Road Traffic Injury in Western Sydney: Serious Motor Vehicle Occupant Injury in the Wentworth and Western Sydney Health Areas

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Summary

This investigation aimed to characterise serious road traffic injury in the Wentworth (WHA) and Western Sydney (WSHA) Health Areas in western Sydney and explain an observed excess of road traffic deaths in one Area (WHA standardised mortality ratio for male road traffic injury 135.8, 99 percent confidence interval (CI) = 110.5,161.1).

An analysis of routinely collected crash and hospitalisation data and a case control study were carried out. Cases in the latter study were residents of the WHA or the WSHA, who had driven during the six month study period and been involved in a motor vehicle crash in which at least one casualty was admitted to hospital. Controls were selected from drivers resident in the same street (population controls) and from those admitted to the same hospital as the index case.

The standardised hospital separation rate (SSR) for WHA residents (214.3 per 100,000, 99 percent CI=191.1,237.2) was significantly higher than that for WSHA residents (184.9, 99 percent CI=170.6,199.2). Police collected crash data showed that there was a significant association ($p < 0.01$) between Local Government Area (LGA) of crash and serious injury (ie fatal or requiring hospitalisation). Those LGAs closer to the city centre and with higher population and traffic densities (Auburn, Parramatta and Holroyd) had a lower likelihood of serious injury (Auburn odds ratio=1, reference; Baulkham Hills odds ratio=1.69; Blue Mountains odds ratio=2.18; Hawkesbury odds ratio=1.83; Blacktown odds ratio=1.21; Holroyd odds ratio=0.88; and Parramatta odds ratio=1.09). All except the Holroyd and Parramatta LGA odds ratios were significantly greater than unity.

The major confounder of this association was location type, with two-way, undivided roads exhibiting the strongest association with serious injury (odds ratio=2.11, 99 percent CI=1.99,2.18). There were significantly more drivers ($p < 0.01$) with elevated blood alcohol in the WHA (12.5 percent) compared to the WSHA (10.7 percent). Significantly more ($p < 0.01$) motor vehicle occupant casualties were from single vehicle crashes in the WHA (29.1 percent, compared to 19.8 percent in WSHA).

We found significant ($p < 0.05$) associations between driver crash involvement and night driving exposure, two or more traffic accidents in the past two years, and being single, whether population or hospital controls were used. The response rate for the case-control study was disappointing and findings confirmed regardless of control group are probably

the most valid.

The study also found significant ($p < 0.05$) associations between driver crash involvement and having been random breath tested in the previous 12 months, sex and day-time driving exposure, in models using population controls. An observed association with the use of medication for sleep, depression and pain, in models with population controls was not found when hospital controls were used. It appeared to reflect the post injury experience of cases and hospital controls rather than a causal mechanism.

Within the limitations of the available data, we found that the road system contributed most to the observed association between serious/fatal injury and crash location. There are a number of implications for injury prevention.

Attention must be directed to questions of road design and engineering. Overtaking lanes, sealed shoulders and edge line markings have been shown to be cost effective in reducing road traffic casualties.

Interventions aimed at reducing drink driving and excess speed are especially important in the road systems seen in outer western Sydney.

A concern for injury prevention should be incorporated in transport planning and maintenance, with activities coordinated at local level and encompassing the roads and traffic, local government and health sectors as well as local community groups.

The studies reported here underline the importance of viewing serious motor vehicle injury as an environmental issue involving interactions between human factors, speed, alcohol and, crucially, road system hazards.

Acknowledgements

The case-control section of this investigation was carried out with funding from the Federal Office of Road Safety (FORS).

The Road Safety Bureau of the NSW Roads and Traffic Authority kindly provided the crash data.

A number of people assisted with various stages of the investigation. Louisa Jorm commented on drafts of the study proposal, questionnaire and final report. Tien Chey assisted with the creation of the Kish grid for selection of the community control group. Wells Research conducted the telephone interviews. Marea Meers was responsible for all data entry. RNR International Marketing provided the contact telephone numbers for the community control group.

We would like to thank all respondents and the participating emergency departments for their co-operation.

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Section 1.

Introduction

1.1 A major public health problem

A range of interacting factors have contributed to a substantial reduction in serious road trauma in recent years (Figure 1). Compulsory seat belt legislation and random breath testing and enforcement of speed limts have been cited as having an impact on road traffic injuries[1].

Nevertheless, road traffic injury continues to have a major impact on the community burden of death and disability[1]. In NSW over the ten years to 1990 road crashes resulted in 10,400 deaths, 92,000 hospital admissions and an estimated 270,000 non-hospitalised injuries. It has been estimated that these injuries had a direct financial cost in the order of 20 billion dollars[2]. In NSW in 1991 44 percent of the deaths between the ages of one and 44 years were due to injury or poisoning. Between the ages of 15 and 24 years injury accounted for 72 percent of all deaths, 44 percent of which were due to road traffic injury[a]. Deaths due to traffic crashes were exceeded only by cancer as a cause of premature mortality in the years 1989 to 1991 (Figure 2).

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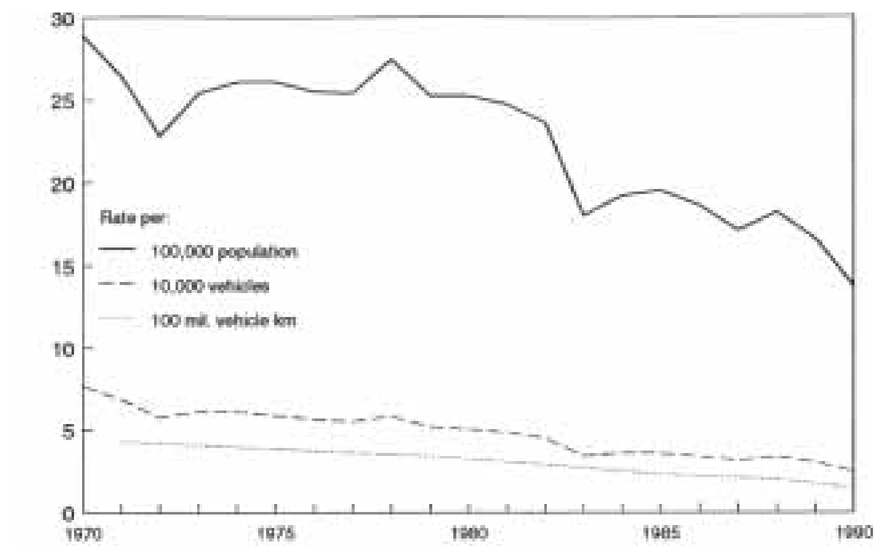
[a] Australian Bureau of Statistics.1992

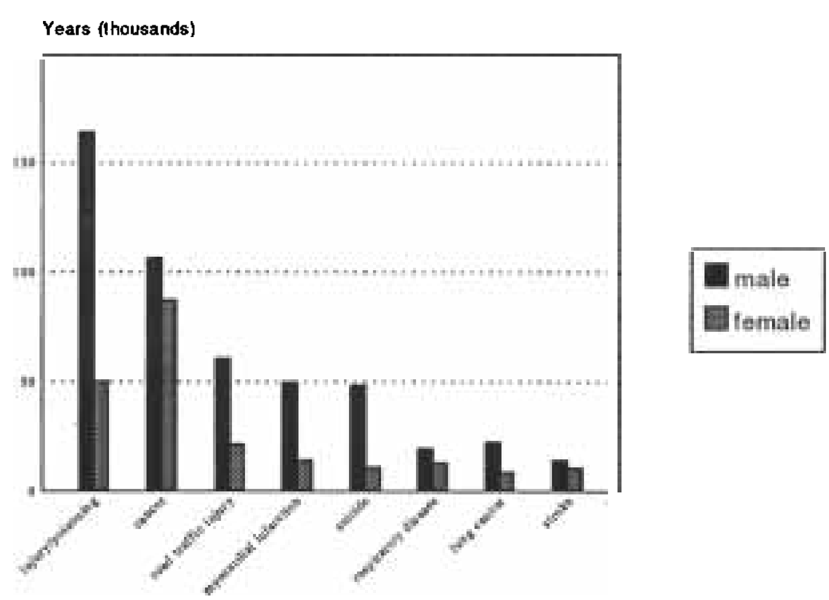
Figure 1

Trends in road traffic fatalities;
NSW, 1970 to 1990



Source: NSW RTA, 1990

Figure 2 Estimated potential years of life lost (PYLL) birth to 70 years of age, NSW, 1989-91.



Attention was focused on this important public health problem in the Wentworth Health Area in particular, when a review of mortality data showed a higher than expected incidence of road traffic deaths for males (standardised mortality ratio=135.8, 99 percent confidence interval=110.5,161.1)[3].

1.2 A model for thinking about injury causation

Injury events are not randomly distributed in terms of place, time or person. Certain times (eg., at night in the case of motor vehicle injuries), places (eg., certain road types) and people (eg., young males) exhibit differential risk of injury, especially severe injury. In this sense injuries are viewed as being eminently preventable.

Important developments in thinking about injury causation followed the promotion of an epidemiologic approach to injury prevention, placing injuries in the context of host (human), agent (some form of energy) and environment. A major contributor to these developments was William Haddon Jnr, whose model of injury causation placed less emphasis on attribution of specific causes to particular events than the understanding of the interaction of human, agent and environmental factors in the pre-injury, injury and post-injury phases of the injury event[4].

Though valuable in directing strategic thinking about injury prevention, this conceptualisation has some shortcomings. A simple application of the matrix approach neglects consideration of reduction of exposure to high risk travel as an option. It also implies a relatively narrow view of the problem and can discourage analysis of the broad picture of transport safety in the context of competing values (safety, mobility, environmental concerns, etc.). Table 1 shows an example of the application of this model (the Haddon factor phase matrix) to road traffic injury.

Table 1. The Haddon matrix of injury causation with reference to road traffic injury.

Phases of injury event	*Factors*			
	Host (Human)	**Vector (Vehicle)**	**Physical Environment**	**Socioeconomic Environment**
Pre-crash	alcohol intoxication driver vision judgement fatigue	brakes, tyres speed, handling	roadside hazards road curvature and gradient divided highways	attitudes to alcohol access to alcohol
Crash	safety belt use osteoporosis	sharp edges/surfaces vehicle size	speed limits guard rails median barriers	attitudes to safety belt use legislation requiring use of child safety restraints
Post-crash	age physical condition	fuel system integrity	access to emergency care rehabilitation services	support for trauma care systems

Haddon had also proposed ten countermeasure strategies for effective injury prevention. These were based on recognition of the importance of the creation and amount of hazard available, the amount and distribution of the hazard that is released and the impact qualities of the hazard[5].

1.3 Western Sydney road traffic injury study

Our aim was, within the limits of available or readily accessible data, to examine a range of factors (notably human and environmental) in the local 'traffic system' to characterise serious road trauma in western Sydney.

We hypothesised that motor vehicle injury (especially in the WHA) might more closely approximate the rural, rather than the metropolitan, experience. Rural crashes have been show to be more severe and are more likely to involve serious injury[6,7]. The 'rural pattern' has been correlated with drink driving, speed of impact, road engineering and lower propensity to use occupant restraints. A recent report from South Australia[8] confirmed this finding and suggested that blue collar males tended to be over-represented in the severe rural crashes.

Our investigation involved a series of studies including an examination of routinely collected data, an analytic study of relevant human factors and a population risk factor survey. This report focuses on the first two of these. The Wentworth Health Area risk factor survey is reported elsewhere[9].

Section 2.

Methods

2.1 Hospitalisation data

NSW health services administration was divided into ten metropolitan Area Health Services (AHS) and six rural Health regions (HR) at the time of these studies. Data relating to each separation (episode of care) for individual patients from hospitals in each AHS/HR are collected into the NSW Hospital Inpatients Statistics Collection (ISC). There are 14 Public Health Units with responsibilities in the areas of communicable disease surveillance, environmental health and health status monitoring. Each is accountable to a AHS/HR. The Western Sector PHU is a unit of the Wentworth and Western Sydney AHS's.

The Wentworth Health Area (WHA) comprises three local government areas (LGAs) in far western Sydney (Penrith, Blue Mountains and Hawkesbury) with a combined population of 270,440 at the 1991 census. The Western Sydney Health Area (WSHA) includes the Auburn, Baulkham Hills, Blacktown, Holroyd and Parramatta LGAs, with a total population at the last census of 586,319.

Data in the ISC are coded according to the International Classification of Diseases Clinical Modification (ICD.9.CM). Motor vehicle traffic accidents were identified under the E810-E819 rubric. Data for the 1986 calendar year and 1990/91 financial year were used.

