author(s)

Ryan, G.A.
Wright, J.N.
Hinrichs, R.W.
McLean, A.J.

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NHMRC Road Accident Research Unit
University of Adelaide
G.P.O. Box 498
ADELAIDE, S.Aust. 5001.

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Road Safety Division
South Australian Department of Transport
G.P.O. Box 1443
ADELAIDE, S.Aust. 5001.

Federal Office of Road Safety
Department of Transport and Cmunications
G.P.O. Box 594
CANBERRA, A.C.T. 2601.

Abstract

An intensive on-scene study of crashes *on* rural roads outside of towns was carried out from June 1986 to July 1987 in an area of roughly 100 kilometres radius around Adelaide, South Australia. A two man team comprising a social scientist and a physical scientist gathered information by detailed examination of the scene of each crash and the vehicles involved, and by interviewing the ,participants in, and witnesses of, the crash. The team was notified of crashes through the regional centres of St. John Ambulance Service. A total of 80 crashes were investigated. This was a 14% sample of the 577 calls to crashes.

Fifty-six crashes involved loss of directional control. The loss of directional control was due to various combinations of driver, vehicle and environmental factors.

The drivers and riders involved in the crashes were predominantly young, (less than 30 years), male, unmarried, in a blue collar occupation, with a limited secondary school education. Almost half of male drivers were not wearing seat belts at the time of the crash. About 15% of drivers and riders had a BAC over the legal limit of 0.08 g/100 ml. Compared with urban crashes these crashes resulted in more frequent and more severe injury.

Recommendations were made regarding measures to increase seat belt wearing rates, and to increase random breath testing in rural areas.

Key Words accident; Australia*; blood alcohol content; car; driver; highway design; human factor; injury; lorry; motorcycle; on the spot accident investigation; road user; rural area; safety belt; severity (accid, injury); vehicle handling.

* non - IRRD

Disclaimer

This report is disseminated in the interests of information exchange. The views expressed are those of the author(s) and are not necessarily those of the Road Safety Division or of the South Australian Government, or of the Commonwealth Government.

AN IN-DEPTH STUDY OF
RURAL ROAD CRASHES
IN SOUTH AUSTRALIA

Ryan G.A.
McLean A.J.
Wright J.N.
Hinrichs R.W.

NH&MRC Road Accident Research Unit
University of Adelaide
Adelaide
South Australia

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C O N T E N T S

PFEFACE

This is the final report of an in-depth study of rural road crashes which was carried out in South Australia from June 1986 to *July* 1987. In Part 1 the methods of work and the equipnent used are explained in some detail together with the principal findings, conclusions, and recommendations. Part 2 contains a canplete set of case summaries, including site diagrams and photographs.

SUMMARY

An intensive on-scene study of crashes on rural roads outside *towns* was carried out fran June 1986 to July 1987 in an area of roughly 100 kilometres radius around Adelaide, South Australia. A two man team comprising a social scientist and a physical scientist gathered information by detailed examination of the scene of each crash and the vehicles involved, and by interviewing the participants in, and witnesses of, the crash. A plane-table survey was conducted at each crash site and plans were produced using the survey data, aerial photographs and a computer-aided drawing package. The team was notified of crashes through the regional centres of the St. John Ambulance Service. A total of 80 crashes were investigated. This was a 14% sample of the 577 calls to crashes.

The Crashes

Nine were classified as mtorcycle crashes, six as forward control van crashes, five as four wheel drive vehicle crashes, twelve as truck crashes, and the remaining forty-eight were classed as car crashes. Sixteen crashes each resulted in at least one death. Fifty-six crashes involved loss of directional control, ten of which resulted in an impact with another vehicle. The loss of directional control was due to various combinations of driver, vehicle and environmental factors, often in a situation in which the driver was attempting to regain the bitumen road surface after the left wheels of a vehicle had gone off the left edge of the road surface.

Driver Characteristics

The drivers and riders involved in the crashes were predominantly young, (less than 30 years), male, unmarried, in a blue collar occupation, with a limited secondary school education.

Restraint *Use*

Almost half of male drivers and one-quarter of female drivers were not wearing seat belts at the time of the crash. This is consistent with surveys showing a lower rate of seat belt wearing in rural areas, particularly in South Australia. Not wearing a seat belt was associated with an elevated blood alcohol concentration (BAC). In thirteen cases occupants required extrication from crashed vehicles. In no case was a seat belt a cause of entrapment.

Alcohol

About 15% of drivers and riders had a BAC over the legal limit of 0.08 g/100 ml. The prevalence of elevated BAC was highest in males aged 20-24 years and 30-49 years. Half of the drivers in night time crashes had a positive BAC. Those with higher BACs drank alcohol more often, drank more on each occasion, and drove after drinking more frequently. They grossly under-estimated the effect of alcohol on their driving ability. When compared with BACs obtained in an exposure survey in the sane area, crash involved drivers with BACs over 0.08 were over-represented by 7 to 30 times. Alcohol is an important factor in crash causation in rural as well as urban areas.

Fatigue

About 30% of drivers reported sane feelings of fatigue before the crash, and fatigue was associated with an elevated BAC. In six cases fatigue played a role in the crash events, when the driver fell asleep.

Drugs

About one-fifth of drivers had taken drugs before the crash. Most of these were prescription drugs. Two crashes were at least partly due to the effects of prescription drugs. There were three crashes where marijuana in canbination with alcohol played a part.

Trip Type

Work-related trips comprised about one-third of all trips. Trips in the course of work were qualitatively different, in that a large proportion were made by trucks and forward control vans, none of the drivers had a positive BAC, and injuries were less frequent than on other trips. More trips originated at a hotel, club or party, than had these places as destinations. In a small number of cases lack of familiarity with the vehicle being driven, and with the site of the crash, appeared to be a factor in the crash process.

Injuries

Compared with urban crashes these crashes resulted in more frequent and more severe injury. Of the 205 participants in the 80 crashes, 22 died, and 79 were admitted to hospital. One-fifth of the crashes involved a death. One driver died of drowning and two had signs of asphyxia, but in only one of these three cases was there an appreciable delay in help arriving. Head and chest were the common sites of injury causing death. Motorcycle riders had relatively few head injuries canpared to car occupants. Three cases of spinal cord injury were examined in detail as they show the importance of using appropriate restraints for children, and the importance of rollover protection for adult car occupants. There were four instances of post crash fire, only one involving an occupant who had received fatal injuries in the impact.

Conclusions

This study has demonstrated that it is possible to use 'at scene' investigation techniques to gather detailed information about rural as well as urban crashes. Rural crashes are qualitatively different fran urban crashes. Important factors involved in the causation of rural crashes are the high frequency of *loss* of directional control of vehicles due to interactions between the driver, the vehicle and the road and the road shoulder; the prevalence of elevated **BACs** in drivers; the low seat belt wearing rates: and the high frequency and severity of injuries relative to urban crashes.

Recommendations

The results of this investigation lead to the recommendations that:

1. programs be set up to increase the rate of seat belt wearing in rural areas, including increased enforcement:

2. programs be introduced to reduce the incidence of driving after drinking in rural areas. Particular attention should be given to increasing the effectiveness of random breath testing programs in rural areas:

3. further studies be undertaken to determine the respective roles of the road side shoulder, and tyre and vehicle characteristics in 'run off the road' crashes:

4. the centre front seating position be eliminated fran cars and car derivatives, because of the lack of effective head and upper torso restraint:

5. a regular program of on-scene studies of rural crashes be instituted to investigate particular mechanisms such as 3. above, to monitor the effects of 1. and 2. above, and to study new topics, such as the role of emergency services in reducing mortality and morbidity.

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INTRODUCTION

Crashes on rural roads now account for about 60 per cent of all road deaths in Australia. They also produce more severe injuries than crashes on urban roads. This is indicated by the fact that, in South Australia, almost 5 per cent of the reported casualty crashes on rural roads result in one or more fatalities, compared with 1.8 per cent in the metropolitan area[1]. Despite such telling statistics the rural road crash problem has been an overlooked aspect of road safety research in Australia. In 1985, in recognition of the need for research in this area, the Federal Office of Road Safety and the Road safety Division of the South Australian Department of Transport funded an in-depth study of a sample of rural crashes in South Australia as part of a more general study of rural crashes. The in-depth study, which is reported here, was carried out by the NH&MRC Road Accident Research Unit at the University of Adelaide. The Unit, through its studies of urban crashes, has developed considerable expertise in this investigation technique, and two of the authors were first engaged on work of this type 25 years ago[2,3].

AIMS

The broad objectives of the in-depth study were to:

1) Conduct a detailed examination of a sanple of out-of-town rural* road crashes to determine the causes and circumstances of such crashes:

2) Determine the injuries sustained by the participants in such crashes and also the mechanisms of injury production;

3) Identify and recommend appropriate countermeasures to reduce the number and severity of rural **road** crashes.

METHODOLOGY

INTRODUCTION

In-depth studies are one of the more effective means of obtaining the detail necessary to provide insights into the causal mechanisms of traffic crashes. The term "In-depth Study" is used to refer to that method of data collection whereby trained investigators attend the scene of the crash while the vehicles and crash participants are still present[4]. The investigators subsequently carry out such follow-up investigations as may be necessary for them to assemble a comprehensive and detailed account of the crash events, circumstances and consequences. This generally involves interviewing drivers, collecting injury data and a detailed examination of the crashed vehicles and the crash site.

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* For the purposes of this study a rural crash was defined as one occurring out-of-town in an 80 km/h or greater speed zone.

At the initial planning stage it was decided that the in-depth study team should be based in Adelaide. After talking to officers of the St. John Ambulance Service and tow truck operators servicing the area concerned, i.e. within a 100 kilometre radius of Adelaide, it was learnt that the damaged vehicles usually remained at the crash site for more than an hour after the crash. Therefore, it was decided that it would be feasible for an Adelaide-based team to attend crash sites within this area while the vehicles were in situ. This type of data collection has distinct advantages as it provides important information on the circumstances and kinematics of the crash that would otherwise be unavailable. It has the disadvantage of requiring at least one team member to be on call. This disadvantage was particularly marked in the present study in which an attempt was made to be on-call at all hours throughout the week.

NOTIFICATION

The study team was notified of rural crashes to which an ambulance was called by the St. John Ambulance Service. In almost every case these were injury-producing crashes.

Within urban Adelaide the ambulance service is cc-ordinated by a centrally located operations room. In the event of a traffic crash, an emergency call is placed directly to the operations room which, in turn, dispatches a vehicle to the scene. In the rural areas of South Australia the procedure is somewhat different. Usually, the local ambulance centre itself is contacted directly by a member of the public. Consequently the ambulance operations room in Adelaide is often unaware of the movements of rural ambulances. After discussions, it was agreed that rural ambulances dispatched to out-of-town crashes in the study area would contact the Adelaide operations room by radio. The central radio controller would then contact the study team through a paging service. In general this method of notification worked well, largely because of the willing support provided by the St. John Ambulance Association of South Australia.

Ambulance radios were fitted to the study team's vehicles. In addition to being able to contact the ambulance service by radio when notified of a crash the team members were also able to obtain additional crash information as it became available. This was of great assistance when locating crash sites and for early notification of ambulance calls which were found to be false alarms.

AT SCENE INVESTIGATIONS

The investigation of a crash was carried out by a two-person team comprising a physical scientist and a social scientist. One or both members of the study team was 'on-call' twenty four hours a day, seven days a week for the twelve month period fran early July 1986 to early July 1987, except between Christmas Day and New Year's Day.

On arrival at the crash scene the team members shared tasks. The physical scientist conducted an initial inspection of the vehicle, paying particular attention to those features that were likely to change when the vehicle was removed from the scene. This included items such as the positions of controls and tyre pressures. The physical scientist also photographed the interior of the vehicle, and noted its make and registration number, together with the name of the towing service removing it from the scene. The second team member took detailed photographs of the site and the vehicle(s) in its rest position. He also spoke to witnesses and energency service personnel at the scene to obtain an account of the crash and details of the crash participants and their destination on leaving the scene.

If uninjured drivers remained at the crash scene the social scientist also took brief statements from them, and made arrangements to conduct a more detailed interview at a later date. If the driver was willing, a breath alcohol reading was also obtained. In many instances, by the time the study team arrived at a crash scene all of the participants had gone, and so it was only possible to talk to drivers at the scene in a small number of cases. This reflects the long time involved in the study team travelling from the city, as well as the severity of the injuries resulting from rural crashes.

Usually, the last task performed by the study team at the scene of the crash was a careful inspection of the site, marking the final positions and orientation of the damaged vehicles, skid and gouge marks, and any other non-permanent features relevant to each crash. This information was later transferred to an accurate map of each site.

For most night-time and weekend crashes only one team member attended the crash scene. In these instances it was not always possible to collect as much information at the scene as was done when both team members attended. However, in every case the site and vehicles were photographed, the site features marked and details of the crash participants were obtained.

FOLLOW-UP INVESTIGATIONS

Interviews

A detailed interview was conducted with active participants, i.e. drivers and riders in charge of vehicles, as soon as possible after each crash. The aim of the interview was to collect data on the person's general characteristics and their recollection of events leading up to the crash and the crash itself. The interview schedule included self-reporting of crash and traffic violation records, licence status and driving experience, drinking behaviour, emotional state prior to the crash and familiarity with the crash site. Information was also collected on the injuries sustained by each crash participant, both through self-reporting of injuries and, where persons were admitted to hospital, by an examination of hospital case notes. Participants were also asked to state their final position after the crash and what they thought caused each injury they received.