We calculated standardised separation rates (SSR) from the ISC data for each AHS in each year using the direct method[10]. Statistical significance was tested by calculation of standardised normal deviates and, where appropriate, 99 percent confidence limits are presented[11].

2.2 Police collected data

The NSW Roads and Traffic Authority (RTA) maintains a data base of police collected information about traffic accidents on NSW roads. To be included in the data base an accident must be reported to the police, have occurred on a public road, have involved at least one moving vehicle and at least one injury or fatality or one vehicle being towed away. These represent about 70 percent of accidents reported on the police P4 Traffic

Collision Report[1].

We obtained data for casualties reported in the RTA data base within the two AHS's for the five years from 1986 to 1990. The study was limited to casualties to minimise the selection bias inherent in analysing all accident data when a proportion are not reported at all and because our primary concern is with injury, especially severe injury, rather than property damage.

RTA data were used to define environmental, human and vehicle factors. These data included location type, impact type, speed limit, weather, surface condition, light (environmental), driver age, sex, experience and blood alcohol, use of an occupant restraint (human) and vehicle age (vehicle). Blood alcohol (driver or casualty) was missing for 11.5 percent of cases and these were excluded in any analysis involving blood alcohol level. Time of injury (coded as between 9pm and 3am or other), and impact type were also included but did not fit neatly into one of the three categories. Local government area (LGA) of the crash was included as the exposure variable of interest. The outcome of interest was serious injury which was defined in the RTA data base as hospital admission or fatality.

Stratified and (unconditional) logistic regression analyses were conducted using the RTA data to determine the importance of the above variables as confounders or effect modifiers of any association between LGA of crash and serious injury[12]. Odds ratios and their 99 percent confidence intervals were calculated using the SAS statistical package[13].

2.3 Case control study

A case control study of human factors hypothesised to be of relevance was conducted.

2.3.1 Case selection

The study was limited to residents of post-code areas falling within the boundaries of the Wentworth or Western Sydney Health Areas. Cases were selected from this population if they were aged 17 years or older and had been the driver of a motor car that was involved in a crash in which at least one person (driver or passenger) was admitted to hospital for at least 24 hours. The study period was from June 1 1992 to November 30 1992.

Cases were identified by searching emergency department logs for name, address and telephone number of anyone admitted following a motor vehicle crash, or with an injury where the external cause was not clear. Given our limited resources we contacted the 11 hospitals that had accounted for 90.2 percent of motor vehicle injury hospitalisations for WHA and WSHA residents in the 1990/91 year.

Medical records for these individuals were checked to confirm eligibility (by post code of residence, age, and whether the injury was motor vehicle related). Injured drivers were identified directly. Injured passengers were contacted by letter and follow up telephone call to request a name and contact address for the driver of the vehicle in which they were travelling when injured.

2.3.2 Control selection

Two groups of controls were selected. The main group was selected, using the electronic white pages, from households with the same street address as cases. Four matched control households were selected for each case.

The individual 'population control' to be interviewed in each household was selected from those who would have been eligible as cases, ie residents of one of the study areas, aged 17 years or older, who had driven a motor vehicle within the study period and could participate in a telephone interview. Where there was more than one eligible person per household a selection table (a Kish grid[14]) was used.

A second, 'hospital control' group, was selected by taking the next two eligible people admitted to the same hospital as the index case, with a non-motor vehicle related injury and within 10 years of age of the index case.

2.4 Data collection

Interviews were conducted in two rounds, the first in November 1992 and the next in February 1993. A standardised questionnaire (Appendix A) was used in a telephone interview to obtain information concerning drugs and driving, including alcohol, cannabis, tranquillisers/sleeping tablets, anti-allergy medication and strong analgesia. Questions were also asked about specified chronic illnesses, previous traffic accidents, random breath testing, use of protective restraints, attitude to speeding, age, sex, history of previous traffic, and other, injury.

The large proportion of cases and hospital controls who indicated having had one injury in the previous two years suggested that many misunderstood the intent of the question and included the index injury. We therefore created a variable for recent history of injury (or traffic accident) where there were at least two events and compared this to one or no events.

Exposure to driving at night and during the day was estimated by asking participants how many days/nights they had driven in the previous month and how many hours they had spent driving on the last occasion on which they had driven.

2.5 Data analysis

The case control study was analysed using the SPIDA[15] statistical package. Associations between crash involvement and specified risk factors were assessed by calculating odds ratios and identifying significant predictors of, and risk factors for, driver crash involvement. Stratified Cox regression models[16] were used to perform conditional logistic regression analyses of associations between driver crash involvement and defined exposures using cases and the matched population controls.

Indicator variables were created for age, day and night driving exposure and average number of occasions per month when alcohol was consumed at various locations. Alcohol consumption was assessed using the quantity frequency method. A question regarding binge drinking (defined as more than eight standard drinks for males, or six for females, on one occasion) was included. Variables were created for alcohol consumption using the National Health and Medical Research Council (NHMRC) criteria for hazardous and harmful levels of consumption. The hazardous range is 15 to 28 standard drinks per week for women and 29 to 42 for men. The harmful range is more than 28 standard drinks for women and more than 42 for men[17].

Section 3.

Results

3.1 Hospitalisation data

In 1990/91 there were 1,167 hospital separations for road traffic injury among residents of the WHA. The corresponding SSR (214.3 per 100,000, 99% CI 191.1-237.2) was significantly higher ($p = 0.004$) than that for WSHA residents, among whom there were 2,226 separations (184.9 per 100,000, 99% CI 170.6-199.2).

The SSR in both Areas fell significantly ($p < 0.001$) between 1986 and 1990/91, from 326.5 per 100,000 (99% CI 357.1-295.9) in the WHA, and from 304.7 per 100,000 (99% CI 285.7-323.6) in the WSHA, in 1986.

The age and sex specific rates shown in Figure 3 (WHA) and Figure 4 (WSHA) indicate that males from 15 to 24 years of age exhibit the highest separation rates and contribute substantially to the between Area difference in separation rates. The WHA separation rate for 15-24 year old males was 701.6 per 100,000 in 1990/91, which was significantly greater ($p < 0.01$) than the rate for the same group in the WSHA (525.8 per 100,000).

Figures 5 to 8 show changes in age specific rates for males and females, from 1986 to 1990/91. The most substantial changes in this time involved the male 15-24 year age group in each area, with the most marked change in the WHA (Figures 5 and 6). There was an increase in the separation rate for males 75 years and older in the WHA (Figure 5). Though this was not significant ($p > 0.05$), when viewed in conjunction with the higher separation rate for that group in 1990/91, it may imply some resistance to the forces promoting an overall reduction in rates of serious road traffic injury.

Figure 3. Road traffic injury hospital separations, Wentworth Health Area residents; 1990/91

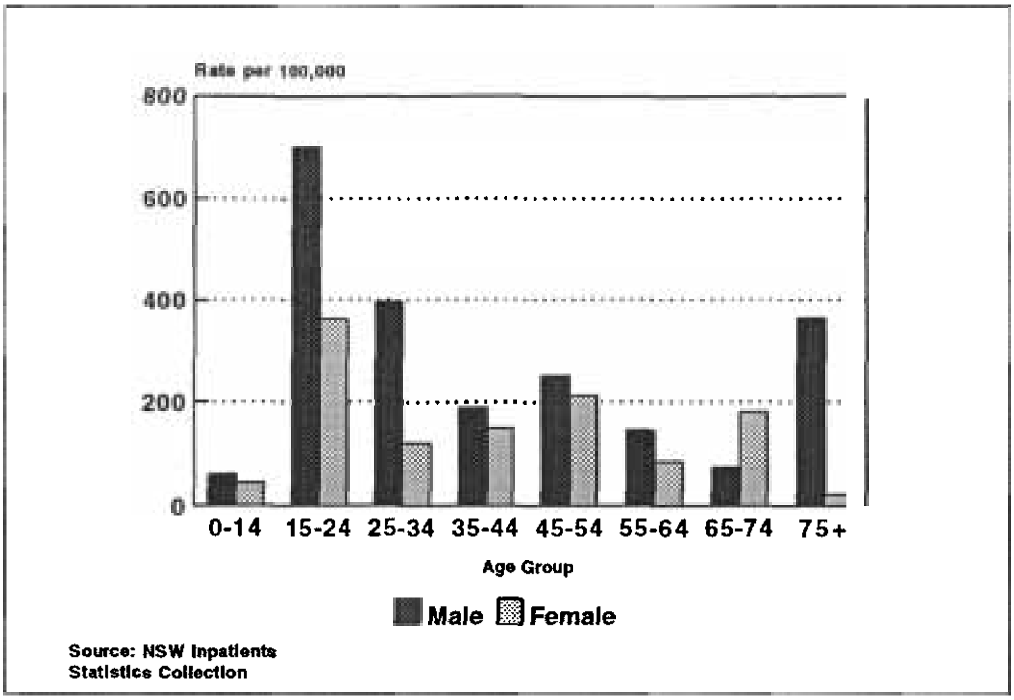


Figure 4. Road traffic injury hospital separations, Western Sydney Health Area; 1990/91.

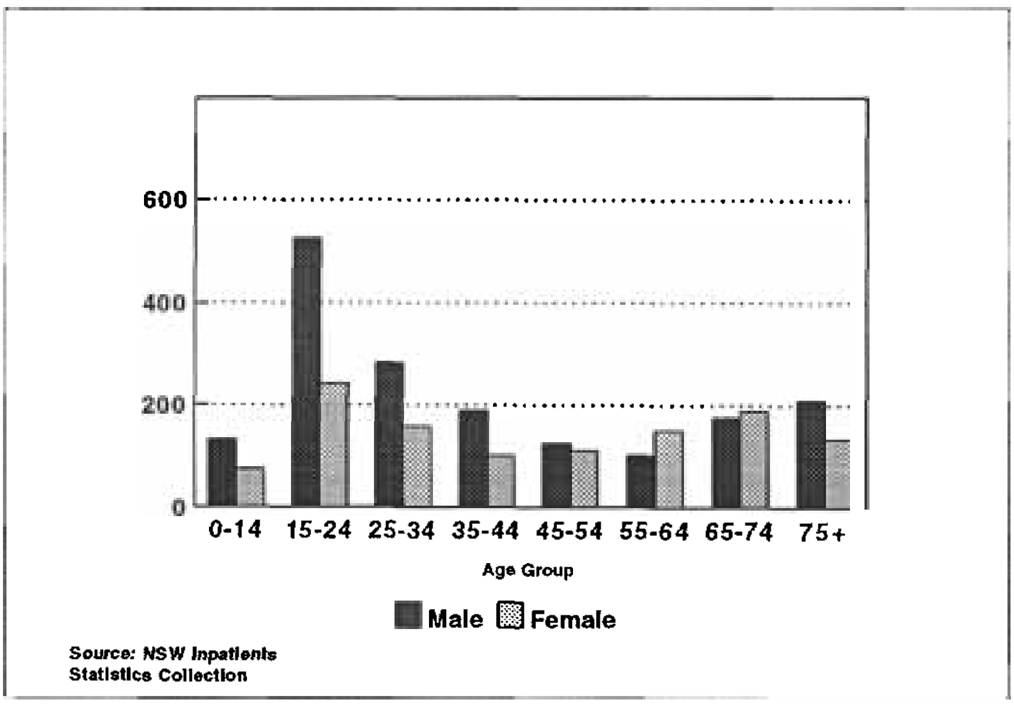


Figure 5. Female road traffic injury; change in hospital separation rates; Wentworth Health Area, 1986 to 1990/91.

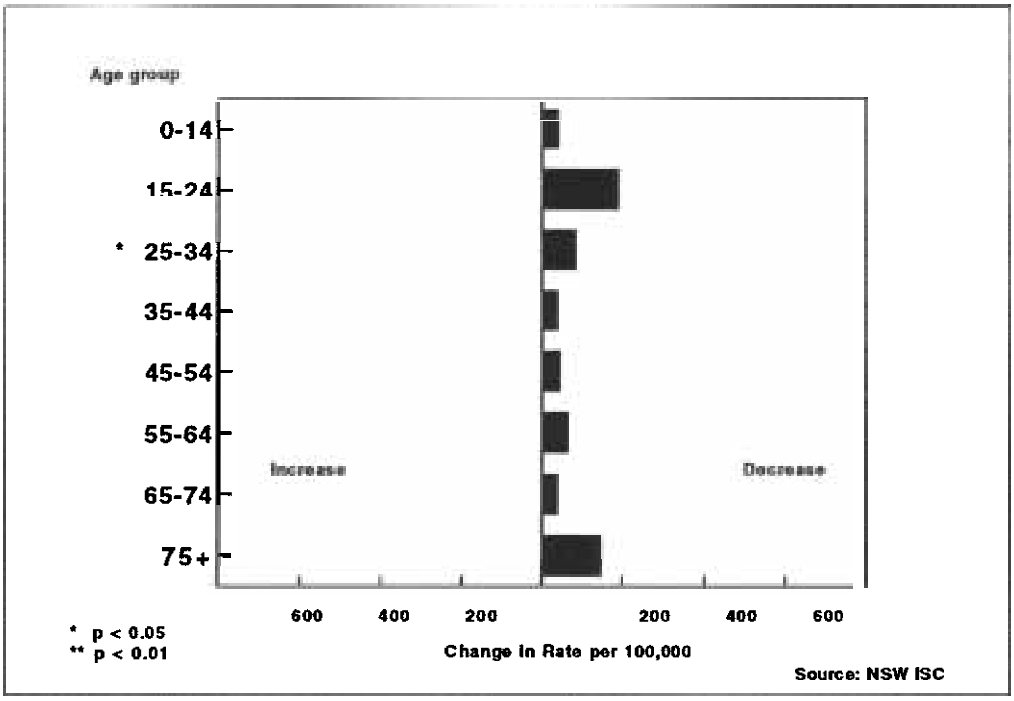


Figure 6. Male road traffic injury; change in hospital separation rates; Wentworth Health Area, 1986 to 1990/91.

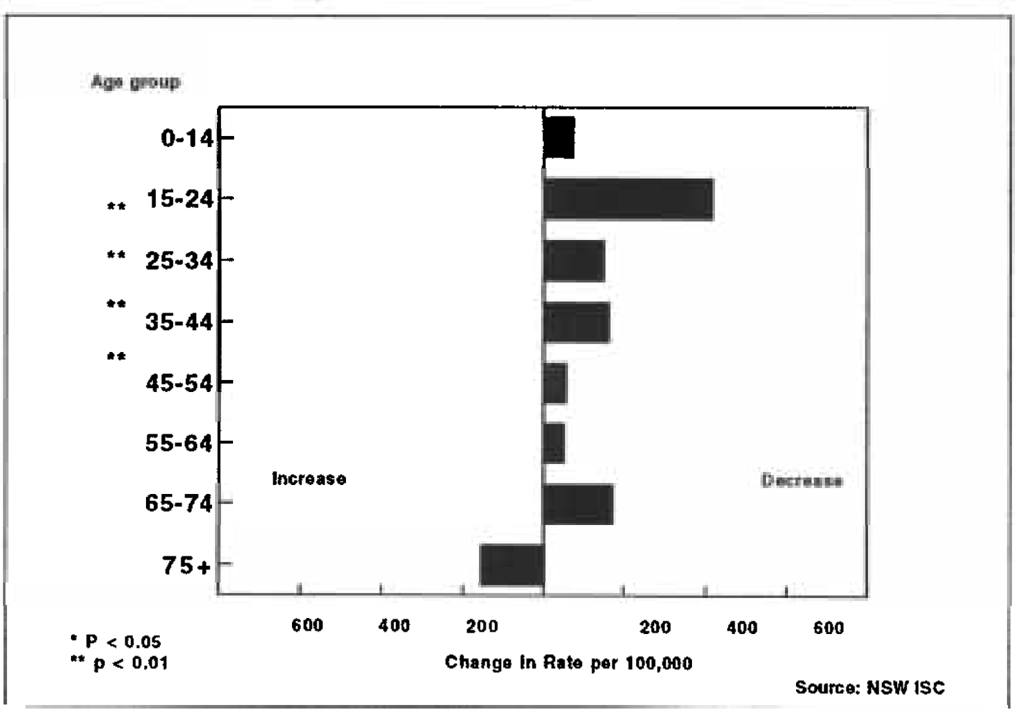


Figure 7. Female road traffic injury; change in hospital separation rates; Western Sydney Health Area, 1986 to 1990/91.

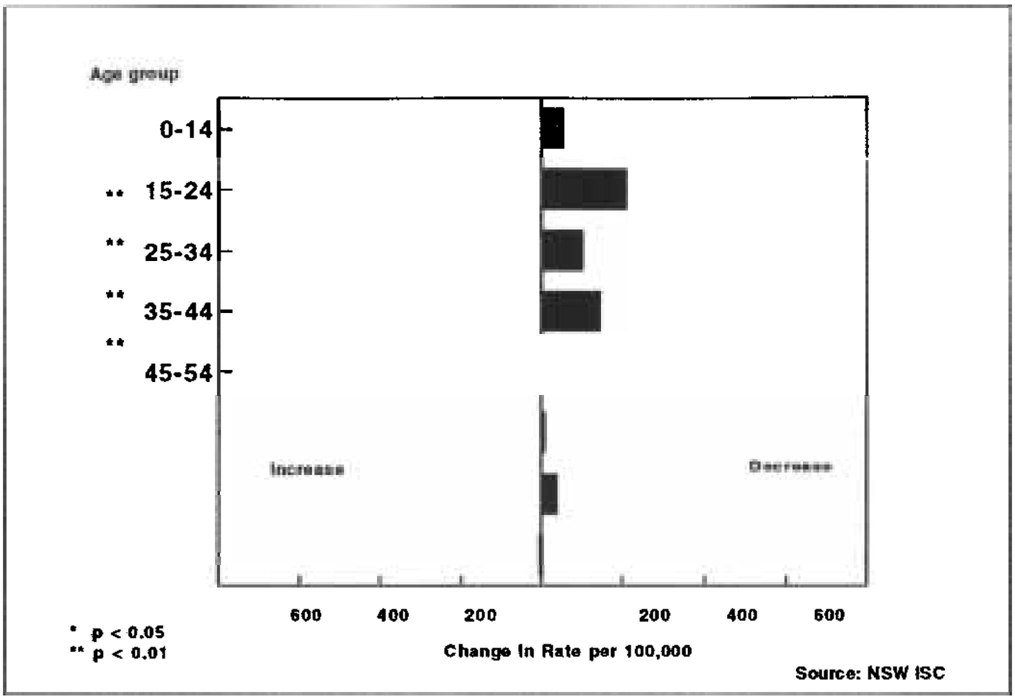
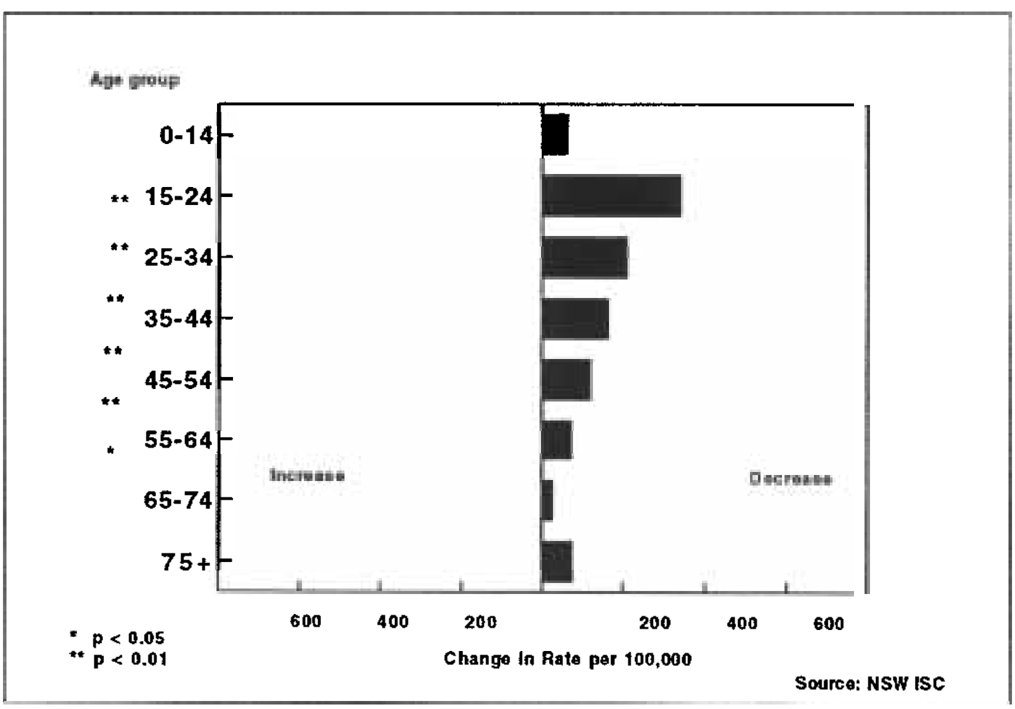


Figure 8. Male road traffic injury; change in hospital separation rates; Western Sydney Health Area; 1986 to 1990/91.



Mortality data were consistent with the hospital separation data. The standardised mortality ratio (SMR) for males in the Wentworth Area in the years 1984 to 1988 was significantly ($p < 0.05$) elevated (Table 2).

3.2 Police collected crash data (Roads and Traffic Authority)

From 1986 to 1990 26,932 road traffic casualties were reported in the RTA database in the eight local government areas comprising the Wentworth and Western Sydney Health Areas. Motor vehicle occupants accounted for nearly three quarters (74.3%) of all casualties, and 63.3% of serious injuries (Table 3).

Table 2. Standardised mortality ratio (SMR) and average deaths per year road traffic injury in Wentworth and Western Sydney Health Areas 1984-1988.

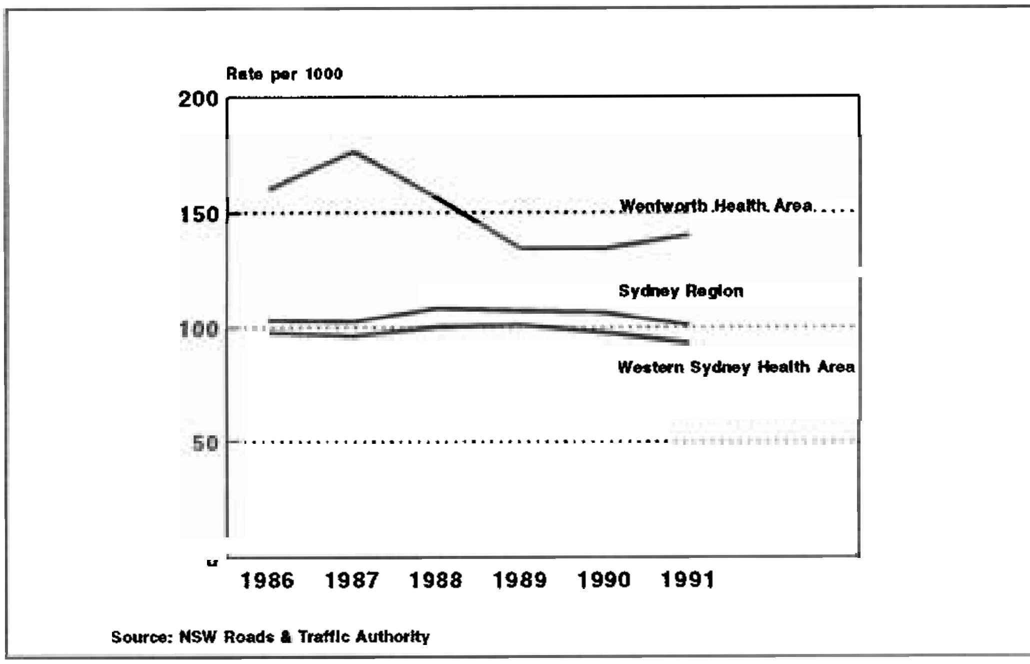
Region	*Average annual deaths*	*SMR (99% CI)*
Wentworth		
female	13	116.5 (79.7-153.5)
male	38	**135.8 (110.5-161.1)**
Western Sydney		
female	26	98.8 (76.6-121.0)
male	74	109.9 (95.2-124.7)
NSW		
female	272	reference
male	659	reference

Table 3. Degree of injury by road user category, road traffic casualties Wentworth and Western Sydney Health Areas, 1986-1990.