In South Australia, each person apparently of or above the age of 14 years presenting to a hospital for treatment following a road crash is required to have a blood sample taken so that a blood alcohol estimation can be carried out. The results of these blood alcohol analyses were made available to the research team. Consequently, in most instances it was possible to get a measure of the blood alcohol concentration (BAC) of crash involved drivers and injured passengers.

Vehicle Inspection

The physical scientist conducted a follow-up examination of the damaged vehicles. These examinations, mostly conducted at the towing service's depot, took about two hours per vehicle. The aims of the inspection included the extent to which vehicle characteristics, in particular any defects and failures, may have contributed to the causation of the crash. Assessments were also made of the performance of the vehicle's safety features, particularly those required by the Australian Design Rules for Motor Vehicle Safety (ADRs).

Each examination included making a detailed record of the vehicle's specifications, equipnent condition and crash damage. A detailed photographic record of the interior and exterior of each vehicle was also made. Particular attention was paid to examining the interior of the passenger canpartment in order to identify areas of occupant contact. These data were collected in association with the injury information to provide a detailed picture of the mechanisms of injury production in each crash. Seat belts were also examined for stress marks indicating usage in the crash. This information was considered together with self-reporting of restraint use to obtain a measure of seat belt usage.

STUDY AREA

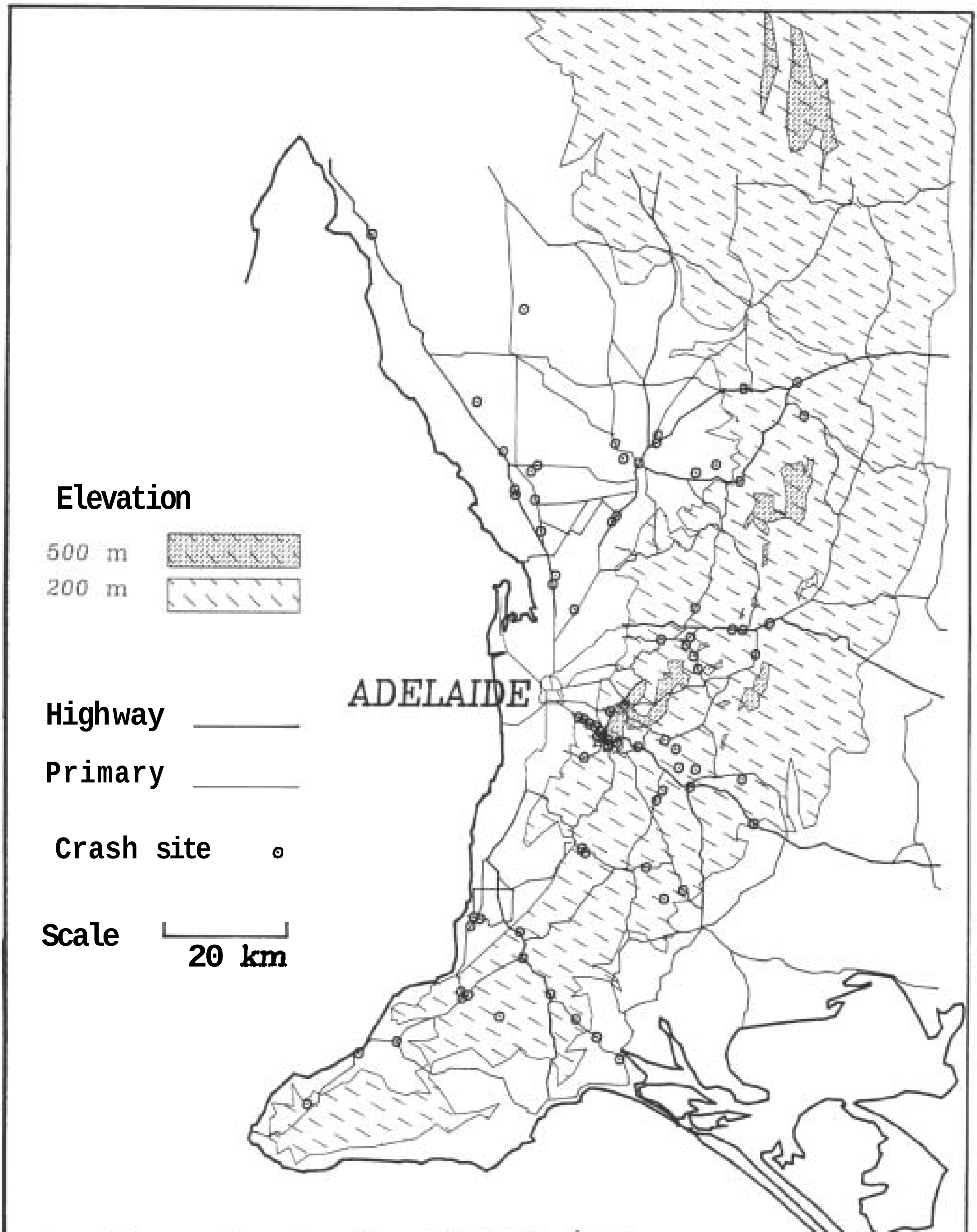
The study area extended for a radius of approximately 100 kms. around metropolitan Adelaide, and closely approximated the Outer Adelaide Statistical Division (Figure 1). It has an area of 11,722 sq. kms. of which **9,136** sq. kms. or **78** per cent, is used for agriculture[5]. It is also one of South Australia's most intensely settled regions with approximately 83 urban settlements, mostly concentrated in the Mt. Lofty Ranges area. In **1986** the study area contained approximately 6 per cent of the State's total population, a figure which has risen progressively in recent years.

Physically, the study area *may* be broadly divided into two regions. It is dominated by the Mt. Lofty Ranges which extend the length of the study area fran north to south and are effectively the eastern boundary of metropolitan Adelaide. These ranges make up approximately two thirds of the study area. In contrast, the northern and the south-eastern areas are coastal and river plains. Consequently the character of the road system in the area is also diverse, making it a particularly useful area for study. The plains areas feature long, straight, flat roads arranged in a grid, with right angle intersections. The Mt. Lofty Ranges, in contrast, are characterised by winding, undulating roads. In addition to the types of terrain that the roads traverse, the types of road themselves vary considerably. They range from formed and gravelled surfaces, particularly in the north and south-east, to the South Eastern Freeway which bisects the Mt. Lofty Ranges.

EQUIPMENT

Vehicles

Two vehicles were used by the study team, a VK Holden Commodore station wagon and an XF Ford Falcon station wagon. Because of the



Rural study 1986/87 (Figure 1.)

continuous 'on-call' status of the study team and the out of hours followup work required, particularly in relation to interviewing, each team member had sole use of one vehicle.

Both vehicles, painted white, were fitted with two revolving amber warning lights for use at crash sites. Each vehicle also had red reflective striping along the sides and across the rear, and the rear doors and tailgate of each carried the name of the NH&MRC Road Accident Research Unit. The Falcon also carried a telescopic mast for overhead photography of crash sites and vehicles.

Photography

Three 35mm SLR cameras were used: an Olympus OM2 with a 35-135mm Tamron zoom lens, an Olympus OM 10 with a 35-70mm zoom lens, and a Topcon Super DM with a 28m lens. The Topcon, fitted with a motor drive, was used solely for overhead photography.

Three electronic flash units were used; two Metz 32 CT4s and a Metz 60 CT2. One of the smaller Metz flash units was used by the physical scientist during the vehicle inspections and for flash photography of crashes at night when he travelled to sites alone. The 60 CT2 was used to photograph crash scenes at night, with the other Metz carried as a backup.

Fujichrome 100 ASA colour reversal film was used throughout with 400 ASA film being used at night.

Breath Alcohol Meters

Each vehicle carried a Lion Alcometer SD2 breath alcohol meter. This meter takes a breath sample as the subject exhales through an open-ended plastic tube, and provides a read-out of the subject's blood alcohol level to the nearest 0.005 gm/100 ml.

Each vehicle was also equipped with other accident investigation equipnent, a full list of which is shown in Table 1.

TABLE 1: List of Equipment Carried

In each vehicle:

6 orange plastic warning cones 740mm. high
crayons and yellow paint in spray cans (used for marking the position of vehicles, etc.)
sturdy boots
rubber boots
yellow wet weather gear
2 pairs of orange overalls
First aid kit
A set of 1:50,000 topographic survey maps of the study area
A 1:250,000 topographic survey map of the study area
photographic equipment
fire extinguisher
Two way radio tuned to St. John Ambulance frequencies
map light
white coats
tow rope
jumper leads
breath alcohol meter (Lion Alcolmeter SD-2)
tyre pressure gauge
3 metre tape measure

Falcon only:

plane table mapping equipment
tool kit
distance measuring wheel
100 metre tape measure

Commodore only:

radar speed measurement meter

RESULTS

THE SAMPLE

Between July 1986 and early July 1987, the St. John Ambulance Service responded to 577 calls to road traffic crashes in the study area. The study team was notified of 110 crashes, and attended 80 of these. This is a sample of 80/577 = 13.9%. The study team was notified of some calls which were 'malicious' false alarms or hoax calls to the ambulance service. Others were legitimate notifications but by the time the study team arrived the vehicle(s) had been transported from the scene. The vehicles had to be still at the scene when the team arrived €or the case to be included in the study. For fatal crashes, and the more severe and complex crashes such as those involving trucks, removal of vehicles took several hours. For less severe crashes and those close to towns, vehicles were removed relatively quickly and were less likely to be still present when the team arrived. Therefore, there was a tendency for severe and fatal crashes to be a little over-represented in the sample. The study team was able to investigate satisfactorily 72% of all incidents of which they were notified. Only one fatal crash was missed. This indicates that the effect of the selection bias is not large. Twenty-two crashes occurred in the plains in the north west of the study area, the remaining crashes occurred in, or about, the Mt. Lofty ranges area.

THE CRASHES

The 80 cases have been classified into five mutually exclusive groups, as shown in Table 2. Seventy per cent of the crashes involved loss of directional control, of which one-fifth resulted in collisions with another vehicle, i.e. the majority of the single vehicle crashes involved an impact with a fixed object. Most of the crashes involving motorcycles, forward control vans, four wheel drive vehicles, and cars were in this loss of directional control group. The majority (58%) of truck crashes, and 30% of car crashes did not result frcm loss of directional control. At least one death occurred in 16 of the crashes, 13 of which resulted from loss of directional control: 8 of the 13 involved impact with fixed objects. There were no pedestrians involved, and only one pedal cycle. Each group is discussed in more detail below. These findings are similar in general to the patterns of rural crashes found in an examination of police accident data by Armour[6].

Throughout the report blood alcohol concentration (BAC) is presented as gm/100 ml. The units are usually omitted.

Crashes Involving Motorcycles

There were nine crashes involving motorcycles in the sample (Table 3). seven of these occurred on curves. Two, involving collisions with other vehicles, occurred on straight sections of road while overtaking slower vehicles.

There were five crashes on left hand curves, in which the motorcyclist ran wide on the exit fran the bend and crossed the centre line, colliding with an oncoming vehicle in four cases. In two of these there were fatal injuries to the motorcyclist. In the two crashes on right hand bends the

TABLE **2:** Vehicle **Type** by Nature of Crash

Vehicle Type	Loss Of Directional Control: YES					NO				Grand Total
	Roll Over	Impact With: FO[1]	Impact With: Truck	Impact With: Car	Total	Impact With: PC[2]	Impact With: Other[4]	Impact With: Car	Total	
Motor-cycle	2	1	2[3](2)[5]	3	8(2)	.	1		1	9(2)
Forward control van	3	1		1	5			1	1	6
Four wheel drive vehicle	2	2(1)	.		4(1)			1	1	5(1)
Truck, semi-trailer	3	1(1)	.	1(2)	5(3)	1(1)		6(1)	7(2)	12(5)
Car	4	27(6)	.	3(1)	34(7)	.	.	14(1)	14(1)	48(8)
TOTAL	14	32(8)	2(2)	8(3)	56(13)	1(1)	1	22(2)	24(3)	80(16)

1 FO: fixed object, e.g. tree, pole, bank, gully

2 PC: pedal cycle

3 includes one bus

4 agricultural tractor with slasher attached

5 ( ): number of crashes with at least one death

TABLE 3: Crashes Involving Motorcycles

case NO.	Road: Curve Left	Road: Curve Right	Road: Straight	Make & Model	Crash Type	BAC	Comments
3	+			Honda CX 500	Car, front	0.0	From work
5	+			Honda GL 400	Truck, front	0.0	Curve tightens Fatal
25	.	+		Yamaha 650	Tree	0.0	
30	+			Yamaha FJ 1100	Bus, front	0.0	Rider fell from motorcycle before impact with bus Fatal
35	+			Kawasaki 21000	Slide down	0.08	Curve over crest
46			+	Honda XL 250	Tractor, rear	0.0	Overtaking, avoid-ing oncaning vehicle
48	+			Suzuki RG 250	Car, side	0.0	Curve Over crest
66			+	Kawasaki KR 250	Car, front	0.0	Overtaking, avoid-ing oncoming vehicle
68		+		Honda CB 750	Slide down	0.04	Curve over crest

motorcyclist again ran wide, off the left edge of the sealed road surface, with the motorcycle then sliding down (and hitting a tree in one case).