Road user category	**Minor injury**		**Severe injury**	
	number	**%**	**number**	**%**
motor vehicle occupant	16338	77.4	3683	63.3
motor cycle rider/passenger	1972	9.3	929	16.0
pedestrian	1762	8.4	945	16.2
pedal cycle rider/passenger	1033	4.9	262	4.5
other	8	0.04	0	0.0
Total	**21113**	**100.0**	**5819**	**100.0**

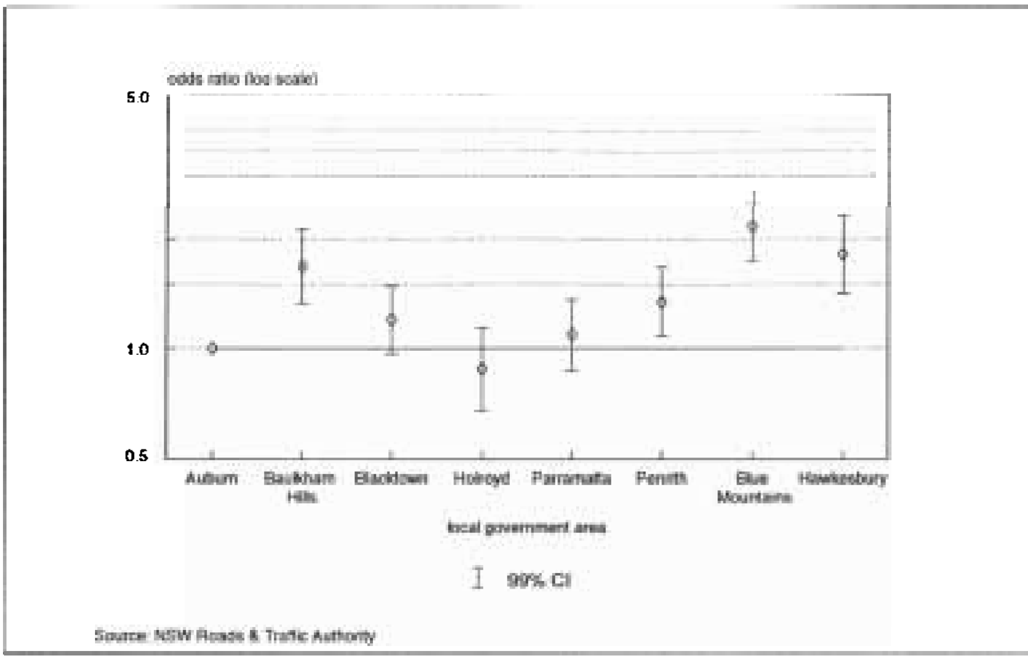
An initial examination of these data suggested that road traffic injury in the WHA was characterised by an excess of severe injuries from a given number of crashes, rather than a greater than expected number of crashes as such (Figure 9).

Figure 9. Fatal and serious injuries per 1000 reported road traffic crashes; by area; 1986 to 1991.



Logistic modelling of the RTA data demonstrated a strong association between LGA and serious injury. Figure 10 shows the unadjusted odds ratios for this association. These odds ratios were significantly elevated ($p < 0.01$) for motor vehicle occupant casualties in the three WHA LGAs and the Baulkham Hills LGA (in the WSHA) compared to the Auburn LGA (reference). There were no significant geographic associations with serious injury for motor cyclist, bicyclist or pedestrian casualties. The ensuing analysis therefore concentrates on motor vehicle occupant casualties.

Figure 10. Estimated odds ratios (unadjusted) for the association between serious injury and LGA of crash, baseline Auburn LGA (OR = 1).



3.2.1 Motor vehicle occupants

The age/sex distribution of drivers of vehicles in which someone was injured (whether the driver was injured or not) and occupant casualties (including injured drivers) is shown in Figures 11 and 12. Among drivers of vehicles in which someone was injured males from 15 to 34 years of age predominated, accounting for 37% of minor, and 45% of serious, injuries.

Figure 11. Drivers of vehicles in injury producing crashes, by age and sex, 1986-1990; Wentworth and Western Sydney Health Areas.

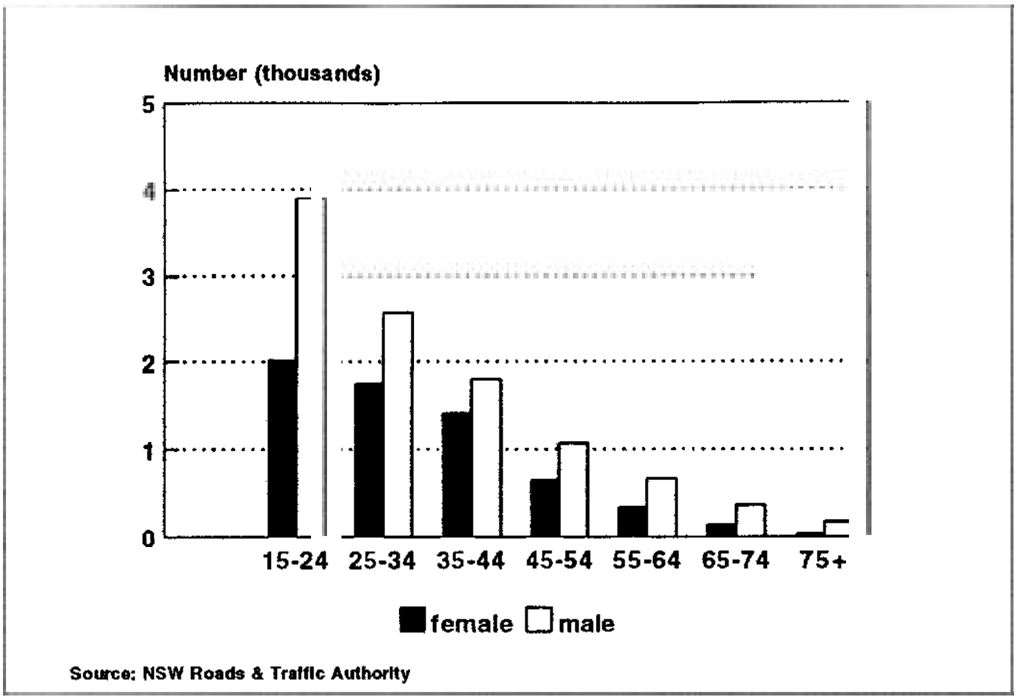
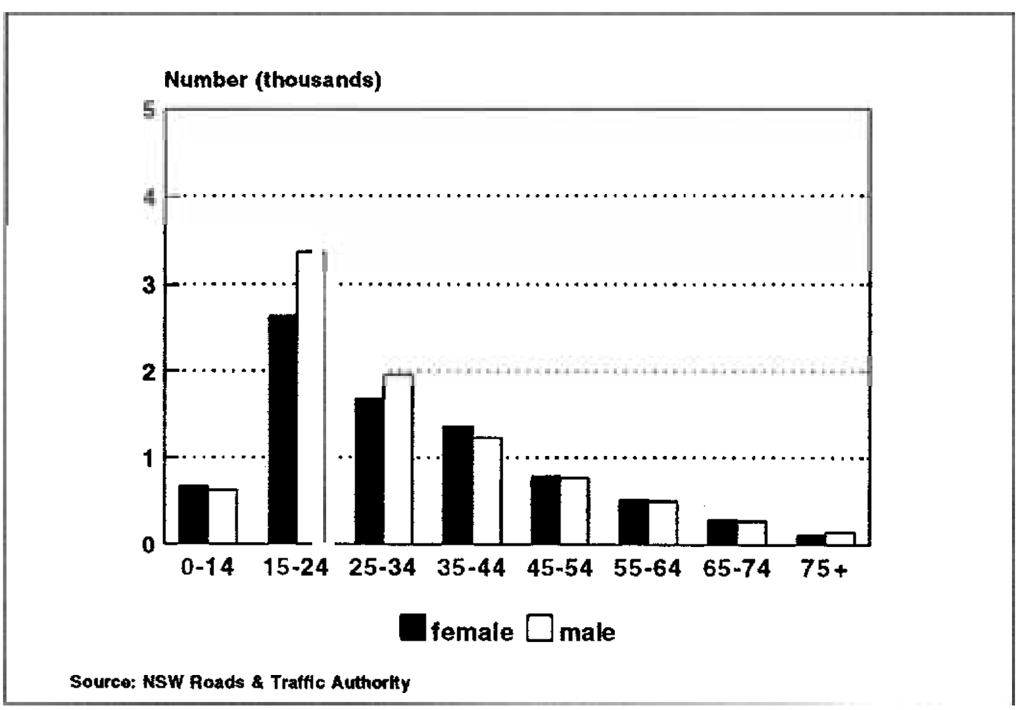


Figure 12. Motor vehicle occupant casualties, by age and sex, 1986-1990; Wentworth and Western Sydney Health Areas.



The association between driver age and serious injury was modified by driver sex. Table 4 shows the estimated odds ratios for this relationship, before and after adjustment. The adjusted odds ratios are from a model including terms for driver blood alcohol, seat belt use, location type, speed limit and time of injury.

There was a significant ($p < 0.01$) association with serious injury and age 75 years and older. This may reflect a relatively high likelihood of serious, compared to minor, injury for the elderly in a given impact. We found no significant ($p > 0.05$) age or sex differences in the association with serious injury below the age of 55 years (Table 4).

Table 4. Estimated odds ratios (ORs) with their 99 percent confidence intervals (CI)for the association between driver age and sex and serious injury, Wentworth and Western Sydney Health Areas, 1986-1990.

Age Group	Female						Male					
	serious injury	*minor injury*	*crude OR*	*99% CI*	*adj. OR*	*99% CI*	*serious injury*	*minor injury*	*crude OR*	*99% CI*	*adj. OR*	*99% CI*
15-24	344	1673	1.00	ref	1.00	ref	883	3022	1.00	ref	1.00	ref.
25-34	259	1486	0.85	0.67-1.06	0.87	0.69-1.11	551	2017	0.93	0.80-1.10	0.93	0.77-1.13
35-44	187	1217	0.75	0.58-0.96	0.82	0.63-1.07	313	1482	0.72	0.60-0.87	0.77	0.62-0.95
45-54	110	534	1.00	0.73-1.37	1.15	0.84-1.58	213	857	0.85	0.68-1.06	1.05	0.82-1.36
55-64	68	267	1.24	0.85-1.82	1.50	1.01-2.22	104	563	0.63	0.47-0.85	0.82	0.60-1.12
65-74	29	106	1.33	0.76-2.33	1.53	0.86-2.71	88	272	1.11	0.79-1.54	1.43	1.00-2.04
75+	11	24	2.23	0.86-5.77	2.78	1.04-7.45	47	121	1.33	0.84-2.09	1.94	1.22-3.10

3.2.2 Geographic variation in serious motor vehicle occupant injury

A stepwise regression analysis (Table 5) indicated that location type and speed limit were the only important confounders of the observed association between LGA and serious injury, with substantial changes in estimated odds ratios when these variables were excluded from, or added to, the model.

The strongest association with serious injury was for casualties in the Blue Mountains LGA (Figure 10 and Table 5). When we adjusted for vehicle controller age, sex and blood alcohol level, casualty seat belt use, time, location and speed limit of crash, the estimated odds ratio for this association was reduced by 31 percent (from 2.18 to 1.50) (Table 5). The odds ratio in a model allowing for location type and speed limit only was identical to that in the full model. The relative impact of crash location and speed limit was similar for the Baulkham Hills, Hawkesbury and Penrith LGAs (Table 5).

Table 5. Estimated odds ratios in stepwise logistic regression analysis of the association between serious injury and lga, baseline Auburn.

Covariates in model	*Auburn (ref)*	*Baulkham Hills*	*Penrith*	*Blue Mountains*	*Hawkesbury*	*Blacktown*	*Holroyd*	*Parramatta*
age, sex, alc, rest, risk, loc-type, speed limit.	1.00	1.29**	1.04	1.50**	1.04	1.01	0.80	1.06
age, sex, alc, rest, risk.	1.00	1.62**	1.30**	2.12**	1.67**	1.12	0.84	1.05
loc-type, speed limit.	1.00	1.31**	1.10	1.50**	1.14	1.07	0.83	1.10
unadjusted.	1.00	1.69**	1.36**	2.18**	1.83**	1.21*	0.88	1.09

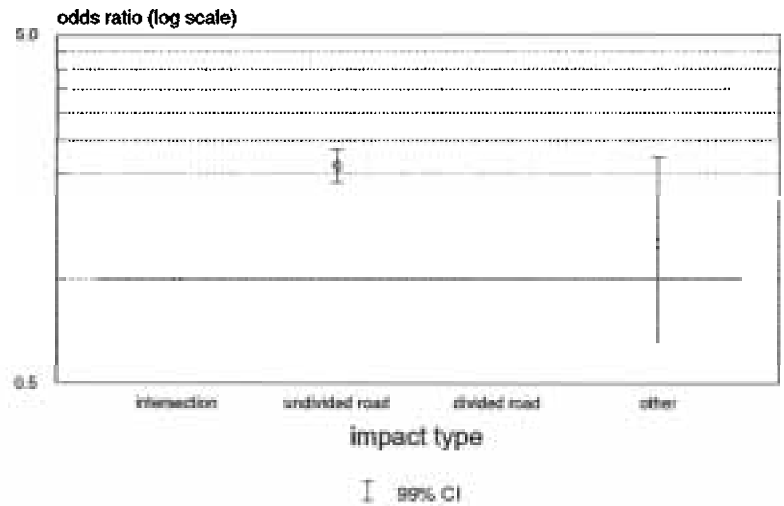
* $p < 0.05$ ** $p < 0.01$

Legend

age:	vehicle controller age
sex:	controller sex
alc:	controller blood alcohol > 0.05 g/100ml
rest:	use of occupant restraint (by casualty)
risk:	crash between 9pm and 3am
loc-type:	type of location of crash
speed limit:	speed limit of location of crash

Casualties from crashes on undivided, two-way roads were significantly ($p < 0.01$) more likely to suffer a serious injury, compared to at intersections and divided roads (Figure 13). Figure 14 shows the proportion of all casualties in each LGA occurring at each major location type. Injuries on undivided roads were more frequent in the four LGAs identified earlier.