In four of the seven cases involving curves there was an environmental feature which misled the motorcyclist by disguising the sharpness of the curve. In two cases there was a crest immediately before, or at, the entrance to the curve: in one other case the curve became progressively tighter after the entrance: and in the remaining case, there was both a crest and a progressive tightening of the curve. At several of these sites, marks of other similar crashes could be seen, showing that the crashes investigated were not isolated cases.

Other noteworthy features of these crashes included the fact that the majority of trips were recreational, only one rider was returning fran work and he had chosen that particular route because it was more enjoyable. Only two of the nine riders had positive blood alcohol concentrations, of 0.04 and 0.08 respectively. The age distribution was typical for motorcycle riders - two aged less than 20 years, six fran 20 to 24 years and one aged 26 years. All were males. As mentioned before, two riders were killed, three sustained moderate injuries and the remainder minor injuries.

In seven of the nine crashes, riders were unfamiliar with the road. Consideration of these crashes suggests that the motorcyclists were misled by the design features of the vertical and horizontal alignment of the road, and thereby entered the curve at too high a speed to negotiate it at all, let alone at a speed which would enable them to avoid, say, a broken down vehicle. As a result they subsequently crossed the centre line or ran off the road altogether and collided with other vehicles or fixed roadside objects.

Crashes Involving Forward Control Vans

There were six crashes in which forward control vans were involved (Table 4). **None** of the drivers had a positive BAC. One (Case 55) was a collision at an intersection on an arterial road which occurred when the hydraulic brake line of a VW Kombi developed a crack with subsequent loss of pressure, before an impact with a car.

The remaining crashes involved loss of directional control, two on left curves, one on a right curve, and two on straight sections of road. In Case 13, a Mitsubishi L300 van crossed a raised median strip on a left hand curve and collided with an oncoming car. There were three instances of rollover: in two, the left wheels moved off the edge of the bitumen leading to uncontrolled yawing and rollover: in the third, a loaded trailer towed by an empty van began to sway causing the van to leave the road and subsequently roll over. In one other similar crash of a van towing a trailer, rollover did not occur, but the van and trailer left the road and hit a pole.

Crashes Involving Four Wheel Drive Vehicles

Four wheel drive vehicles were involved in five crashes (Table 5). One driver had a positive BAC. One case occurred at the intersection of minor roads when a Subaru Brumby utility collided with a car. The remainder were on curves or straight roads.

TABLE 4: Crashes Involving Forward Control Vans

Case No.	Make & Model	Curve Left	Curve Right	Straight	Inter-section	Off Road To Left	Off Road To Right	Crash Type	BAC	Comment
13	Mitsu-bishi L300	+					+	Car	0.0	Raining, downhill
49	Nissan Vanette			+		+*		Rollover	0.0	-
51	Mitsu-bishi L300			+		+*		Rollover	0.0	-
55	VW Kombi				+			Car	0.0	Brake *line* cracked before crash
62	Toyota Hi Ace, trailer		+				+	Rollover	0.0	Van empty, trailer loaded
71	Toyota Tarago, trailer	+					+	pole	0.0	Road wet

* left wheels on shoulder

TABLE 5: Crashes Involving Four Wheel Drive Vehicles

Case No.	Make & Model	Road: Curve Left	Road: Curve Right	Road: Straight	Accident: Inter-section	Accident: Off Road To Left	Accident: Off Road To Right	Crash Type	BAC	Comments
16	Toyota Hilux		+			+	.	Rollover into gully	0.138	Fatal
21	Holden Jackaroo & trailer			+		+	.	Rollover	0.0	Avoiding other vehicle
43	Toyota Hilux		+			+*	.	Tree	0.0	
56	Subaru Brumby utility	*	*		+		.	Car	0.0	
76	Daihatsu			+		+	.	Rollover	0.0	Avoiding other vehicle, lug tyres, road wet

* Left wheels on shoulder

The driver (Case 16) with an elevated BAC (0.138) was killed when the vehicle landed on its roof having rolled over during a 15 metre drop into a gully. It had gone off the road to the left on a slight right hand curve. One vehicle (Case 43) collided with a tree after crossing the centre line during a series of uncontrolled yaws resulting frun attempts to regain the bitmen surface after the left wheels went off the left edge on to the shoulder. In two cases, (21, 76) rollovers resulted from a violent turning manoeuvre to avoid another vehicle. These last two cases are consistent with claims that the stability of sane four wheel drive vehicles is not adequate under these conditions.

Crashes Involving Trucks

This section includes crashes involving trucks, both rigid and articulated, and prime movers. A collision between a motorcycle and a dump truck (Case 5) and another between a motorcycle and a bus (Case 30) have been included in the motorcycle group. It is notable that all of the 12 crashes of trucks considered here occurred fran Monday to Friday and all were related to the driver's work. No alcohol was reported in any of the drivers involved (Table 6).

Table 7 summarizes the types of truck involved.

Five crashes involved trucks leaving the roadway, two on straight sections, three on left hand curves. In three of these five crashes the truck rolled over after leaving the road. All three trucks were loaded. The reasons for some of these crashes were unclear, in part because of the reluctance or refusal of the drivers and/or owners of the companies involved to be interviewed. There are indications that sane combination of driver fatigue, loss of concentration, and speed, particularly in the two downhill crashes, was involved.

In crashes on right hand curves on the other hand, it was clear that in each case another vehicle, travelling in the opposite direction, crossed the centre line and collided with the truck. In the most serious of these incidents the right side of a car struck the right front corner of the box bcdy of a rigid truck and caused the truck to yaw clockwise, roll on its left side and catch fire. The driver of the car, who sustained fatal head injuries, had a BAC of 0.142 at 6 a.m., the time of the crash.

There were four collisions at intersections, or at breaks in the median of a divided highway. Three involved cars making right turns, and in the fourth, a car struck the rear wheels of a semi-trailer which was stationary while waiting to turn right through a gap in a median.

The final crash involved a semi-trailer striking the rear of a bicycle at night. The bicycle had no lights, and the rider had a BAC of 0.166.

Crashes Involving Cars

There were 48 crashes classified as car crashes (Table 8). They included car derivatives such as utilities. There were 13 other crashes in which cars were involved but which have been discussed under one of the preceding headings.

TABLE 6: Crashes Involving Trucks

Case No.	Road: Curve Left	Road: Curve Right	Road: Straight	Road: Intersection	Crash Type	Rollover Of Truck	BAC Truck Driver	Comments
6			+	+	Semi-trailer into rear of Holden HJ		0.0	
10			+	+	R. front of semi-trailer into R. front of VW Golf	+	0.0	
20		+			R. side International truck into R. side of Holden Monaro	+	0.0	Fatal Post impact fire in truck Car driver BAC 0.142
24	+			.	Leyland truck off road	+	0.0	Down hill
27		+		.	Scania semi-trailer, Falcon XD		0.0	Car struck R. rear wheels of trailer
33			+	+	Semi-trailer, Holden HJ	.	0.0	Car struck R. rear wheels of trailer
34			+	.	White semi-trailer, pedal cycle	.	0.0	Fatal Cyclist BAC 0.165
50			+	.	International Prime Mover	.	0.0	Fatal* Off right side of road into pole
58	+				Ford Louisville truck and trailer	+	0.0	Off right side of road
60			+	+	Kenworth semi-trailer, Holden Camira		0.0	Fatal Truck struck R. front of car

* Truck driver

TABLE 6: (cont)

Case No.	Road: Curve Left	Road: Curve Right	Road: Straight	Road: Inter-section	Crash Type	Rollover Of Truck	BAC Truck Driver	Comments
67	+				Semi-trailer struck 4 cars		0.0	Fatal *Off* R. side of road, crushed car beneath prime mver
73			+		Mack seni-trailer	+	0.0	*Off* left side *of* road

TABLE 7: Types of Truck

Type of Truck	Number
Articulated semi-trailer	8
Rigid body truck	2
Rigid body with trailer	1
Prime mver alone	1
TOTAL	12

TABLE 8: Crashes Involving Cars

Loss of Directional Control and Road Section

Loss of Direction Control	Road Section			Total
	Straight	Curve	Intersection	No. (%)
Yes	11	23	0	34 (71)
No	3	1	10	14 (29)
Total	14	24	10	48 (100)

Crashes of cars on rural roads can be classified into two groups: those involving **loss** of directional control of a vehicle, and those in which this did not occur. Evidence of loss of directional control in this sample was assumed when, without any prior collision, the car left its lane unintentionally, i.e. went of€ the left side of the roadway, or crossed the centre line.

The **48** car crashes have been further divided into the following groups: those occurring at intersections, those occurring on straight sections of road and those occurring on curves. The ten crashes at intersections did not involve any cases of loss of directional control. Three of the 14 crashes on straight sections of road, and one of the **24** on curves also did not result from a car losing directional control (Table **8).**

Intersection Crashes

There were two broad groups of crashes at intersections. One, at intersections on arterial roads, involved cars making turns, while the other, at intersections of minor roads, involved cars travelling straight ahead, across the intersection.

Six cases occurred at an intersection of an arterial road or highway with a lesser road. In five of these, one car was making a turn. Four were turning right and one, left. In the remaining case both vehicles were travelling straight ahead when they collided at the intersection. This was in contrast with the four crashes at intersections where both roads were minor, or not arterial roads. In three of these, both vehicles were travelling straight ahead (see, for example, Case 01), and in the fourth, one car was turning right. In Case 65, where both cars were travelling straight ahead, three occupants were killed. Positive BACs **were** recorded for two of the drivers in the crashes at intersections on arterial roads and for none of the drivers in crashes at intersections on minor roads. There seemed to be an assumption on the part of the drivers in these latter cases that the road they were using had sane kind of priority and/or there would be no traffic on the intersecting road.

Crashes on Straight Sections of Road

In 11 of the 14 crashes on straight sections of road the car ran off the roadway to one side of another, with a subsequent collision with a fixed object and/or, rollover (Table 9). The three remaining cases were collisions between cars. In Case 19 a car doing a U-turn collided with another. In Case 42 an overtaking car struck the side of the car it was attempting to pass, both going off the road. One of these cars then struck a tree and the other rolled over into a gully. The third case occurred when a utility stopped to avoid a cow on the road, and was struck in the rear by a car tawing a horsefloat (Case 79).

In the 11 cases where a car left a straight section of road, six went off to the left and five to the right. Ten struck trees, poles or embankments, while in one case rollover was the major event. In one case (No. 40) a car rolled over after striking a tree.

A variety of factors played a major role in precipitating the loss of directional control in these 11 crashes. Four drivers had elevated blood alcohol levels; one driver appeared to have fallen asleep just before leaving the road; in one case, a violent turning manoeuvre to avoid another vehicle caused the car to leave the road; in two cases tyres deflated, one rapidly, one slowly, leading to difficulty in control, and in one case the road was wet.

A particular pattern of events became evident on examination of the six cases in which leaving the road on the left side was the initial event. In two of these, when the left wheels went off the edge of the bitumen onto the shoulder, which was often gravel, the driver then turned the steering wheel sharply to return to the bitmen surface. This led to the vehicle then yawing rapidly clockwise as the front wheel regained the bitumen. If this yaw **was** not corrected the vehicle then left the road on the right side usually to strike a fixed object or roll over.

Often, the driver over-corrected this initial yaw by turning in the opposite direction, which led to a further yaw anti-clockwise, with the car leaving the road on the left side again. This pattern of difficulty in control after the left side wheels left the road was found to a larger extent in crashes on curves.

Crashes on Curves

There were 24 car crashes which were associated with curves in the road. All except one (Case 53) involved a car leaving the road; in this one case, two cars collided head-on as one overtook a third car on a curve. Of the remaining 23 cases, seven (30 per cent) occurred on left hand curves, and sixteen on right hand curves (Table 10).

In all of the seven crashes on left hand curves, the car crossed the centre line. Two of these cars collided with a car travelling in the opposite direction, two collided with trees, one collided with an **embank-**ment, one ran into a gully, and one collided with a railway carriage used as a museum. Three of these drivers had been drinking heavily, their BACs being 0.137, 0.261, and 0.158 gm/100 ml. Two of the seven drivers had been smoking cannabis (one of these also had an elevated BAC), and one driver was thought to have been taking large doses of sedatives. Only one crash involved a wet road. In summary, five of the seven crashes on left curves involved alcohol or other drugs, one involved a wet road, and for one there was no obvious explanation.

Of the 16 crashes in which cars left the road on right hand curves, three cars initially crossed the centre line, and 13 others initially went off, or partly off, the left side of the road. The cars going off to the right struck an embankment in one case, a tree in another, and a road sign in the third *(see,* for example, Case 23).

Of the 13 cars initially going off the left side of the road, in six cases the left wheels went of€ the edge of the bitumen on to the shoulder, and the driver's attempt to return to the bitumen surface caused a series of more or less uncontrolled yaws resulting in the car either colliding with another vehicle travelling in the opposite direction (Case 38), or leaving the road on the right side (Cases 23, 29, 39, 47). Therefore, in five of the six cases where the initial event was the left side wheels leaving the left edge of the road surface, the car ultimately went off to the right.

Seven of the car drivers in the 16 crashes where cars left the road on right hand curves had an elevated BAC, six being above 0.100 gm/100 ml. Objects struck during the crash sequence in these cases included embankments (4 cases), a gully or creek bed (2 cases), a tree or pole (6 cases), another car (1 case), and there was rollover alone in 3 cases. Five of these crashes resulted in fatal injuries to one or more occupants.