Figure 13. Estimated odds ratio for the association between serious injury and location type, baseline intersection (OR = 1); 1986-1990.



Source: NSW Roads and Traffic Authority

Figure 14. Proportion of motor vehicle occupant casualties in each local overnment area by location type.

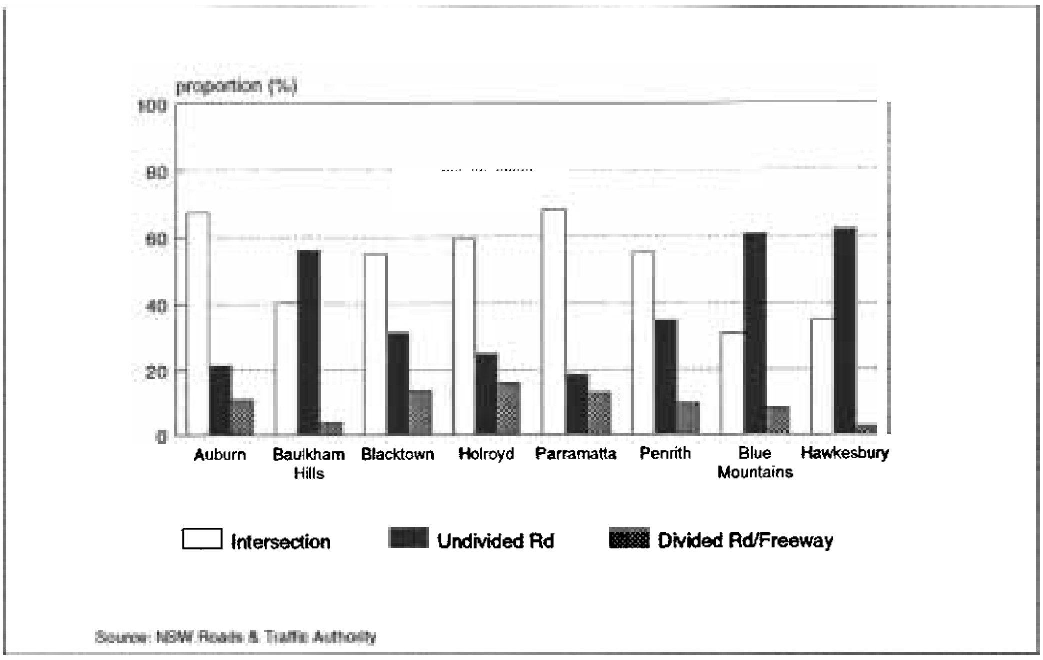


Table 6 shows that type of impact was the major confounder of the association between serious injury and crash location, with elevated driver blood alcohol and, to a lesser extent, speed limit, also affecting this association.

The strongest association with serious injury was for casualties of crashes on two way undivided roads (Table 6). Allowing for type of impact substantially attenuated this association (the estimated odds ratio was reduced by 38 percent from 2.11 to 1.30) (Table 6). Allowing for driver blood alcohol level and speed limit had as much effect as adjustment in the full model. The major influence on the geographic differential in likelihood of serious injury was the type of impact most common in each location.

Table 6. Estimated odds ratios in stepwise logistic regression analysis of the association between location type and serious injury.

Covariates in the model	*Intersection*	*Undivided Road*	*Divided Road*	*Other*
impact type, speed limit, alc, rest, sex, age, risk	1.00	1.18 *	0.98	
age, sex, rest, risk	1.00	1.96 **	1.28 **	0.99
impact type, speed limit, alc	1.00	1.17 *	0.96	0.80
impact type, speed limit	1.00	1.29 **	1.10	0.80
impact type, alc	1.00	1.26 **	1.10	0.83
alc	1.00	1.86 **	1.25 **	1.41
speed limit	1.00	1.89 **	1.11	1.16
impact type	1.00	1.30 **	1.10	0.80
unadjusted model	1.00	2.11 **	1.33 **	1.26

* $p < 0.05$ ** $p < 0.01$

Legend

age:	vehicle controller age	*risk:*	crash between 9pm and 3am
sex:	controller sex	*loc-type:*	type of location of crash
alc:	controller blood alcohol > 0.05 g/100ml	*speed limit:*	speed limit of location of crash
rest:	use of occupant restraint (by casualty)		

The association between impact type and serious injury was significantly greater ($p < 0.01$) for head-on and vehicle-object collisions than other impact types (Figure 15), and these crashes were relatively more common on undivided roads. Almost 75% (74.7%) of head-on collisions leading to an injury, 64.5% of vehicle object collisions and 72% of rollovers occurred on undivided roads (Table 7).

Figure 15: Estimated odds ratios for the association between serious injury and impact type, baseline head-on collision (OR = 1); 1986-1990.

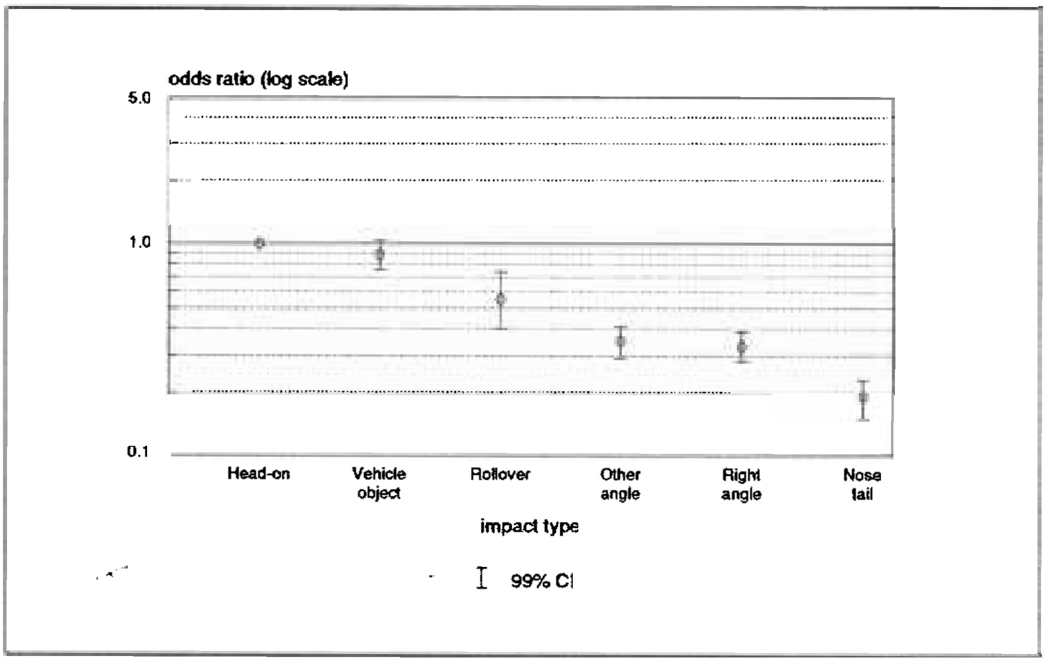


Table 7. Type of impact by type of location, motor vehicle crashes, Wentworth and Western Sydney Health Areas, 1986 to 1990.

Impact Type	**Location Type**									
	Intersection		*Undivided Road*		*Divided Road*		*Other*		***TOTAL***	
	n	*%*	*n*	*%*	*n*	*%*	*n*	*%*	*n*	*%*
Head-on	283	14.6	1446	74.7	200	10.3	6	0.3	1935	100
Other angle	6574	83.2	1025	13.0	300	3.8	1	0.0	7900	100
Nose-tail	1418	47.5	835	27.9	722	24.2	13	0.4	2988	100
Vehicle-object	673	19.8	2189	64.5	511	15.1	20	0.6	3393	100
Rollover	71	14.0	363	71.7	71	14.0	1	0.2	506	100
Other	29	23.0	82	65.1	14	11.1	1	0.8	126	100
TOTAL	9048	53.7	5940	35.3	1818	10.8	42	0.2	16848	100

Table 8 shows that the strongest association with serious injury was for casualties occurring in areas with speed limits of 80 km/hour or more. Further, the major impact of type of location was in those areas (Table 8).

For speed limits of 70 km per hour or less, the association with serious injury was less marked in the Blue Mountains and Baulkham Hills LGAs and did not reach statistical significance in the Hawkesbury and Penrith LGAs (Table 8).

The strongest association between serious injury and LGA was in areas with speed limits of 80 km per hour or more, especially in the four 'high risk' LGAs (Table 8). The addition of a variable representing type of location to the model of the relationship between serious injury and LGA reduced the estimated odds ratio for the Blue Mountains by 30 percent (from 2.37 to 1.66) and that of the Baulkham Hills LGA by 34 percent (from 2.63 to 1.74) for casualties in 80 km per hour or greater speed zones. The impact of adjusting for location type was less marked in the lower speed limit areas (an increase in the estimated odds ratio of 18 percent in the Blue Mountains LGA and 16 percent in the Baulkham Hills LGA) (Table 8).

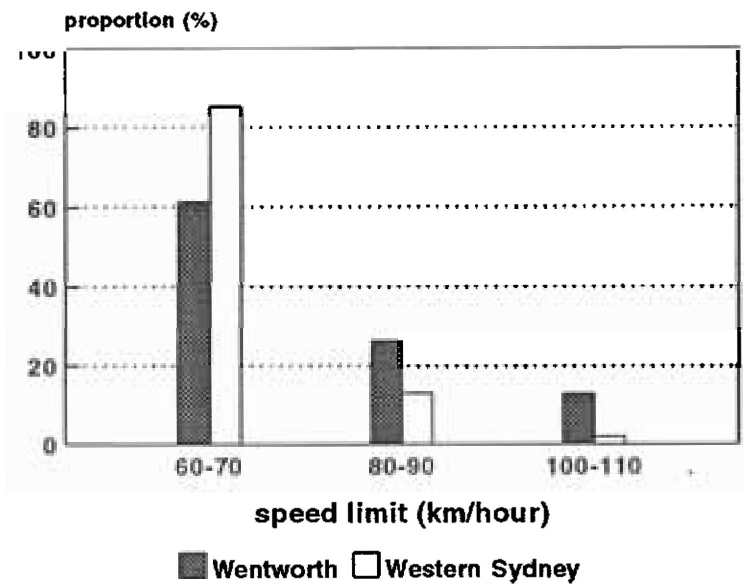
Table 8. Estimated odds ratios for the association between serious injury among motor vehicle occupant casualties and LGA by speed limit, with and without location type.

Speed limit	*Auburn (ref)*	*Baulkham Hills*	*Penrith*	*Blue Mountains*	*Hawkesbury*	*Blacktown*	*Holroyd*	*Parramatta*
80 km per hour or more:								
univariate	1.00	2.63**	1.20*	2.37**	2.13**	1.28	0.89	1.20
including location type	1.00	1.74	1.46	1.66	1.39	1.11	0.91	1.21
70 km per hour or less:								
univariate	1.00	1.47**	1.10	1.77**	1.27	1.17	0.86	1.07
including location type	1.00	1.24*	1.06	1.45**	1.12	1.09	0.82	1.08
All speed limits								
univariate	1.00	1.69**	1.36**	2.18**	1.83**	1.21*	0.88	1.09
including location type and speed limit	1.00	1.31**	1.10	1.50**	1.14	1.07	0.83	1.10

* $p < 0.05$ ** $p < 0.01$

It is apparent from Figure 16 that, though the majority of occupant casualties occur in 60 and 70 km/hour speed limits (mostly 60km/hour), relatively more occur in the WHA in crashes in the higher speed limit zones.

Figure 16. Proportion of occupant casualties at each speed limit by Area



Source: NSW Roads and Traffic Authority

3.2.3 Single and multiple vehicle crashes

Figures 17 and 18 show the relationship between location type and impact type for the two Health Areas and for multiple (Figure 17), and single (Figure 18), vehicle crashes. Head-on and vehicle object collisions were relatively more frequent on undivided roads, accounting for much of the observed excess risk on these roads.

Though the majority of multiple vehicle crashes occurred at intersections in each Area, relatively more of these crashes in the WHA occurred on undivided roads than those in the WSHA (Figure 17). Further, multiple vehicle crashes on undivided roads in Wentworth were significantly more likely ($p < 0.01$) to involve a head-on collision than those in Western Sydney (Figure 17).

The majority of single vehicle crashes were vehicle-object and occurred on undivided roads (Figure 18). Significantly more ($p < 0.01$) occupant casualties in WHA were from single vehicle crashes than in the WSHA (29.1%, compared to 19.8% in WSHA).

Single vehicle crashes were associated with more severe injury (29.6% serious compared to 15.9% where more than one vehicle is involved). Nearly half (42.8%) of occupant injuries on undivided roads were from single vehicle crashes (compared to 22.9% overall).

Figure 17. Proportion of casualties from multiple vehicle crashes in each location type by impact type and Area

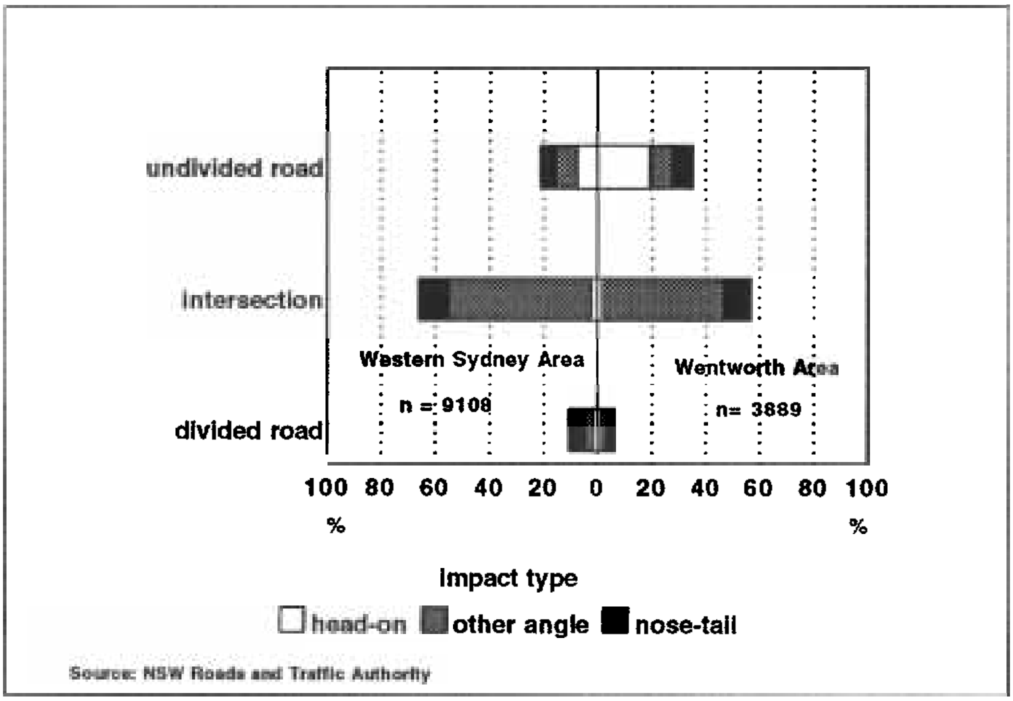
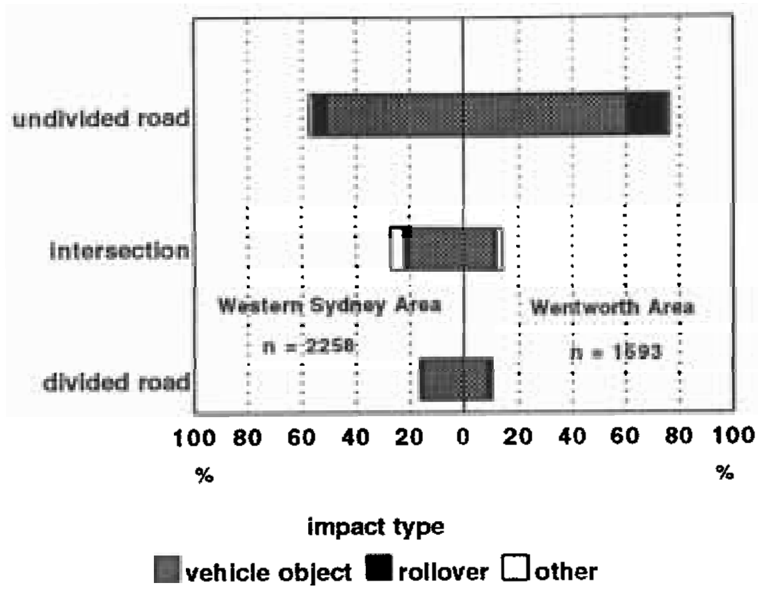


Figure 18. Proportion of casualties from single vehicle crashes in each location type by impact type and Area.



Source: NSW Roads and Traffic Authority

3.3 Driver blood alcohol level

Almost a third (29 percent) of the single vehicle injury crashes involved a vehicle controller with an elevated blood alcohol (ie., 0.05 g/100ml or higher), compared to 6 percent in the case of multiple vehicle crashes.

A significantly greater ($p < 0.01$) proportion of drivers of vehicles in which someone was injured had an elevated blood alcohol in WHA crashes (12.5 percent) than in the WSHA (10.7 percent). Alcohol was a particular issue in the Hawkesbury LGA where 16.4 percent of drivers in injury producing crashes had an elevated blood alcohol.

It should be noted that 11.5 percent of reported motor vehicle occupant casualties did not have a driver blood alcohol recorded (either missing or unknown)(Table 9). Of those that did, 11.3 percent were recorded as being 0.05 gm per 100ml or above. Of some concern was the finding that 13.8 percent of those with a missing or unknown blood alcohol had sustained a serious or fatal injury. These casualties presumably would have come to the attention of people who were aware of the legislative requirements.

The true proportion of drivers with elevated blood alcohol was between 10 percent (if all of the unknown blood alcohols were below 0.05 gm per 100ml) and 21.5 percent (if they were all above this level).

Table 9. Proportion of occupant casualties by LGA; and whether driver blood alcohol known or unknown (including missing)

LGA	Missing/unknown blood alcohol		Known blood alcohol	
	no.	%	no.	%
Auburn	128	7.3	1615	92.7
Baulkham Hills	296	16.3	1523	83.7
Blacktown	588	13.2	3876	86.8
Holroyd	207	11.1	1663	88.9
Parramatta	376	14.0	2689	87.7
Penrith	341	10.9	2791	89.1
Blue Mountains	90	6.1	1384	93.9
Hawkesbury	174	11.7	1307	88.3
Total	**2200**	**11.5**	**16848**	**88.5**

Source: NSW RTA. 1986-1990.

The effect of elevated driver blood alcohol (≥ 0.05 gm/100ml) was modified by age and sex (Table 10). Proportionately more male than female drivers had an elevated blood alcohol in each age group (other than the over 75 group), with the largest proportion of all elevated driver blood alcohol levels in the male 15-24 year age group (Table 10). However, odds ratios for the association between elevated driver blood alcohol and serious injury were greater for females than for males at each age and were highest in the female 35-44 year age group.

Adjustment in a multivariate logistic model had a substantial impact on the age specific odds ratios for males (Table 11). The adjusted odds ratios quoted are from a model containing main effects terms for driver age, sex and blood alcohol level, casualty restraint use, high risk time, location type and speed limit, along with cross products terms for driver alcohol and sex and driver alcohol and age.

The only important confounder of the relationship between elevated blood alcohol and serious injury was location type, with high risk period (ie., from 9pm to 3am) of lesser importance. The likelihood of serious injury for casualties where the driver had an elevated blood alcohol was greater on two-way, undivided roads. Almost two thirds (61.8 percent) of fatal and serious injuries involving a driver with an elevated blood alcohol occurred on two-way, undivided roads, whereas only 48.7 percent of all fatal and serious injuries were on these roads (Table 11).

More than half (53.9 percent) of the fatal and serious injuries involving a driver with an elevated blood alcohol occurred between the hours of 9pm and 3am. Crashes occurring in this high risk period were strongly associated with serious injury (odds ratio=1.99, 99 percent CI=1.76,2.25). Even when allowing for the impact of driver blood alcohol, age and sex, casualty seat belt use, location and speed limit of crash this association persisted (adjusted odds ratio=1.48, 99 percent CI=1.29,1.69).

One in three (33.5%) casualties with an elevated blood alcohol were reported as not wearing a seat belt. Seat belt use was strongly protective against serious injury overall (crude odds ratio=0.45, 99 percent CI=0.39,0.53). This effect was not related to casualty age, sex, blood alcohol, crash location or speed limit (adjusted odds ratio=0.52, 99 percent CI=0.44,0.61). A significantly higher ($p < 0.001$) proportion of Wentworth Area casualties were reported as not wearing a seat belt (9.8%) compared to Western Sydney (8.1%).

Table 10. Estimated odds ratios (ORs) and their 99 percent confidence intervals (CI) for the association between elevated driver blood alcohol (≥ 0.05 gm/100ml) and serious injury, by sex and age group, Western Sector, 1986-1990.

Age Group	**Female**						**Male**					
	serious injury	*other injury*	*crude OR*	*99% CI*	*adjusted OR*	*99% CI*	*serious injury*	*other injury*	*crude OR*	*99% CI*	*adjusted OR*	*99% CI*
15-24	47	77	1.00	ref.	1.00	ref.	283	482	1.00	ref.	1.00	ref.
25-34	46	68	4.14	2.87-5.98	2.98	2.03-4.38	182	291	3.09	2.38-4.01	2.25	1.71-2.95
35-44	21	28	5.03	3.19-7.92	3.78	2.38-6.11	75	117	3.75	2.40-5.86	2.87	1.83-4.24
45-54	7	15	3.02	1.64-5.55	2.51	1.33-4.72	31	56	2.25	1.30-3.91	1.89	1.07-3.34
55-64	3	6	1.86	0.71-4.83	1.77	0.67-4.70	8	30	1.38	0.55-3.47	1.34	0.52-3.42
65-74	1	1	2.40	0.71-8.10	2.06	0.59-7.24	7	13	1.79	0.56-3.23	1.56	0.47-5.23
75+	1	0	3.14	0.08-123.20	3.74	0.90-153.91	0	1	2.34	0.06-92.44	2.82	0.07-115.89

Table 11. Motor vehicle occupant casualties by injury severity, blood alcohol and speed limit in each location type; Wentworth and Western Sydney Health Areas, 1986-1990.

Location Type	60-70 km/hour speed limit				80-90 km/hour speed limit				100-110 km/hour speed limit			
	blood alcohol ≥ 0.05 gm/100ml		*blood alcohol < 0.05 gm/100ml*		*blood alcohol ≥ 0.05 gm/100ml*		*blood alcohol < 0.05 gm/100ml*		*blood alcohol ≥ 0.05 gm/100ml*		*blood alcohol < 0.05 gm/100ml*	
	serious injury	*other injury*	*serious injury*	*other injury*	*serious injury*	*other injury*	*serious injury*	*other injury*	*serious injury*	*other injury*	*serious injury*	*other injury*
Intersection	158	347	928	6528	16	40	171	780	6	5	24	45
Undivided Road	298	494	646	2677	84	107	290	711	58	54	186	335
Divided Road	47	82	119	700	28	39	93	518	11	9	35	137
Other	5	7	3	16	1	1	0	7	0	0	0	2
TOTAL	**508**	**930**	**1696**	**9921**	**129**	**187**	**554**	**2016**	**75**	**68**	**245**	**519**

3.3 Case control study

3.3.1 Overview

Data were available from 87 cases, 316 population controls and 139 hospital controls. This represents a response rate of 57 percent for cases, 52 percent for population controls and 47 percent for hospital controls. The refusal rate was only 16 percent (7 percent for cases, 20 percent for population controls and 12 percent for hospital controls). Ineligibility (mainly having not driven in the study period) excluded 10 percent of population controls and 17 percent of hospital controls. A major problem with the methodology is reflected in the large proportion who were simply not contactable (having moved or given a contact address in the medical record). This involved 34 percent of cases, 13 percent of population controls and 22 percent of hospital controls. Language was a problem for only 1 percent of cases, 6 percent of population controls and 2 percent of hospital controls.