TABLE 9: <u>Crashes Involving Cars on Straight Sections of Road</u>

Case NO.	Off Road To Left	Off Road To Right	Crash Type	BAC	Comments
04	+		Tree	0.250	Fatal
08	+		Bank	0.0	Wet
09		+	Tree	0.042	
11	+		Tree	0.0	Tyre deflated
15		+	Tree	0.099	
18		+	Pole	Not known	Stolen
19	*		Car	0.0	Head on during U-turn
40	+		Tree	0.214	
41		+	Wall	0.0	Avoidance
42			Car	0.0	Side swipe, same direction, subsequent collision/rollover
44	+*		Pole	0.0	
45	+		Rollover	0.0	Tyre deflated rapidly
54		+	Fence	0.0	Fatigue
79			Car/horse float	0.0	Rear end, car stopped for cow on road

* left wheels on shoulder

TABLE 10: <u>Crashes Involving *Cars* on Curves</u>

Case No.	Curve To Left	Curve To Right	Off Road To Left	Off Road To Right	Crash Type	BAC	Comments
07	.	+		+	Sign	0.0	Wet
12	+			+	Bank, rollover	0.0	Wet
14	.	+	*	+	Bank	0.0	Wet
17	.	+	+		Rollover	0.025	
22	+		*	+	Tree	0.137	
23	.	+	+*		Creek,rollover	0.206	Fatal
29	.	+	+		Tree, rollover	0.142	Tyre
32	+			+	Railway carriage	0.261	
36	+			+	Trees	0.0	Fatal, Medication
37	+		*	+	Gully, rollover	0.158	Cannabis, rear axle locator separated
38	.	+	+*		Car	0.0	Fatal
39	.	+	+*		Rollover	0.0	
47	.	+	+		Pole, rollover	0.0	Fatal
52	+			+	Car	0.0	
53	.	+			Car	0.0	Head on, car over-taking
59	.	+	+		Rollover	0.142	
61	.	+	+		Bank, rollover	0.0	
63	.	+	+		Bank	0.112	Cannabis
64	+			+	Car	0.0	Cannabis
70	.	+		+	Tree	0.050	
72	.	+	+		Tree, rollover	0.0	
74	.	+	+		Tree	0.0	Fatal. *wet*
75	.	+	+		Bank, gully	0.0	
77	.	+	+		Gully, rollover	0.160	

* left wheels on shoulder

CHARACTERISTICS OF ACTIVE PARTICIPANTS

The term 'active participant' refers here to a person who was in control of a vehicle, whether it was a pedal cycle, motorcycle, car or truck (there were no pedestrians in this sanple of crashes).

Each surviving active participant was interviewed as soon as possible after the crash, on average after abut five days. All interviews were conducted by the same person, and lasted from forty minutes to three hours. The content of the questionnaire which was used is outlined in Table 11. of the 116 active participants, 100 (86.2%) were interviewed, three refused, one driver of a stolen car was not found and 12 were fatally injured. Most (74) of the interviews took place at the respondent's home, but 9 persons were interviewed in hospital, 8 at work, 6 were interviewed by phone, and one at the site of the crash. One interview took place in a motel, and one in a park. This latter arrangement was made to accommodate the wishes of the respondent for privacy. In all but three cases, some information was available about the participant from other sources, such as friends, relatives, coroner's reports etc., so that 113 cases were available for analysis. Not all of the requested information could be obtained from all of the respondents, so the total number of cases varies in the following tables.

Age and Sex

The age and sex distribution of the active participants is shown in Table 12. Over one-third were less than 25 years of age, more than half were less than 30 years, and one-eighth were over 60 years. The last group were all car drivers. There were no female motorcycle riders or truck drivers. Females, who comprised 30% of car drivers, had a very similar age distribution to males.

Marital Status

About half (50.4%) of the active participants were unmarried. This is almost double the figure €or the South Australian population aged over 14 years.[8] The next largest group, (41.6%) were persons either married or living in a de facto relationship. Of the remaining 7.1%, all but one, who was a widow, were divorced or separated.

Education Level

The majority (82.2%) of active participants had no post-secondary education qualifications (Table 13). Three-quarters of these, constituting a majority in all road user categories, had left the education system after completing only three or four years of high school. There were two males, an elderly retired fanner and a European immigrant respectively, who had only primary schooling.

Occupation

Seventy-five (66.4%) of the active participants were employed in the labour force (Table 14). Almost two-thirds (64%) of these were employed in 'blue collar' occupations, notably in the 'transport, tradesmen, production process workers' category. By comparison, 38.3% of the South Australian population in 1986 was employed in 'blue collar' occupations.[8]

TABLE 11: Structure of the Active Participant Questionnaire

1) Demographic and socio-economic characteristics.
2) Description of the crash.
3) Visual and auditory acuity.
4) Sleep pattern and fatigue level.
5) Smoking behaviour.
6) Alcohol consumption pattern.
7) Consunption of other drugs or intoxicants.
8) Health status and medical conditions.
9) Driving and licensing experience.
10) Emotional state.
11) Secondary activities.
12) Crash avoidance procedures attempted.
13) General attitudes to existing penalties for traffic offences, opinion on drink driving and own behaviour, attitude to compulsory restraint use, desired vehicle characteristics, effect of the crash on driving attitudes and behaviour.

TABLE 12: Active Participants, Age, Sex and Vehicle Type

Vehicle Type		Age (years) 16-24	25-29	30-39	40-49	50-59	60+	Total	Male (%)
Motorcycle		6	3	0	0	0	0	9	100.0
Car		30	9	11	9	4	14	77	70.1
Truck		4	2	4	2	2	0	14	100.0
Forward Control Van		0	4	2	0	0	0	6	83.8
Four Wheel Drive		2	0	1	1	1	0	5	80.0
Other		0	0	1	1	0	0	2	100.0
Total	N	42	18	19	13	7	14	113	77.9
	%	37.2	15.9	16.8	11.5	6.2	12.4	100.0	

Note: the minimum licencing age is 16 years in South Australia

TABLE 13: Education Level

Highest Education Level	Number	%
secondary School	88	18.6
Trade Qualification	11	9.8
Tertiary	5	4.5
Current Tertiary	4	3.6
Current Secondary	2	1.8
Primary School	2	1.8
Total	112	100.0

TABLE 14: Occupational Classification

Occupation	Number	%
Transport/Trades	42	31.2
Clerical/Sales	12	10.6
Professional/Admin.	9	8.0
Service, Sport, Rec.	6	5.3
Farmers, Fishermen	6	5.3
unemployed	9	8.0
Not in Labor Force	29	25.7
Total	113	100.0

TABLE 15: Restraint Use by Driver by Type of Vehicle

Type of Vehicle		Restraint: Worn ELR*	Worn 3 point static	Worn Sash only	Not worn	None available	Total
Car	N	31	22	1	22	1	77
	%	40.3	28.6	1.3	28.6	1.3	100.0
Truck	N	-	-	-	6	8	14
	%				42.9	57.1	100.0
Forward Control Van	N	1	-	-	5	-	6
	%	16.7			83.3		100.0
Four wheel drive	N	3	-	-	2	-	5
	%	60.0			40.0		100.0
Other	N	-	-	-	-	1	1
	%					100.0	100.0
Total	N	35	22	1	35	10	103
	%	34.0	21.4	1.0	34.0	9.7	100.0

* Emergency Locking Retractor

Twenty-seven active participants were employed in 'white collar' occupations. Most of these, however, were in low status occupations such as sales and clerical employment. Eight active participants, all women, classified their occupation as 'home duties'. A further nine active participants, all but one of whom were male, were unemployed. Eleven active participants were retired, a further four were receiving social security benefits, and there were six students.

Birth place

Three-quarters of the active participants were born in Australia. This figure is almost identical to that for the South Australian population.[8] Of the remainder, m s t were born in the United Kingdom. There were also three people born in Italy, two born elsewhere in Europe and two born in New Zealand. Altogether, 95.4% of the active participants were born in English speaking countries.

RESTRAINT USE

Fifty-eight (56.3%) of the 103 drivers of all types of vehicle reported wearing a seat belt at the time of the crash (Table 15). Most of these (60.3%) were wearing an emergency locking retractor (ELR) seat belt, with 22 (37.9%) wearing a static 3 point seat belt, and one person wearing a sash belt only. Of the 45 drivers not wearing a seat belt, in 10 cases there was no restraint fitted, eight trucks, one car, and one tractor.

Seat belt wearing was much higher amongst women, 72.0% of 25 women drivers were wearing seat belts compared with 51.3% of male drivers.

Examination of wearing rates by age revealed that slightly fewer drivers under 30 years were wearing seat belts (Table 16). Altcgether, about one-third of drivers were not wearing the seat belts fitted to their vehicle. This is a lower rate than for urban drivers, but is typical of drivers not involved in crashes in the rural areas of South Australia.[9]

There is an association between a positive blood alcohol concentration and not wearing a seat belt (Table 17). About 80% of drivers with zero BAC were wearing a seat belt, compared with 30% of those with a BAC above the legal limit. Put another way, sober drivers were almost ten times more likely to be wearing a seat belt.

Comparing seat belt wearing across road user types indicates that the lowest wearing rates were amongst truck drivers. None of the 14 truck drivers who had a belt available, said that they were wearing the belt at the time of the crash (Table 15). In eight cases truck drivers reported that there were no seat belts fitted to their vehicle. In at least one of these the vehicle inspection revealed that a seat belt had been fitted but had been removed. These drivers reported that even if seat belts had been fitted, they would not have been *worn.*

Reasons for Non-Use

Drivers' stated attitudes to compulsory seat belt wearing was strongly reflected in their belt-wearing behaviour. Two-thirds of the drivers who said that the decision to wear a seat belt should be up to the individual were not wearing a seat belt. Conversely, 87% of drivers who thought that compulsory wearing of seat belts was a good idea were wearing a seat belt (Table 18).

Truck Drivers

The reasons given by truck drivers for non-use of seat belts can be summarized under two headings: seat belts are uncomfortable to wear in trucks, and they are dangerous in crashes. For the first reason drivers stated that the sash strap was often mounted too low so that it did not pass across the shoulder but rather across the upper arm. Drivers also commented that with suspension seats, as the seat moved up and down so the inertia reel belt gradually became tighter and tighter.

All truck drivers said that seat belts were dangerous in crashes as drivers could be trapped in their cabs. They said that in the event of being involved in a crash they did not want to be held fast in their seats. Most said they wanted the option of being able to jump clear of their vehicle and wearing a seat belt would reduce their ability to do that. All the truck drivers had anecdotes of people that they knew who they considered would have been killed or seriously injured had they been wearing a seat belt and therefore not been able to jump clear of their vehicle. It is interesting to note, however, that in none of the truck crashes in this sample did drivers attempt to leave their vehicles during the crash. In two cases, the truck driver required extrication after the impact, but in neither case was a seat belt worn.

The attitude and behaviour of truck drivers to seat belt wearing contrasts with that of motorcyclists to the compulsory wearing of crash helmets. All nine motorcyclists were wearing helmets and all agreed that they were a valuable item of crash protection.

other Drivers

Twenty-two (28.6%) car drivers were not wearing a seat belt, nor were five out of the six forward control van drivers and two of the five people driving a four wheel drive vehicle. Again, the most frequently given reasons for non-usage were that seat belts were dangerous in crashes as they inflict injuries and trap drivers within their vehicles. In most cases, those drivers not wearing a seat belt because they considered that belts were dangerous, cited evidence which they considered supported their claim. One driver, for instance, reported that he had witnessed a person incinerated in their crashed vehicle. He said that they had been trapped in their vehicle by their seat belt. The driver of a car which collided with another car and then sideswiped a utility pole, stated that he was glad that he had not been wearing a seat belt because in his opinion if he had been he would have sustained serious injuries (Case 31). He said that when he realized the right side of his car was going to collide with the utility pole he moved out of the driver's seat and sat on the centre console where he braced himself for impact. This movement could not have been made in the time between the two impacts. This is an example of post-hoc justification.

A female who received serious thoracic injuries when the car she was driving struck a tree, reported that she had not been wearing a seat belt

TABLE 16: **Restraint Use and Age of Driver***

Age		Seat Belt Worn	Seat Belt Not worn	Total
Less than 30 years	N	28	15	43
	%	65.1	34.9	100.0
30 years and over	N	30	12	42
	%	71.4	28.6	100.0
Total	N	58	27	85
	%	68.2	31.8	100.0

* Excludes truck drivers

TABLE 17: **Restraint Use and BAC of Driver***

Restraint use	BAC (g/100 ml) Nil		0.001-0.079		0.08+		Total	
	N	%	N	%	N	%	N	%
Worn	52	78.8	1	25.0	4	28.6	57	67.8
Not Worn	14	21.2	3	75.0	10	71.4	27	32.1
Total	66	100.0	4	100.0	14	100.0	84	100.0

* Excludes truck drivers

$x^2 = 12.2$ $p < 0.01$ BAC nil v. BAC positive

TABLE 18: Restraint Use and Attitude to Seat Belt Wearing of Drivers*

Restraint use	Attitude to Ccmpulsory Wearing of Seat Belts					
	In favour		Against		Total	
	N	%	N	%	N	%
Worn	47	87.0	7	33.3	54	72.0
Not worn	7	13.0	14	66.7	21	28.0
Total	54	100.0	21	100.0	75	100.0

* Excludes truck drivers

TABLE 19: Driver's Restraint Use by Position in Vehicle After the Crash*

Restraint Use		Remained seated	On floor	Front to rear	Partial ejection	Complete ejection	Total
Worn	N	56	1	1	-	-	58
	%	96.6	1.7	1.7			100.0
Not worn	N	9	16	2	1	2	30
	%	30.0	53.3	6.7	3.3	6.7	100. 0
Total	N	65	17	3	1	2	88
	%	73.9	19.3	3.4	1.1	2.3	100.0

* Excludes truck drivers

because she had heard of people wearing seat belts who had been killed (Case 22). She did not consider that she would have been less seriously injured had she been restrained. She also reported that when she drove in an urban area she draped the seat belt over her shoulder so that it would appear she was wearing it. In a further case a car driver involved in a side impact collision at an intersection had not been wearing a seat belt but her teenage son sitting in the rear had *(Case* 56). She claimed that after the collision his seat belt could not be unfastened and had to be cut to remove him. She said that this incident vindicated her belief that seat belts were unsafe. In this case the vehicle came to rest on its side, which would have made the seat belt buckle difficult to reach, but not undo. The above statements by drivers are evidence of gross under estimation of the forces acting in a collision, and probably represent one or more psychological defense mechanisms.

The next most frequent reason given for not wearing a seat belt falls under the rubric of 'I'm ok, nothing is going to happen to me'.

One of the sample of forward control van drivers not wearing a seat belt was a courier (Case 13). He reported that in his type of job where he was continually stopping and getting in and out of his vehicle it was a nuisance to wear a seat belt. He also said that most courier van drivers did not wear a seat belt for similar reasons.

Another forward control van driver, whose vehicle rolled after leaving the road, stated that she had been wearing a seat belt but when the vehicle began to roll she unfastened it and crouched down (Case 49). She said that she did this because she was afraid that if she remained seated upright the roof would be crushed on top of her and she would be seriously injured. A male driving a four wheel drive vehicle which rolled after striking an embankment also reported,that he undid his seat belt and lay across the front seats when he realized that the vehicle was going to roll (Case 76).

These two explanations are probably rationalizations to explain the seat belt being undone, since the sequence of events would be *so* rapid that it would be unlikely €or the drivers to have time to carry out the claimed actions.

Post-impact Position, Ejection, and Restraint Use

Drivers were asked to indicate their final position in the vehicle after the crash. All but two of the 58 restrained drivers remained in their seat compared with less than half of the unrestrained drivers.

Unrestrained Drivers

Of those not wearing seat belts, 16 (53.3%) said they came to rest partially on the seat and partially on the floor, 2 (6.7%) were thrown fran the front to the rear, 1 was partially ejected and 2 were completely ejected (Table 19). The first partial ejection was of a car driver through the left front door when his vehicle struck a tree (Case 42), and the second involved a truck driver who was partially ejected through the windscreen when his vehicle struck a steel and concrete utility pole (Case 50). Two unrestrained drivers reported being canpletely ejected. In Case 15, a car driver, who claimed to have fallen asleep, was ejected through the front left door onto the road shoulder when his car ran off the road and struck a tree. In Case 37, the driver of a utility which ran off the road and rolled into a ditch was ejected via the right front door onto the road shoulder.

Restrained Drivers

There were two restrained drivers who *came* to rest out of position after the crash. In Case 20, the driver was wearing a static 3 point seat belt and came to rest on the back seat. His car had been fitted with a non-standard seat mounted on improvised rails. The seat failed in a side-swipe impact with a truck, which tore off the A and B pillars and the right side of the roof. In the second case (Case 38), the young male driver was wearing a retrc-fitted, static, 3 pint seat belt which failed during the impact on the front of the left side of the car. He said that he cane to rest partially on the floor of the car with his head in the driver's footwell. Examination of the seat belt webbing showed it to be unacceptably deteriorated. The seat belt was worn loosely, which together with the deterioration, caused the final failure of the webbing which occurred where the running loop passed through the buckle. In the other car in this **sane** collision, the webbing of the driver's emergency locking retractor seat belt also failed, the driver striking the steering wheel with his face. It is assumed that the seat belt provided a significant level of protection in the initial stage of being loaded, before failure occurred. The failure may have occurred because the webbing passed around a sharp metal structure on the bench seat.

These two cases suggest strongly that restrained occupants who come to rest out of their normal seated position have been the subject of equipnent failure during the impact.

Entrapment and Extrication

Review of the cases in this survey did not find any instance where an occupant was trapped in a vehicle by a seat belt. There were six cases where a seat belt was cut to ease access, but often this was done unnecessarily as the seat belt buckle could be operated normally. There were 13 cases where occupants required extrication. Sometimes this was merely using force to open doors jammed shut, and in other cases the vehicle was virtually dismantled, with emergency service personnel using metal cutting equipment, and powerful jacks. Usually in these cases the lower limbs were caught by intrusion of vehicle structure into the occupant space.

ALCOHOL

Active participants were asked to report the amount of alcohol they had consumed in the 24 hours prior to the crash. The amount was defined in terms of the number of glasses of alcohol consumed, each glass being equivalent in terms of alcohol to one 702 glass of beer.

Of the 108 active participants for whom alcohol consumption information was available, 48 (44%) reported that they had consumed some quantity of alcohol in the 24 hours prior **to** the crash. Of this number, 37 had drunk alcohol within 12 hours of the crash and 30 within 6 hours. When asked how much they had consumed, 58% reported drinking between 1 and five glasses, 22.9% reported drinking between six and ten glasses, and 18.8% more than 10 glasses.

Beer was by far the most popular type of alcohol, being consmed either alone, or with wine or spirits, by three-quarters of those who had been drinking. Just over a quarter had been drinking spirits, and half that number, wine (Table 20).

A hotel was the place of drinking for almost half of the drivers, followed in frequency by their own home, or the home of a friend or relative (Table 21). Four drivers had been drinking in their cars as they were driving, and a further two had been drinking while parked.

Blood Alcohol Concentration

The Forensic Science Centre routinely analyses blood samples to obtain the blood alcohol concentration (BAC) of all persons aged 14 years and over involved in a motor vehicle crash in South Australia who attend hospital. BACs were available for 78 of the 113 active participants. In the remaining cases a blood sanple was either not available or it was not possible to match the active participant with the lists from the Forensic Science Centre.

For the 32 active participants €or whom a BAC measurement was not available it was possible to estimate a BAC at the time of the crash by considering the amount of alcohol consmed and the time elapsed between the time of drinking and the crash. Only two of these drivers were estimated to have had a positive BAC, (greater than zero) at the time of the crash, the remainder were all judged to have had a zero BAC. Table 22 shows the results of the combined BAC measurements and estimates.

Eighty-one percent of the active participants had a zero BAC. Sixteen of the 21 drivers or riders with a positive BAC exceeded 0.08 g/100 ml, the legal limit in South Australia, about half this number being above 0.150 g/100 ml. More than three-quarters of the drivers with a positive BAC were above 0.08.

Canparison of the BAC of the different road user categories reveals that 17 of the car drivers (23.0%) had a positive BAC, as did two motor-cyclists (22.2%), one person driving a four wheel drive vehicle (20.0%), and the one cyclist. None of the truck or forward control van drivers had a positive BAC.

A positive BAC was associated with a crash occurring at night. Four (5.1%) of the 79 drivers and riders involved in day time crashes had a positive BAC, compared with 17 (54.8%) of the 31 involved in night-time crashes.

BAC, *Sex* and Age

Only two of 25 female drivers had a positive BAC compared with 19 of 86 male drivers. Both females were aged less than 20 years. More than half of the males with a positive BAC were aged 30-49 years (10 of 19 cases) and approximately one-third (6 cases) were aged 20-24 years (Table 23). Fifteen of these 19 cases had BACs above the legal limit. None of the drivers over 60 years of age had a positive BAC.

TABLE 20: Type of Alcohol Consumed

Type of Alcohol	No.	%
Beer	28	58.3
Wine	4	8.3
Fortified Wine	1	2.1
Spirits	6	12.5
Beer and Wine	1	2.1
Beer and Spirits	7	14.6
Wine and Spirits	1	2.1
Total	48	100.0
Did not drink	60	

TABLE 21: Location of Alcohol Consumption

Location	NO.	%
Home	9	18.8
Friends/Relatives	10	20.8
Restaurant	1	2.1
Club	2	4.2
Hotel	20	41.7
Car (driving)	4	8.3
Car (parked)	2	4.2
Total	48	100.0
Did not drink	60	

TABLE 22: BAC and Type of Road User

Type of Road User		BAC (gm/100 ml)					Total
		Nil	0.001 - 0.049	0.050 - 0.079	0.080 - 0.149	0.150+	
Motorcycle	N	7	1	0	1	0	9
	%	77.8	11.1		11.1		100.0
Car	N	57	2	2	7	6	74
	%	77.0	2.7	2.7	9.5	8.1	100.0
Truck	N	14	0	0	0	0	14
	%	100.0					100.0
Forward Control van	N	6	0	0	0	0	6
	%	100.0					100.0
Four wheel drive	N	4	0	0	1	0	5
	%	80.0			20.0		100.0
Other	N	1	0	0	0	1	2
	%	50.0				50.0	100.0
Total	N	89	3	2	9	7	110
	%	80.9	2.7	1.8	8.2	6.4	100.0

TABLE 23: Age and BAC (Male Drivers and Riders)

Age (years)		BAC (g/100 ml) Nil	0.001 - 0.049	0.050 - 0.079	0.080 - 0.149	0.150+	Total
16-19	N	9	1	0	0	0	10
	%	90.0	10.0				100.0
20-24	N	15	1	0	4	1	21
	%	71.4	4.8		19.0	4.8	100.0
25-29	N	14	1	0	0	0	15
	%	93.3	6.7				100.0
30-39	N	9	0	0	3	3	15
	%	60.0			20.0	20.0	100.0
40-49	N	5	0	1	1	2	9
	%	55.6		11.1	11.1	22.2	100.0
50-59	N	3	0	0	0	1	4
	%	75.0				25.0	100.0
60+	N	12	0	0	0	0	12
	%	100.0					100.0
Total	N	67	3	1	8	7	86
	%	77.9	3.5	1.2	9.3	8.1	100.0

Frequency and Amount of Consumption

Active participants were asked how often they drank alcohol. When the frequency of alcohol consumption was compared with BAC at the time of the crash it was apparent that, as might be expected, those active participants who drank most often were also more likely to have a positive BAC (Table 24). Only one of 37 active participants who drank alcohol less than Once a week had a positive BAC. This compares with 19 (27.5%) of 69 who drank more than once a week. Most (78.9%) of these drinking drivers had a BAC over 0.08.

There was also a correlation between an elevated BAC and the number of drinks consumed on an occasion (Table 25). Just under 10% of those who had one to three drinks per occasion had a positive BAC, compared with about a third of those who had four or more drinks. The heavier drinkers in terms of this classification, were five times more likely to have had a positive BAC: (Relative odds = 5.2).

Perception of Effect of Alcohol

Drivers and riders were asked to make a subjective assessment of their level of intoxication at the time of the crash. It was found that with increasing BAC there was also increasing inaccuracy in estimating their level of intoxication. Of 89 active participants who said that they were not intoxicated at all at the time of their crash four (4.4%) had a positive BAC, and two of these were over 0.08. In contrast, of the 18 people who said they were intoxicated to a slight or greater extent, one had a zero BAC, and 14 had a BAC in excess of 0.08. It is interesting to note that none of the active participants considered that they were severely intoxicated, even though seven were above 0.15.

The inability of drivers who had been drinking to estimate their level of intoxication is illustrated by the behaviour of a young female who drove her car into a tree whilst on her way home from an extended 'happy hour' at work (Case 22). she had a BAC of 0.137 and yet when interviewed said that she was careful to limit her drinking when she knew that she had to drive. She went on to add that at the time of the crash she did not think that she was intoxicated and would not have driven if she thought that she had been. In a further case a driver with a BAC of 0.261 who lost control of his car and struck a building whilst on his way home from a hotel stated that he felt slightly intoxicated but did not consider that he was unfit to drive (Case 32).

Attitudes to Drinking and Driving

All but one of the 21 drivers and riders with a positive BAC considered that it was permissible to drive a vehicle after drinking alcohol, with most adding the rather vague caveat 'so long as my driving isn't physically impaired'. By comparison, 46.5% of the 86 active participants with a zero BAC thought that driving should not be permitted with any quantity of alcohol present in the blood. Many of these active participants were vehement in this belief, stating that if the South Australian government was really serious about wanting to reduce the number and severity of road crashes it should lower the legal BAC to zero.

Further, canparison of the active participant's self reported drink-driving behaviour with his or her actual BAC indicates that those with the highest BAC were also most likely to drive after drinking alcohol. Of the 13 active participants with a BAC in excess of 0.08, and for whom this information was available, 12 said that they regularly drove after drinking alcohol, and the other one did so occasionally. In comparison, 26.7% of the 86 active participants with a zero BAC said they regularly drove after drinking alcohol. All but two of the active participants with a positive BAC either drove immediately after their last drink, or within an hour of drinking.

Licence Suspension and Violations

Those active participants with a positive BAC were more likely to have had their licence suspended, had been involved in more crashes and had a larger number of mving violations (traffic convictions other than parking offences, etc.). Considering driving suspensions first, 61.1% of those 18 active participants who had a positive BAC had had their driver's licence suspended at least once. This compares with 23.3% of drivers with a zero BAC.