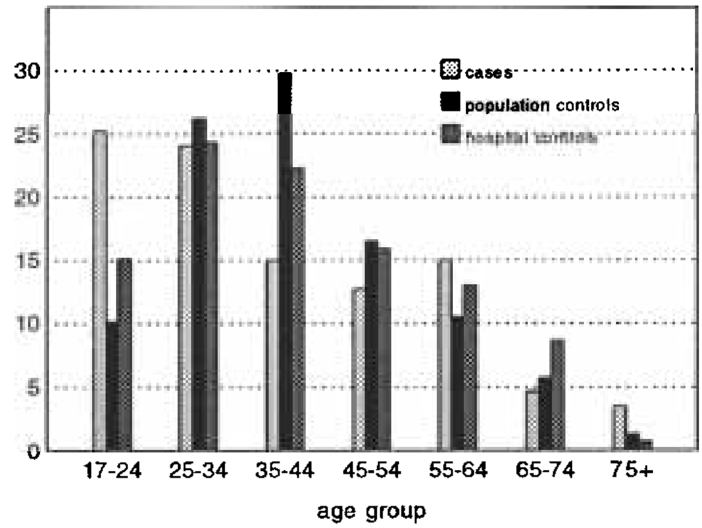
Only 79 cases had at least one matched population control who responded and were available for inclusion in a conditional logistic regression. There were 176 population controls matched to the 79 cases.

Approximately half the cases (54 percent) and half the population controls (48.7 percent) were male, however 70.5 percent of the hospital controls were male.

The age distribution of each of the three study groups is shown in Figure 19. Relatively more cases were in the 17-24 years age group compared to either control group (Figure 19).

The median case age was 35 (95 percent CI= 29,42), with a range of 17 to 83 years. The population control group were slightly older with a median age of 40 (95 percent=CI 37,41) and a range of 18 to 78 years. The median age of hospital controls was also 40 years (95 percent CI 36,42) and the age range 17 to 79 years.

Figure 19. Age distribution by study group (proportion of each group by age)



The median number of years of driving experience for cases was 14 years (95 percent CI=10,18), for population controls 19 years (95 percent CI=17,20) and for hospital controls 19 years (95 percent CI=15,20). Cases were relatively overrepresented among those with less than 6 years driving experience (Figure 20 and Table 12). The proportion of cases with five years or less driving experience (25.2 percent) was significantly greater than the corresponding proportion of population controls (11.7 percent) ($p < 0.01$ for the difference in proportions).

Driving experience of three to five years was significantly associated with driver crash involvement (odds ratio=2.76, 95 percent CI=1.10,6.93). A positive association was found with experience of only one or two years, but this was not significant (odds ratio=2.78, 95 percent CI=0.82,9.45).

Figure 20. Distribution of years of driving experience by study group (proportion of each group by years of experience).

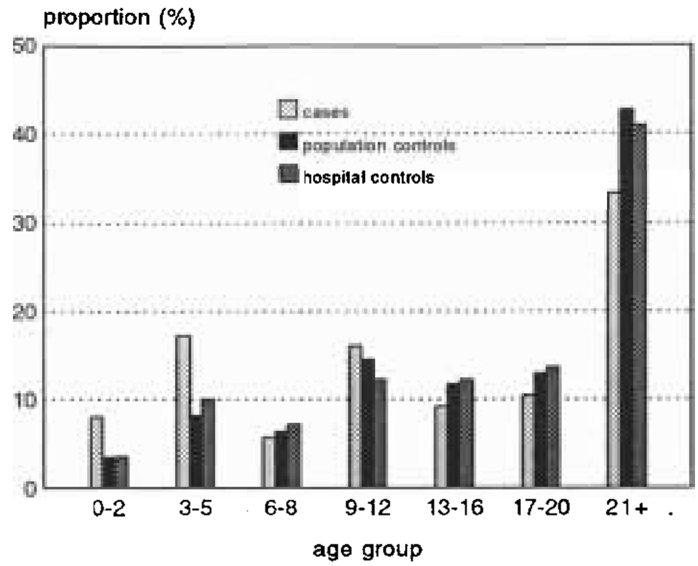


Table 12. Estimated odds ratios for the association between years of driving experience and motor vehicle injury in a univariate conditional logistic model.

experience	*odds ratio*	*95 % confidence interval*
1 to 2 years	2.78	0.82-9.45
3 to 5 years	2.76	1.10-6.93
6 to 8 years	0.86	0.25-3.00
9 to 12 years	1.53	0.62-3.77
13 to 16 years	0.78	0.28-2.21
17 to 20 years	1.15	0.43-3.10
21 + years	1.00	ref.

Age was strongly positively correlated with years of driving experience among cases and population controls (Pearson correlation coefficient 0.88, $p < 0.01$). Allowing for driver age reversed the association between experience and crash involvement for the least experienced drivers (change in the odds ratio from 2.78 in a univariate model of crash involvement and driver experience to 0.89 in a model with driver age as well) (Table 13). Driver age had little or no impact on this association for those with three to five years experience (odds ratio=2.83, 95 percent CI=0.47,17.10). Though not significant in this study this suggests that a 'little experience' may be associated with an increase in crash involvement.

Table 13. Estimated odds ratios for the association between years of driving experience and motor vehicle injury when age is added to the conditional logistic model in Table 6.

years of driving experience	odds ratio	95 % confidence interval
1 to 2 years	0.89	0.08-10.35
3 to 5 years	2.83	0.47-17.10
6 to 8 years	1.09	0.20- 5.90
9 to 12 years	2.05	0.50- 8.44
13 to 16 years	0.99	0.28- 3.58
17 to 20 years	1.33	0.46- 3.85
21 + years	1.00	ref.

Overall 31.0 percent of participants were born overseas and there was no significant association between being born in Australia and driver crash involvement (odds ratio=1.15, 95 percent CI=0.64,2.08). Virtually all participants (93.2 percent) reported English as the major language spoken at home.

3.3.2 Univariate modelling

Significant predictors ($p < 0.05$) of driver crash involvement in univariate conditional logistic models are shown in Table 14. Drivers involved in injury producing crashes were less likely than population controls (though not hospital controls, odds ratio=0.57, 95 percent CI=0.31,1.03), see Table 15) to report that the month prior to interview was typical of their behaviour over the previous 12 months (odds ratio=0.37, 95 percent CI=0.20,0.71).

To assess any differential exposure/outcome relationships between those reporting, and those not reporting, this change in behaviour, a variable for 'past month typical' was included as an interaction term in models examining associations between exposures of interest and driver crash involvement.

The only significant ($p < 0.1$) interaction found was with a report of having been random breath tested in the past 12 months. Cases reporting a change in the past month were less likely to have been random breath tested in the previous 12 months, while cases reporting a that the past month had been typical were more likely than controls to have been random breath tested in the past year.

Being a crash involved driver was associated with current use of medication for depression (odds ratio=5.21, 95 percent CI=1.35,20.10), to sleep (odds ratio=2.72, 95 percent CI=1.05,7.09) and strong analgesia (odds ratio=2.49, 95 percent CI=1.42,4.38) in the six months prior to interview.

Being single was associated with driver crash involvement (odds ratio if married=0.43, 95 percent CI=0.24,0.77). This appeared to be at least partly related to age as the association was not significant if age was added to the model estimating the association between marital status and crash involvement (adjusted odds ratio=0.56,
95 percent CI=0.28,1.10).

Drivers in the 25 to 34 and 35 to 64 year age groups were significantly less likely to be involved in injury producing crashes than those in the 17 to 19 years group (Table 14).

Table 14. Estimated odds ratios and 95 percent confidence intervals for significant predictors, or effect modifiers, from univariate models using population controls.

Factor	*Odds ratio*	*95% CI*
random breath tested in the past 12 months		
past month typical of last 12 months		
no	1.00	ref
yes	3.78	0.52-27.56
past month not typical		
no	1.00	ref
yes	0.78	0.38-1.62
use of medication for depression		
no	1.00	ref
yes	5.21	1.35-20.10
use of medication to sleep		
no	1.00	ref
yes	2.72	1.05-7.09
use of medication for pain relief		
no	1.00	ref
yes	2.49	1.42-4.38
married (including defacto)		
no	1.00	ref
yes	0.43	0.24-0.77
age		
17-19	1.00	ref
20-24	0.44	0.09-2.15
25-34	0.22	0.05-0.97
35-64	0.19	0.05-0.80
65+	0.34	0.06-1.92
daytime driving (hours driven in month prior to interview)		
0	1.00	ref
1-10	0.04	0.01-0.26
11-20	0.05	0.01-0.22
21-40	0.04	0.01-0.19
41-100	0.09	0.02-0.51
101+	0.20	0.03-1.19
night driving exposure (hours driven in month prior to interview)		
0	1.00	ref
1-10	0.26	0.13-0.55
11-20	0.38	0.16-0.91
21-30	0.57	0.20-1.61
31+	5.28	1.08-25.72
more than one injury requiring medical attention in past two years		
no	1.00	ref
yes	3.58	1.61-7.99
more than one traffic accident as a driver in past two years		
no	1.00	ref
yes	13.91	3.09-62.69

The association between daytime driving exposure and driver crash involvement was 'U' shaped, with the strongest association for those who drove infrequently or very frequently (Figure 21).

Figure 22 shows a 'J curve' relationship between night driving and crash involvement. The association fell with moderate exposure, but was highest for those driving most frequently at night.

Figure 21. Estimated association between daytime driving exposure in the month prior to interview and driver involvement in an injurious crash.

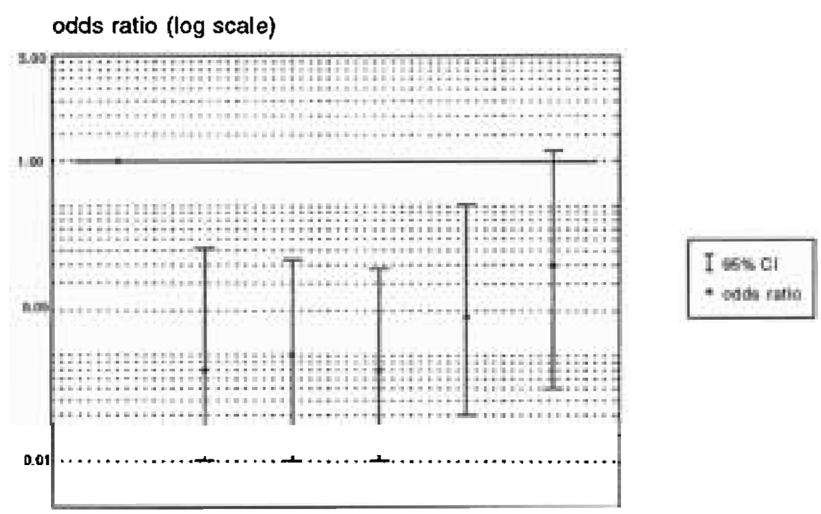
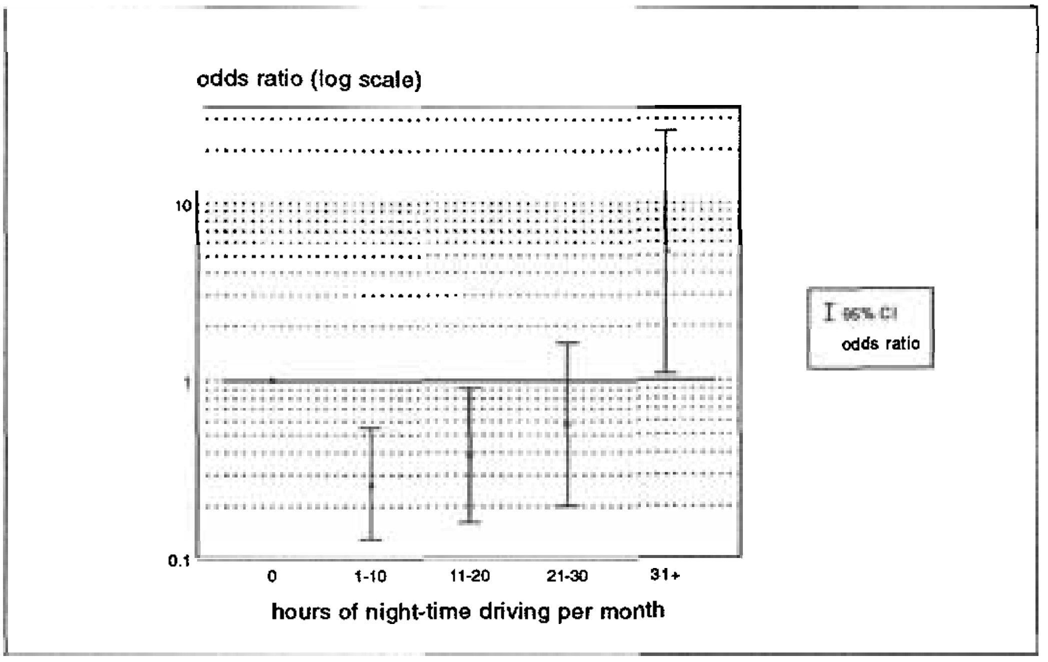


Figure 22. Estimated association between night-time driving exposure in the month prior to interview and driver involvement in an injurious crash.