Of those active participants with a positive BAC, 77.8% had had at least one other crash; this contrasts with 57.6% of active participants with a zero BAC. Those active participants with the higher BACs had also had the greatest number of previous crashes. Sixty percent of those with a BAC in excess of 0.08 had been involved in two or more previous crashes, canpared with 24.7% for those with a zero BAC.

Only three (11.7%) of the active participants with a positive BAC said that they had had no moving violations in the five years prior to the crash, canpared with 41.9% of active participants with a zero BAC. These are all self reported misdemeanors and therefore may be under-reported.

Socio-Econcmic Status

A measure of socio-economic status was obtained by combining active participants' occupations into three groups, 'white collar', containing professional, clerical, sales, and service, sport and recreation: 'blue collar', consisting of tradesmen, labourers, farmers, and unemployed: and a third group, classed as "not in the workforce" consisting of home duties, students and pensioners. Table 26 shows that approximately 24% of blue collar workers, 11% of white collar workers, and none of the group not in the workforce had a BAC greater than 0.08. However, this difference between white and blue collar groups is not statistically significant, possibly because of the small number of cases.

Comment

In this group of active participants, 20% had a positive BAC, about 15% had a BAC exceeding the legal limit of 0.08 and 6% had a BAC of 0.150 or greater, a level indicating a probable alcohol problem. None of the 16 truck drivers or the six drivers of forward control vans had a positive BAC. Having a BAC of 0.08 or over was associated with being male, being aged 20-24 years or 30-49 years, and having a blue collar occupation. An elevated BAC was also associated with drinking alcohol more often, drinking more on each occasion, and driving after drinking more frequently. This

TABLE 24: Frequency of Drinking and BAC of Driver and Riders

Frequency of Drinking		BAC (g/100 ml) Nil	0.001-0.079	0.08+	Total
Less than once/week	N	36	1	0	37
	%	97.3	2.7		100.0
One or more times/week	N	50	4	15	69
	%	72.5	5.8	21.7	100.0
Total	N	86	5	15	106
	%	81.1	4.7	14.1	100.0

$X^2 = 8.109$ $p < 0.01$ Nil v. BAC positive

TABLE 25: Number of Drinks Usually Consumed and BAC

NO. of Drinks		BAC (g/100 ml) Nil	0.001-0.079	0.080+	Total
1-3 Drinks	N	43	2	2	47
	%	91.5	4.2	4.3	100.0
4 or more	N	33	3	13	49
	%	67.3	6.1	26.5	100.0
Total	N	76	5	15	96
	%	79.2	5.2	15.6	100.0

$X^2 = 8.479$ $p < 0.01$ Nil v. BAC positive

TABLE 26: Occupational Status and BAC of Drivers and Riders

Occupation		BAC (g/100ml) Nil	0.001-0.079	0.08+	Total
White Collar	N	23	1	3	27
	%	85.1	3.7	11.1	100.0
Blue Collar	N	38	4	13	55
	%	69.1	7.3	23.6	100.0
Not in Work Force	N	28	0	0	28
	%	100.0			100.0
Total	N	89	5	16	110
	%	80.9	4.5	14.5	100.0

$X^2 = 2.463$ n.s. white v. blue collar, nil v. positive BAC

TABLE 27: Canparison of BAC Distributions of Driver and Riders

survey	BAC (g/100 ml) 0.001-0.079 %	0.08+ %	No. of Estimations
Rural Crashes	4.5	14.6	110
Rural RBT*	13.0	1.7	2214
Rural Household* Survey	2.3+	0.5+	2066

* Reference 12

\+ Based on personal estimates, not direct measurement of BACs of drivers finding is similar to observations made by *Ryan* and Salter in Melbourne[10] and McLean et al in Adelaide[11]. Those with an elevated BAC also reported more driving licence suspensions, and more moving traffic convictions. This group also grossly underestimated the effect of alcohol on their ability to drive, and persisted in this belief even in the face of the evidence of their *own* recent crash.

The importance of alcohol as a factor in crashes can be estimated by comparing the BACs obtained for the crash-involved drivers and riders in this survey with the results of the exposure survey carried out by Rungie and Trembath in the same geographical area[12]. They obtained BACs for rural drivers by using police random breath testing stations and, by estimation, (not direct measurement of BACs of drivers) through a household survey. The findings are set out in Table 27.

There are obvious differences in the prevalence of elevated BACs between the three surveys, and between the two exposure surveys. The results of the household survey are clearly an under-estimate of the true value. The percentage of crash involved drivers over the legal limit is, respectively, about 7 and 30 times greater than the corresponding percentage of drivers with the same BAC in the RBT and household surveys. This supports the findings of McLean et al[13], and Borkenstein et al[14] with regard to increased crash involvement with elevated BAC in urban crashes, and reinforces the argument that alcohol is a potent factor in the causation of rural crashes.

FATIGUE

Driver fatigue is commonly regarded as an important causal factor in rural crashes. Armour et al for example, in an interim report of a study of single vehicle rural crashes in Victoria, estimate that in approximately a quarter of the crashes in their sample drivers had fallen asleep.[15] In this study active participants were asked to make a subjective assessment of their fatigue level at the time of their crash. Most (68.6%) said that they were not fatigued at all at the time of the crash (Table 28). However, 15 people reported being slightly fatigued, 11 were moderately fatigued and 7 said they were very fatigued. The highest percentage of fatigued drivers occurred in trucks (41.7%) and motorcycles (50.0%). It seems likely that in six cases crashes resulted directly from the driver falling asleep. Three of these involved cars, two involved trucks and one involved a forward control van. Four of the seven very fatigued drivers fell asleep, as did one in each of the other two fatigue categories.

In the first of the three cases involving cars the driver was on his way hane when his car left the road and struck a tree (Case 15). He had been drinking and had a BAC of 0.099. He reported that in the six days prior to the crash he had been sleeping only 3-4 hours each night due to work commitments. He usually slept for 7 hours each night. The driver also reported that he had been smoking in the vehicle at the time of the crash, that his side window was open slightly, and the heater was on. In the second case an elderly male was returning home after an outing with friends (Case 54). He reported that he *had* been feeling very tired and was looking for sanewhere to pull over and rest. Before he was able to do this he fell asleep, his car ran off the road and struck a bank. He reported that he usually had 7 hours sleep each night, and on the night prior to the crash he had gone to bed earlier than usual and slept for 8.5 hours. The driver also reported that the windows in the car were slightly ajar to allow fresh air to circulate within the occupant space. The third case (Case 39) involved an elderly male travelling home alone. After whit he described as a lapse in (his) concentration, his car ran off the road and rolled over. He stated that his wife had pointedly told him to drive with the windows down and the air-conditioner on *so* that he would remain alert. He also said that he seldan drove alone outside of metropolitan Adelaide as he often became drowsy.

There were two cases involving trucks where it seems likely that the crashes resulted directly from the driver falling asleep. In the first case the driver of a loaded semi-trailer failed to negotiate a left hand bend (Case 67). The truck continued straight ahead, crossing a raised median and striking several other vehicles before coming to rest in the rear of a house. The driver, who had driven from Melbourne the previous night, indicated that due to the nature of his employment he had a very irregular sleep pattern: 'I snatch a few hours here and a few hours there'. He reported that on average he tried to get between five and six hours sleep each night, and on the night prior to the crash had slept for approximately 5 hours. The circumstances of the second truck crash were very similar (Case 73). Again, the driver had driven for a long period without rest and had averaged only 5 hours sleep each day in the seven days up to the crash. He commented that '.. to make a decent living you have to do a lot of miles, and that means not a lot of sleep'.

There was also one crash involving a forward control van which resulted when the driver fell asleep *(Case* 51). The driver reported that he was on his way home from a northern provincial town where he had spent two weeks working long hours and sleeping less than usual. He had been driving continuously for approximately 2.5 hours and despite feeling tired did not consider that he would not be able to stay awake.

BAC and Fatigue

Comparing reported fatigue with BAC reveals that those active participants who were feeling fatigued were more likely to have a positive BAC than those who said that they were not fatigued (Table 29). Forty percent of fatigued drivers had a positive BAC, compared with 14% of non-fatigued drivers. This difference is statistically significant. There were two cases where lack of sleep was associated with drinking alcohol. Both involved personal circumstances of a particularly stressful nature. The first case, (Case 4) concerned a driver who had recently separated from his wife, was sleeping much less than usual and was drinking large quantities of alcohol. He had a BAC of 0.250. In the second case, a male car driver had been having serious financial problems which were having a marked effect on his sleeping pattern. On the night of the crash he had gone out drinking with relatives to 'try and work things out'. It was while returning hone early in the morning, having had no sleep the previous night, that his car left the road and rolled into a creek. He had a BAC of 0.219 (Case 23).

Age

There was no association found between age and fatigue. However, if drivers with a positive BAC were excluded, there was a tendency for more older drivers to report fatigue, but this trend was not statistically significant (Table 30).

Travel Time

Active participants were asked how long they had been travelling when the crash occurred. Contrary to what might be expected there was no clear relationship between time on the road and level of fatigue: 21.2% of those who reported fatigue and 17.8% of those who did not feel fatigued had been travelling for more than 60 minutes. There was very little difference between fatigued and non-fatigued drivers with respect to breaks. Seventy-two percent of drivers who said they were feeling fatigued had been driving continuously compared with 69.9% who said they were not fatigued.

Heater Use

Drivers were asked what ventilation there was to the occupant space at the time of the crash. The only difference between fatigued and non-fatigued drivers related to heater use. One-third of drivers who reported being fatigued had the heater operating in their vehicle compared with one eighth of drivers who said that they were not feeling fatigued.

Sleep Pattern

Active participants were asked how many hours they usually slept each night, the average number of hours slept each night in the week prior to the crash, and how many hours sleep they had had the night before the crash. Those active participants who reported any level of fatigue were more likely to have slept fewer hours than usual the night before the crash than those not fatigued (Table 31). This difference is statistically significant. For the six active participants who were very fatigued, four had had less sleep than usual the night before the crash.

In summary, feelings of fatigue were reported by abut one-third of drivers and riders involved in the crashes studied. Six crashes resulted directly from drivers falling asleep. Five of these six were single vehicle crashes. The remaining crash involved a loaded semi-trailer striking four other vehicles, resulting in death to one car occupant. There was a strong association between an elevated BAC and fatigue, between lack of sleep and fatigue, and between use of heaters and fatigue. There was a non-significant association between increasing age and fatigue. There was no association between fatigue and length of time spent driving, or with taking breaks.

While feelings of fatigue are relatively common in this sample of crash-involved drivers, only a small number of crashes resulted directly from drivers apparently falling asleep, although the performance of drivers in other crashes may have been degraded by fatigue to some extent.

TABLE 28: Fatigue Level and Road User Type

Road User Type		Fatigue Level: None	Slightly	Moderately	Very	Total
Motorcycle	N	4	3	1	0	8
	%	50.0	37.5	12.5		100.0
Car	N	53	7	9	5	74
	%	71.6	9.5	12.2	6.8	100.0
Truck	N	7	4	0	1	12
	%	58.3	33.3		8.3	100.0
Forward Control van	N	4	0	1	1	6
	%	66.6		16.7	16.7	100.0
Four Wheel Drive	N	3	1	0	0	4
	%	75.0	25.0			100.0
Other	N	1	0	0	0	1
	%	100.0				100.0
Total	N	72	15	11	7	105
	%	68.6	14.2	10.4	6.6	100.0
No. Falling Asleep		0	1	1	4	6

TABLE 29: Fatigue and BAC Level

Fatigue		BAC (g/100mL): 0	≤ 0.08	0.08+	Total
Yes	N	14	1	8	23
	%	60.9	4.3	34.8	100.0
NO	N	44	4	3	51
	%	86.3	7.8	5.9	100.0
Total	N	58	5	11	74*
	%	78.4	6.7	14.9	100.0

* Cases where BAC measurement obtained

$X^2 = 6.046$ $p < 0.05$, nil vs. positive BAC

TABU 30: Age and Fatigue, For Drivers with Zero BAC

Fatigue		Age (Years) ≤ 50	50+	Total
Yes	N	8	6	14
	%	57.1	42.9	100.0
No	N	35	9	44
	%	79.5	20.5	100.0
Total	N	43	15	58
	%	74.1	25.9	100.0

$x^2 = 2.033$ not significant

TABLE 31: Fatigue and Sleep Pattern

Fatigue		Less sleep than usual Yes	No	Total
Yes	N	10	22	32
	%	31.2	68.8	100.0
NO	N	4	68	72
	%	5.6	94.4	100.0
Total	N	14	90	104
	%	13.5	86.5	100.0

$x^2 = 12.553 \quad p < 0.01$

PRESCRIPTION AND NON-PRESCRIPTION DRUGS

Active participants were asked abut their use of prescription and non-prescription drugs prior to the crash. As the data is based on self-reporting it may under-estimate drug use, in particular the use of illegal drugs. Table **32** lists the frequency with which drugs were reported as having been used. Twenty-five active participants (about **20%)** reported the **use** of drugs prior to the crash: eighteen (15 males) had taken prescription drugs; two had taken non-prescription drugs; and five had used illegal drugs.

The prescription drugs taken were primarily for medical conditions such as high **blood** pressure, arthritis and mature onset diabetes (i.e. not insulin dependent). Two male car drivers had consumed non-prescription drugs prior to their crash. The first had taken medication for a sinus complaint, and the second had consumed several aspirins as he was not feeling well the morning after a late night out with friends.

It seems likely that in two cases prescription drugs were factors in the chain of events leading to the crash. In the first case (Case 4) an emotionally distressed male car driver had taken tranquillizers and had been drinking heavily. Whilst travelling on a straight section of road his car ran off the left side of the road and struck a tree. The driver was killed.

In the second case (Case **36)**, a middle aged male and his wife were travelling on a four lane arterial road when their car yawed clockwise, left the road and struck a tree. Both occupants were killed. It was reported that the driver had been taking large quantities of therapeutic drugs for a spinal injury and had been advised not to drive because of their effect on him.

Five males reported using illegal drugs prior to crashing. In all five cases, the drivers had smoked marijuana, in four cases alcohol had also been consumed, and in the remaining case the driver had used marijuana and an hallucinogenic drug. In two cases (Cases 55 and **68)**, the marijuana had been smoked the night prior to the crash and was therefore unlikely to have been a factor. In the remaining three cases the use of the illegal drug **was** within two hours of the crash, and in each of these it seems likely that it was a contributing factor (Cases 27, **63** and **64)**.

Although **25** of 113 **(22.1%)** active participants reported taking drugs before their crash, there were only five cases in which the effect of the drugs were thought to have played a significant part in the chain of events leading to the crash. Two of these involved prescription drugs, and three, cannabis. The consumption of alcohol played a potentiating role in one case of prescription drugs and two of cannabis.

TRIP CHARACTERISTICS

The origin and destination of the drivers and riders involved in the crashes studied are set out in Table **33.** Home, and place of work were each the origin or destination of about **30%** of trips. Seventeen percent of trips began at a hotel, club or party, but only 5% of trips had these as a destination, perhaps denoting the influence of alcohol consmed in these establishments. Trips between hane and work, or while at work, accounted for 38 (or 34.5%) of the journeys. Ten trips had no fixed destination, the drivers and passengers either sightseeing, or in 5 cases, just 'driving around'.

Active participants were also asked the total estimated time for their trip and how long they had been travelling when the crash occurred. In general the trip lengths were relatively short. Sixty-one percent of active participants said *that* the total estimated time of their trip was less than one hour. Only 16.7% of active participants had a total trip length in excess of 2 hours. Almost two-thirds of active participants' said that they had been travelling for 30 minutes or less when the crash occurred.

Active participants were also asked if they had made a break in their journey. Most (71.1%) reported that they had been driving continuously. Of those who had broken their journey, two-thirds (64.5%) had stopped only briefly (15 minutes or less).

Work Related Trips

Almost one-quarter (22.7%) of the 110 active participants were travelling in the course of their employment when their crash occurred (Table 34). Over *one* half of these were truck drivers. A further 5% were travelling to work, and 9% were travelling from work at the time of the crash. Altogether, 37% of trips were work-related. For truck and forward control vans all or most of their trips were work related, in contrast with one-quarter of cars.

The severity of injuries sustained in crashes on work-related trips is less than that for other trips, presumably due to the large proportion of truck occupants in work related journeys. Table 35 shows that the percentage of occupants with severe or greater injuries ranges from 2.7% for work trips to 28.6% travelling home fran work. The average number of persons per vehicle varies with the type of trip, being lowest (1.2) for trips to work, and highest (2.1) for non-work related trips.

There is an association between BAC and type of trip, as shown in Table 36. For drivers who had a BAC measurement, none of the drivers at work had a positive BAC, compared with one of four drivers on the way to work, and three of eight returning frcm work. Fifteen of 54 drivers on other trips (27.8%) had a positive BAC. The driver involved on the way to work with a BAC of 0.142 at 0600 hours, had been drinking until early in the morning, slept for about four hours, and was obviously still affected when on his way to work (Case 20). Trips from work resemble non-work-related trips in their severity of injury, and BAC levels. Trips "at work" are qualitatively different, in terms of vehicles involved (mostly trucks and vans), injury severity (low), and BAC levels (none), from trips for other reasons.

Motor vehicle crashes are an important cause of morbidity (and mortality) usually not considered in occupational health and safety programs. The employer has some control over the purchase of equipnent and vehicles, their use, and the training and supervision of operators. This is one area where road and occupational health and safety overlap.

TABLE 32: Drug Use and Sex of Active Participants

Class of Drug	Sex: Males N	Males %	Females N	Females %	Total N	Total %
Prescription	15	17.0	3	12.0	18	15.9
Non-Prescription	2	2.3	-		2	1.8
Illegal	5	5.7	-		5	4.4
None	59	67.0	21	84.0	80	70.8
Drug Use Not Known	7	8.0	1	4.0	8	7.1
Total	88	100.0	25	100.0	113	100.0

TABLE 33: Origin and Destination of Trips

Origin		Destination: Home	Work	Friends/ Relatives	Hotel, Club, Party	Shopping, Personal	No fixed Destin.	Other	Total N	Total %
Home	N	0	9	4	3	7	5	7	35	31.8
	%		25.7	11.4	8.6	20.0	14.3	20.0	100.0	
Work	N	13	16	0	0	2	0	0	31	28.2
	%	41.9	51.6			6.5			100.0	
Friends/ Relatives	N	9	0	1	2	3	1	0	16	14.5
	%	56.2		6.2	12.5	18.8	6.2		100.0	
Hotel, Club Party	N	14	1	1	1	0	2	0	19	17.3
	%	73.7	5.3	5.3	5.3		10.5		100.0	
Shopping, personal	N	1	0	0	0	0	1	0	2	1.8
	%	50.0					50.0		100.0	
Other	N	4	0	0	0	0	1	2	7	6.4
	%	57.1					14.3	28.6		
Total	N	41	26	6	6	12	10	9	110	100.0
	%	37.3	23.6	5.4	5.4	10.9	9.1	8.2	100.0	

TABLE 34: Work Trips and Vehicle Type

Road User Type		Trip					
		At Work	To Work	From Work	Other	Not Known	Total
Motorcycle	N	0	0	1	7	1	9
	%			11.1	77.8	11.1	100.0
Car	N	6	5	7	55	1	74
	%	8.1	6.8	9.4	74.3	1.3	100.0
Truck	N	14	0	0	0	0	14
	%	100.0					100.0
Forward Control van	N	3	1	1	1	0	6
	%	50.0	16.7	16.7	16.7		100.0
Four wheel drive	N	1	0	1	3	0	5
	%	20.0		20.0	60.0		100.0
Other	N	1	0	0	1	0	2
	%	50.0			50.0		100.0
Total	N	25	6	10	67	2	110
	%	22.7	5.4	9.1	60.9	1.8	100.0

TABLE 35: Work Trips and Injury Severity

Trip type	% Occupants with Severe or greater injury*	Total occupants	Average persons/vehicle
	%		
At work	2.7	37	1.48
To Work	14.3	7	1.2
From work	28.6	14	1.4
Other	23.6	144	2.1

* *AIS:* 3+

Familiarity with Crash Site

About half of the active participants used the road where their crash took place four or more times per week (Table 37). This compares with ten percent who had not travelled on that section of road before. In three of the latter cases the driver thought that lack of familiarity with the site contributed to the crash.

The first case was a side-impact collision involving two cars at an uncontrolled intersection on an unsealed road (Case 01). The driver stated that as he was travelling along the road a dash board warning light came on. He slowed slightly and looked down at the dashboard to see what the problem was. When he looked up at the road again he realized that he was entering an intersection and directly ahead travelling across the intersection was a car. The driver said that had he been familiar with the road he would have known that he was approaching an intersection and been prepared for conflicting traffic.

The second case was at night and involved a car on a winding sealed section of road (Case 63). The driver failed to negotiate a sharp right hand bend, The car yawed clockwise onto the gravel shoulder and struck a rock embankment. The driver stated that he thought the road went straight ahead and was taken by surprise by the comer. He had an elevated BAC of 0.112.

The third case involved a motorcycle which ran off the bitumen on a deceptively sharp right hand corner over a crest. It ran onto the gravel shoulder and slid down on its right side (Case 68). The rider stated that as he approached the bend it appeared to curve relatively gently to the right but then became much sharper.

In each of these cases the driver was speaking with the benefit of hindsight and there is definitely an element of rationalisation in their statements. Taken together, however, they do suggest that the environment did not supply enough clues to alert these drivers to the change in the road geometry.

Familiarity with the Vehicle

Information was sought fran active participants regarding their familiarity with the crash-involved vehicle to see if this was associated with crash causation. The ownership of the vehicles involved in these crashes and the frequency with which the crash-involved active participant *used* them is shown in Table 38.

Most (69.7%) of the crash involved vehicles belonged to the active participant, the remainder belonging to friends, relatives or employers. There were two rented vehicles, and one on loan fran a vehicle repairer. Almost 90% of active participants regularly drove the crash involved vehicle and considered that they were familiar with it. In two of the five cases where the vehicle had not been driven before, it is possible that this lack of experience was a contributing factor to the crash.

In the first of these two cases (Case 31), a young female driver was travelling with a group of friends along an unsealed road towards an intersection with a four lane arterial road. She had not driven the car before, did not have a driver's licence, had only limited driving experience and had not driven a vehicle with manual gear change before. As she proceeded along the road the front seat passenger, who was the vehicle's owner, told her when to depress the clutch and to change gears. As the vehicle entered the intersection it stalled, and while the driver was attempting to restart the car it was struck by a vehicle travelling in the left lane of the arterial road. The driver said later that her lack of driving experience, particularly in a manual vehicle, resulted in her stalling the car.

The second case involved a motorcyclist (Case 66). Whilst travelling downhill he decided to overtake a slower moving vehicle and collided head on with a car travelling in the opposite direction. The rider had owned the second-hand motorcycle, a high performance machine, for only a few hours. This was his first ride on it. He stated that if he had been more familiar with its performance, handling and braking characteristics, the crash would not have occurred.

Involvement of Tourists

Tourists, or interstate or out of the region travellers do not play a major role in rural crashes. About 75% of persons involved in these crashes travelled regularly on the road where the crash took place (Table 37). The active participant's home or work was either the origin or the destination of 95 (86.4%) of the trips resulting in these crashes (Table 33). Most trips were shorter than an hour, and only 5% could be classed as 'sight seeing'.

There were seven drivers or riders with hane addresses in another state, plus two truck drivers fran other states. Apart *fran* the truck drivers these out-of-state drivers were all on holiday.

It is evident therefore that the vast majority of rural crashes involve people who live and work in the region, and who are familiar with the roads and their vehicles.

TABLE 36: Work Trips and BAC

Trip Type		BAC (g/100 ml)			
		Nil	≤ 0.08	0.08+	Total
At work	N	12	0	0	12
	%	100.0			100.0
To work	N	3	0	1	4
	%	75.0		25.0	100.0
From work	N	5	1	2	8
	%	62.5	12.5	25.0	100.0
Other	N	39	4	11	54
	%	72.2	7.4	20.4	100.0
Total	N	59	5	14	78*
	%	75.6	6.4	17.9	100.0

* cases with known BAC.

TABLE 37: Previous Exposure to Crash Site

	Previous Exposure to Crash Site				
	None	1-3 times per year	once per month-	4 times per week	Total
N	10	16	27	55	108
%	9.3	14.8	25.0	51.0	100.0

TABLE 38 Ownership and Frequency of Use of Crash Involved Vehicle

Owner of Vehicle		Driver Used Vehicle			Total
		Regularly	Infrequently	Never Before	
Driver	N	73	2	1	76
	%	96.0	2.6	1.3	100.0
Friend/ Relative	N	7	7	1	15
	%	46.7	46.7	6.7	100.0
Employer	N	15	-	-	15
	%	100.0			100.0
Rented	N	-	-	2	2
	%			100.0	100.0
Other	N	-	-	1	1
	%			100.0	100.0
Total	N	95	9	5	109
	%	87.2	8.3	4.6	100.0

CONSEQUENCES OF THE CRASHES

The injuries of the 205 persons involved in the 80 crashes are summarized in this section. About one-quarter did not require any treatment, onequarter required treatment but were not admitted to hospital, and about 40% were admitted to hospital (Table 39). Just over one-tenth died. In most cases death occurred at the scene of the crash. Car occupants made up almost 75% of the total number of persons involved. Occupants of trucks and vans were injured less often than car occupants or riders of motorcycles.

Fatalities

There were 22 deaths in 16 of the 80 crashes, i.e. one in five crashes involved a fatality. Fourteen car occupants died at the scene of the crash, as did two motorcyclists, the driver of a semi-trailer which collided with a utility pole, the driver of a four wheel drive utility, and a cyclist who was struck by a semi-trailer. In addition, two car occupants died within 24 hours of admission to hospital, and one after 13 days. The majority of these deaths were due to head and chest injuries.

Trucks were involved in six fatal crashes, four being semi-trailers (Table 40). Only one truck driver was injured and he was killed (Case 50). A motorcyclist was killed in a collision'with a bus, the other heavy vehicle in the study. Deaths among car occupants occurred in collisions with trees or poles, with trucks, or, relatively rarely, with other cars.

There were three other fatal crashes involving vehicles leaving the road, striking an object and rolling over, in each of which an occupant died of indirect causes. The driver of a four-wheel drive utility died after it left the road and plunged down a 15 metre drop, landing on its roof. He suffered facial fractures and blood was found in his air passages suggesting that death was due to asphyxia (Case 16). In Case 37, an occupant died after inhaling vomitus, when the utility in which he was travelling left the road and rolled over in a gully. He suffered severe chest injuries, rib fractures and a hagnothorax (Case 37). A third driver sustained derate injuries when his vehicle left the road on a bend, struck the brick abutment of an abandoned bridge, and landed upside down in a creek. He died of drowning (Case 23). Only in Case 37 was there an appreciable, but unknown, length of time before help arrived.

There were two deaths due to complications of injuries. A 76 year old front seat passenger suffered a laceration of the right ventricle of her heart when her car was struck by a semi-trailer. The heart laceration was repaired at operation, but she died 13 days later of congestive cardiac failure (Case 60). Also, a 15 year old rear seat passenger died of pulmonary oedema secondary to a closed head injury sustained in a right angle collision with another car, in which three other occupants died (Case 65).

Injury severity

Injuries were rated using the Abbreviated Injury Scale (1985) (AIS), with up to six injuries per person being recorded[16]. The most severe injuries were recorded first, and, for injuries of equal severity, in descending order from the head downwards. Table 41 shows the range of maximum *AIS* scores for each type of vehicle occupant or rider. About 20% received no injuries, one-third minor injuries, one-quarter moderate injuries, and one-fifth serious or greater injuries. Just over 10% received critical or maximal injuries. Occupants of other vehicles received relatively few serious injuries, cmpared with motorcyclists and car occupants.

The head, chest and lower limbs were the body areas most frequently sustaining injuries of more than minor severity (Table 42). Motorcyclists had particularly high frequencies of such injuries to the upper and lower limbs, compared to car occupants. Car occupants suffered a high incidence of more severe injuries to the head and chest. The mall numbers involved in the other groups of occupants renders the percentages observed unreliable. It is worth noting that neck injuries of moderate or greater severity were only recorded in car occupants.

Mechanisms of spinal Injuries

One of the important advantages of in-depth studies of this type is that mechanisms of injury can be determined in detail. As an example, in Case 38, two cars collided front to side following the loss of directional control by one of the cars. The centre front and centre rear seat passengers of Unit 2, a 1985 XF Ford Falcon sedan, were a male aged 4 years, and a female aged 6 years, respectively. Each was wearing a lap belt. The impact was on the front right corner of the car. The boy in the centre front seat sustained facial injuries from striking the centre of the instrument panel, together with a fracture of the third thoracic vertebra and spinal cord damage resulting in quadriplegia. The spinal injury probably resulted from compressive axial loading of the spine due to the impact of the head and face on the centre console.

The centre rear seat passenger sustained disruption of the second and third lumbar vertebrae, with tearing of the paraspinal muscles and ligaments, resulting in spinal injury and paraplegia. This injury probably resulted fran flexion of the torso over the lap belt producing a tensile axial loading on the spine, thereby injuring the vertebral bodies and the large and mall bowel.

These two injury cases illustrate, first, the importance of restraining the thorax in frontal impacts, particularly for children, and secondly, the inadequacy of the lap belt as a means of restraint, particularly where there is insufficient occupant space to avoid head and face impacts and/or the belt is not correctly located across the pelvis of the wearer.

Consideration of this crash further re-inforces the view that children should be carried only in restraining devices which are appropriate for their size, weight, and stage of development.

This crash also demonstrates the need for eliminating the centre front seating position in passenger vehicles or for incorporating upper torso restraint in all occupied front seat positions. The lap belt currently supplied in the centre front position provides inadequate restraint, as demonstrated. Even children, let alone adults, will sustain head impacts on the instrument panel and the area below it, with accompanying injury to head or spine (as demonstrated). The convenience of having a third front seat position is outweighed by the risk of injury.

TABLE 39: Occupant Injuries by Treatment Level and Outcome (percent)

Vehicle type	Treatment Level								
	No treatment	First Aid Only	Medical Rx Treatment Only	Admitted to Hospital < 1 week	Admitted to Hospital ≥ 1 week	Death at scene	Death within 30 days	Total persons N	Total persons %
Motorcycle	0.0*	0.0	10.0	40.0	30.0	20.0	0.0	10	4.9
Car	19.2	5.3	21.8	25.8	16.6	9.3	2.0	151	73.7
Heavy Truck	61.1	5.6	22.2	5.6	0.0	5.6	0.0	18	8.8
Forward Control Van	43.7	18.7	12.5	18.7	6.3	0.0	0.0	16	7.8
4-wheel Drive	0.0	12.5	37.5	0.0	37.5	12.5	0.0	8	3.9
Other**	50.0	0.0	0.0	0.0	0.0	50.0	0.0	2	1.0
Total N	48	13	43	47	32	19	3	205	
Total %	23.4	6.3	21.0	22.9	15.6	9.3	1.5	100.0	

* row percentage
** one cyclist struck by a semi-trailer and killed, one driver of a tractor uninjured.

TABLE 40: Fatal Crashes

Car v. tree or p l e	4
Car v. truck	3
car v. car	2
Motorcycle v. heavy vehicle (1 bus)	2
semi-trailer v. pole	1
Semi-trailer v. bicycle	1
Car *off* road, rollover	2
Four wheel drive off road, rollover	1
TOTAL	16

Even with correctly worn seat belts, injury can occur if there is intrusion of car structure into the occupant space. In Case 72 a 1982 Ford Meteor sedan left the road in a clockwise yaw, hit a tree with the left rear comer and landed on its roof, facing away from the road. The driver, who was wearing an inertia reel seat belt, suffered a fracture dislocation of the sixth and seventh cervical vertebrae, with spinal cord damage. After the impact he found himself upside down in the car, unable to feel or move his arms and legs. The roof of the car was crushed down to level with the top of the steering wheel (Figure A70).

These three injuries demonstrate the vulnerability of the human spine to longitudinal and twisting loads. Case 72 shows particularly that the lack of rollover protection is a potent factor in producing head and neck injury.

Severity of Injuries and Crash *Type*

There were 20 crashes involving cars or car derivatives in which at least one car occupant sustained an injury of AIS 3 or greater to one body area. Seven involved collisions with trees or poles, one car collided with a building, three cars plunged into gullies and rolled over, and there were six collisions each involving two cars. There were also four collisions involving a car and a truck. For cars, crashes on curves appear to be associated with both loss of directional control, and with serious injuries (Table 43), as 11 of the 16 severe injury crashes involving cars occurred on curves. Of the crashes between cars and trucks, two occurred on curves and two on straight sections of road.

The two deaths of motorcyclists occurred when the motorcycles *crossed* the centre line on left hand bends and collided with the front of a dump truck and a school bus, respectively. The truck in which the driver died after it struck a stobie pole, also left the road while negotiating a bend.

Fire

There were four cases of post crash fire. In two cases, there was a fire in the engine compartment immediately post hpact (Cases 04, 65). In another, a fire broke cut in the left side of the passenger compartment of a Ford Fairmont which collided with a pole on the left front comer. The driver was extricated, but the passenger, who suffered fatal chest injuries at impact, was burned (Case 47). In the fourth case (Case 20), an International truck with a box body was struck on the right front and side by a Holden Monaro which crossed the centre line on a curve. The truck yawed clockwise, rolled over, and caught fire. The fuel tanks were ruptured during the impact.

Canparison with Urban Crashes

McLean and Robinson (1979) in an on scene study of crashes in Adelaide found 20.9% of persons involved were admitted to hospital, and 0.9% died, compared with 38.6% and 10.8% in this study.[17] Considering injury severity, 4.2% of the urban sample suffered injuries of AIS 4 or greater, compared with 13.3% of the rural sample. These differences are due primarily to the higher impact speeds of rural crashes, and the larger proportion of impacts with fixed objects, and heavy vehicles, and to a lesser extent to the minor selection bias outlined previously.

TABLE 41: Occupant Injuries by Vehicle Type and Severity (percent)

Vehicle type	Injury Severity* None	Minor	Moderate	Serious	Severe	Critical	Maximum	Total Persons
Motorcycle	0.0**	10.0	40.0	30.0	0.0	0.0	20.0	10
Car	15.2	35.8	26.5	7.3	2.6	6.6	6.0	151
Truck	61.1	33.3	0.0	0.0	0.0	5.6	0.0	18
Forward Control van	50.0	25.0	25.0	0.0	0.0	0.0	0.0	16
4-wheel Drive	0.0	50.0	25.0	25.0	0.0	0.0	0.0	8
Other	50.0	0.0	0.0	0.0	0.0	50.0	0.0	2
Total	21.0	33.7	24.4	7.8	2.0	5.9	5.4	205

* Abbreviated Injury Scale (1985)

** Row percentages

TABLE 42: Occupant Injuries by Vehicle Type and Body Area

(% Injuries moderate (AIS:2) and greater in each body area)

Vehicle type	Body Area						
	Head	Neck	Thorax	Abdomen	Upper Limb	Lower Limb	N
Motorcycle	10.0	0.0	50.0	10.0	30.0	70.0	10
Car	33.8	6.0	19.2	6.6	9.9	15.3	151
Heavy Truck	5.6	0.0	0.0	0.0	0.0	0.0	18
Forward Control Van	12.5	0.0	6.2	0.0	12.5	0.0	16
4-wheel Drive	50.0	0.0	25.0	0.0	0.0	25.0	8
Other	0.0	0.0	50.0	50.0	50.0	50.0	2
Total	28.8	4.4	18.5	5.9	10.2	16.1	205

TABLE 43: Loss of Control, Road Alignment, and Serious Injuries in Car Crashes

(Numbers of car crashes)

Loss of Directional Control	Road Alignment	AIS3+ Injuries Yes N	No N	Total	% Yes
Yes	Curved	11	12	23	47.8
	Straight	1	10	11	9.1
No	Curved	0	1	1	0.0
	Straight	1	2	3	33.3
	Intersection	3	7	10	30.0

DISCUSSION AND CONCLUSIONS

This study has demonstrated the practicality of collecting detailed information at the scene of crashes on rural roads. This means that it is now possible to analyse rural crashes in Australia in the same detail as urban traffic crashes. In this report we have described some of the basic characteristics of a sample of rural crashes. While the relatively small number of cases has resulted in some of the findings being of a descriptive rather than a definitive nature, there is sufficient information to derive several important conclusions.

Nearly three-quarters of the crashes involved loss of directional control due to one or more of a variety of factors related to the driver, the vehicle, or the road and environment. However caused, the loss of control resulted in the vehicle leaving the lane in which it was travelling. Whether it then struck another vehicle, a utility pole, a tree, or an embankment, etc., was determined by the local topography and traffic conditions. All but one of the seven crashes which could be classed as 'head-on' were due to one vehicle leaving its lane following a loss of directional control.

In a sub-set of these 'loss of directional control' cases, a particular pattern of events was identified. This involved an attempt by the driver of a car to steer back onto the paved road surface after the left wheels had run off the edge of the bitumen onto the unsealed shoulder. As the front wheel mounted the paved surface the car yawed sharply clockwise across the roadway with the resultant risk of a collision with another vehicle, or a fixed object adjacent to the far side of the road.

The influence of shoulder width on crash frequency was reviewed by Armour and McLean[18], and the frequency of running off the road onto the shoulder was pointed out by King[19]. These findings also suggest that the characteristics of the shoulder are as important as the alignment, profile, or texture of the sealed surface.

Another characteristic of this sample of rural crashes which is of some significance is the low rate of seat belt wearing, particularly by males. Almost half of male drivers were not wearing seat belts. Non-wearing of seat belts was associated with elevated BAC. The reported attitudes of the drivers involved suggests that there is a need for more information to be made available regarding the effectiveness of seat belts, in a form acceptable to the group of drivers at risk.

The high frequency of elevated BACs, mostly well above 0.10, is the third characteristic of rural crashes which is of some importance. Having a BAC at these high levels is known to increase greatly the risk of involvement in a crash. Alcohol has been shown in this survey to be associated also with fatigue, and with the use of therapeutic and of illegal drugs. Elevated BACs are a serious and frequent contributing factor in the causation of crashes on rural roads.

The injuries produced in rural crashes are more extensive and more severe than those seen in similar samples of urban crashes. A death occurred in one crash in five of this sample of crashes to which an ambulance was called. There was evidence that an adult lap belt is not an adequate restraint for the younger child. There is also a strong case for not allowing the provision of a centre front seat position in cars because the lap belt does not provide adequate restraint to prevent head, face and spine injuries to occupants of any age.

It is apparent that in this sanple of rural crashes the great majority involved local residents travelling on their local roads. There were relatively few 'tourists' or non-residents involved. Therefore, preventive campaigns can be appropriately directed primarily at the residents of rural areas.

From the evidence given above we recommend that a random breath testing program operate in rural areas at a level of intensity which will make it effective, and that it be combined with an ongoing campaign, including enforcement, to increase the level of seat belt wearing. This combined activity would address two of the major problems identified in this study of rural crashes - low seat belt wearing rates and elevated BACs. Any public information campaign should be aimed particularly at the population most at risk: males, under 50 years of age and in blue collar jabs.

RECOMMENDATIONS

1. A random breath testing program operate in rural areas at a level which will make it effective.

2. Enforcement of seat belt wearing be instituted in rural areas. This could be done in combination with 1.

3. The effectiveness of 1 and 2 be formally evaluated.

4. The role of road shoulder width and other characteristics, in crash causation be studied further, particularly possible interactions with vehicle tyre and suspension characteristics.

5. The centre front seating position be eliminated from cars and car derivatives, because of the lack of effective restraint.

6. A regular program of intensive crash research into rural crashes should be instituted, to monitor the effects of countermeasures, and to detect trends in crash and injury causation.

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