Reporting more than one injury requiring medical attention (visit to a doctor, hospital or dentist) in the previous two years was strongly associated with crash involvement during the study period (odds ratio=3.58, 95 percent CI=1.61,7.99).

Involvement in more than one traffic accident in the past two years was even more strongly associated with crash involvement (odds ratio=13.91, 95 percent CI=3.09,62.69).

The analysis shown in Table 14 was repeated using hospital, rather than population, controls (Table 15). Though cases were more likely than population controls to report that the month prior to interview had not been typical of the previous 12 months, there was no significant corresponding difference between cases and hospital controls (odds ratio=0.57, 95 percent CI=0.31,1.03). Cases were no more likely than hospital controls to report having been random breath tested in the past 12 months (odds ratio=1.25, 95 percent CI=0.73,2.13).

The observed associations between crash involvement and use of antidepressants, sleeping tablets and strong analgesia in models using population controls were not found in models using hospital controls (odds ratio=1.67, 95 percent CI=0.63,4.38, odds ratio=1.01, 95 percent CI=0.46,2.20 and odds ratio=0.87, 95 percent CI=0.51,1.49, respectively).

Cases were no more likely than hospital controls to report more than one injury requiring medical attention in the past two years (odds ratio=0.87, 95 percent CI=0.46,1.63).

The association between driver crash involvement and daytime driving exposure in models using hospital controls was significantly greater for those with no recent driving exposure (Table 15).

The associations between crash involvement and age, night driving exposure, marital status and history of more than one traffic accident were similar in models using population and hospital controls (Table 15).

Table 15. Estimated odds ratios and 95 percent confidence intervals for factors shown in Table 14, using hospital controls.

Factor	*Odds ratio*	*95% CI*
random breath tested in the past 12 months		
no	1.00	ref
yes	1.25	0.73,2.13
use of medication for depression		
no	1.00	ref
	1.67	0.63,4.38
use of medication to sleep		
no	1.00	ref
yes	1.01	0.46,2.20
use of medication for pain relief		
no	1.00	ref
yes	0.87	0.51,1.49
married (including defacto)		
no	1.00	ref
yes	0.45	0.26,0.79
age		
17-19	1.00	ref
20-24	0.29	0.07,1.31
25-34	0.23	0.06,0.97
35-64	0.20	0.05,0.78
65+	0.20	0.04,1.01
daytime driving (hours driven in month prior to interview)		
0	1.00	ref
1-10	0.24	0.06,0.88
11-20	0.33	0.14,0.78
21-40	0.26	0.09,0.77
41-100	0.24	0.08,0.69
101+	0.20	0.06,0.66
night driving exposure (hours driven in month prior to interview)		
0	1.00	ref
1-10	0.34	0.13,0.68
11-20	0.37	0.16,0.84
21-30	0.66	0.24,1.79
31+	1.31	0.42,4.15
more than one injury requiring medical attention in past two years		
no	1.00	ref
yes	0.87	0.46,1.63
more than one traffic accident as a driver in past two years		
no	1.00	ref
yes	7.96	2.20,28.84

3.3.3 Multivariate models

The results of multivariate modelling of the association between crash involvement and those factors found to be significant in univariate models depended on which measure of driving exposure was used (ie, day or night).

Tables 16-18 show the estimated odds ratios from multivariate models containing those variables found to be significantly associated with driver crash involvement in univariate models (Table 14), and including driver age and sex. The first model (Table 16) makes no adjustment for driving exposure. A history of more than one traffic accident in the past two years (odds ratio=14.56, 95 percent CI=2.64,80.22) and current use of sleeping tablets (odds ratio=4.28, 95 percent CI=1.43,12.83) were independently associated with crash involvement in this model (Table 16).

When daytime driving exposure was included (Table 17) the odds ratio for the association between crash involvement and history of more than one traffic accident changed substantially (odds ratio=34.09, 95 percent CI=3.67,317.19). The odds ratio for current use of sleeping tablets changed little (odds ratio=4.31, 95 percent CI=1.28,14.53)

Including night time exposure in the model (Table 18) changed the odds ratio for history of more than one traffic accident in the past two years very substantially (odds ratio=11.86, 95 percent CI=2.02,69.67).

A history of more than one traffic accident in the past two years (odds ratio=9.37, 95 percent CI=2.21,29.03) was the only independent predictor of driver involvement in a crash in a multivariate model including variables for past month typical, sex, age and daytime exposure, using hospital controls. In the corresponding model including night driving exposure sex (odds ratio=0.48, 95 percent CI=0.25,0.91) and history of more than one traffic accident in the past two years (odds ratio=7.65, 95 percent CI=1.89,30.92) were significant independent predictors.

Table 16. Estimated odds ratios and 95 percent confidence intervals in a multivariate model including factors found to be significantly associated with crash involvement in univariate models, but not including driving exposure. Age and sex are included.

Factor		*Odds ratio*	*95% CI*
sex			
	female	1.00	ref
	male	1.38	0.74,2.56
age			
	17-19	1.00	ref
	20-24	0.56	0.07,4.33
	25-34	0.25	0.04,1.71
	35-64	0.38	0.06,2.39
	65+	0.53	0.06,4.65
more than one motor vehicle accident in the past two years			
	no	1.00	ref
	yes	14.56	2.64,80.22
use of sleeping tablets			
	no	1.00	ref
	yes	4.28	1.43,12.83

Table 17. Estimated odds ratios and 95 percent confidence intervals in a multivariate model including factors found to be significantly associated with crash involvement in univariate models, including daytime driving exposure. Age and sex are included.

Factor		*Odds ratio*	*95% CI*
using medication to sleep			
	no	1.00	ref
	yes	4.31	1.28,14.53
sex			
	female	1.00	ref
	male	1.27	0.59,2.71
age			
	17-19	1.00	ref
	20-24	0.46	0.05,4.12
	25-34	0.21	0.03,1.60
	35-64	0.34	0.05,2.31
	65+	0.29	0.03,3.21
daytime driving (hours driven in month prior to interview)			
	0	1.00	ref
	1-10	0.04	0.01,0.31
	11-20	0.03	0.01,0.20
	21-40	0.02	0.01,0.13
	41-100	0.07	0.01,0.48
	101+	0.06	0.01,0.53
more than one traffic accident as a driver in the past two years			
	no	1.00	ref
	yes	34.09	3.67-317.19

Table 18. Estimated odds ratios and 95 percent confidence intervals in a multivariate model including factors found to be significantly associated with crash involvement in univariate models, including night driving exposure. Age and sex are included.

Factor		*Odds ratio*	*95% CI*
sex			
	female	1.00	ref
	male	1.46	0.72,2.98
age			
	17-19	1.00	ref
	20-24	0.78	0.07,8.54
	25-34	0.27	0.03,2.39
	35-64	0.27	0.03,2.31
	65+	0.34	0.03,4.16
more than one motor vehicle accident in the past two years			
	no	1.00	ref
	yes	11.86	2.02,69.67
night-time driving (estimated hours driven in past month)			
	0	1.00	ref.
	1-10	0.21	0.09,0.50
	11-20	0.30	0.11,0.83
	21-30	0.21	0.06,0.80
	31+	2.67	0.38,16.09
using medication to sleep			
	no	1.00	ref
	yes	4.39	1.30,14.84

3.3.4 Alcohol

Though 80 percent of those interviewed had consumed some alcohol in the previous six months, and 55.9 percent had done so in the past month, only 3.3 percent admitted to consuming at levels considered hazardous and 1.3 percent at levels considered harmful[17]. The study found no significant association between crash involvement and the driver reporting consumption of alcohol in the previous six months (odds ratio=0.85, 95 percent CI=0.44,1.61).

Of those who had consumed some alcohol in the past month, 48.2 percent admitted to binge drinking (ie more than 8 drinks for males and more than 6 drinks for females, on the one occasion). Within this group (consumed alcohol in the past month) 27.6 percent of cases, 25.3 percent of population controls and 30.2 percent of hospital controls, reported binge drinking in the past six months, and 18.4 percent of cases, 22.5 percent of population controls and 23.0 percent of hospital controls reported binge drinking in the past month. There was no significant association between reported binge drinking and crash involvement (odds ratio=1.33, 95 percent CI=0.73,2.43).

We found positive associations between problem drinking behaviour and motor vehicle injury (Table 19) but these did not reach statistical significance.

Table 19. Estimated odds ratios for the association between problem drinking and motor vehicle injury.

Level of alcohol consumption	*odds ratio*	*95% confidence interval*
safe	1.00	ref.
hazardous	1.24	0.30- 5.12
harmful	2.50	0.35-18.03
binge drinking on at least one occasion in the past six months[a]		
no	1.00	ref.
yes	1.33	0.73-2.43

[a] for males more than 8 alcoholic drinks, or females more than 6 alcoholic drinks, on the one occasion

The home was the most frequent site for alcohol consumption overall (53.3 percent of those interviewed had drunk at home on at least one day in the previous month, compared to 37.8 percent at a friends home, 27.5 percent in a public bar, 21.8 percent at a restaurant and 11.1 percent at a public function).

There was some evidence (Table 20) for an association between driver crash involvement and frequent (9 or more days, ie, more than twice a week on average), compared to no, alcohol consumption in private houses (odds ratio=2.25, 95 percent CI=0.13,37.82) and in public bars (odds ratio=3.06, 95 percent CI=0.86,10.93). There was a positive association between consumption of alcohol in a public bar on at least one occasion (compared to not at all) and driver crash involvement (odds ratio=1.84, 95 percent CI=1.25,2.72).

Table 20. Estimated odds ratios for the association between drinking frequency in selected locations and crash involvement.

place, and frequency of, alcohol consumption in the month prior to interview	*odds ratio*	*95% confidence interval*
own or friends house		
not at all	1.00	ref.
1 to 3 days	0.54	0.30,0.96
4 to 8 days	1.00	0.35,2.91
9 or more days	2.25	0.13,37.82
public bar		
not at all	1.00	ref
1 to 3 days	1.90	0.90,4.03
4 to 8 days	2.07	0.67,6.41
9 or more days	3.06	0.86,10.93

3.3.5 Drink driving

More than half the respondents (57.4 percent) reported not drinking at all, or not drinking when driving. This figure may have been slightly inflated due to misunderstanding as 24 percent reported not drinking at any time, when only 20 percent had stated that they had not consumed alcohol in the past month.

Among those who reported drinking alcohol at some time, 49.1 percent of cases, 43.4 percent of population controls and 42.3 percent of hospital controls said they did not drink if they were driving. Further, 47.4 percent of cases who drank restricted alcohol intake when driving, as did 55.7 percent of population controls and 56.8 percent of hospital controls. There were no significant differences between cases and population controls in reporting not drinking when driving (odds ratio 1.17, 95 percent CI 0.67-2.06) or restricting drinking when driving (odds ratio 0.96, 95 percent CI 0.70-1.13).

More than one in four participants suggested that the possibility of being random breath tested had influenced the amount of alcohol they had consumed in the four weeks prior to interview. Fewer people reported a similar impact on the amount of driving they did in that time (14.0 percent). There were no significant differences between cases and population controls in reporting an effect of RBT on alcohol consumption (odds ratio 0.66, 95 percent CI 0.33-1.32) or driving frequency (odds ratio 1.83, 95 percent CI 0.84-4.00).

3.3.6 Medications and other drugs

Participants were asked about use of medications for the management of diabetes, depression, insomnia and allergies as well as the use of strong analgesics and marijuana in the six months prior to interview. Only nine (1.7 percent) reported use of hypoglycaemic medication in that time, which is insufficient for further analysis.

Five percent (n=27) of participants had used medications for treatment of depression (nine cases, nine population controls and nine hospital controls). Relatively more cases (10.3 percent) reported use of these medications than population (2.9 percent) or hospital (6.5 percent) controls, and cases used them more frequently than either control group. Though equal proportions of those using these drugs everyday were cases and controls, this represented 5.7 percent of cases, 1.6 percent of population controls and 3.6 percent of hospital controls. Univariate conditional logistic modelling (Table 8) indicated a strong positive association between use of medication for depression and involvement in an injury producing crash (OR 5.21, 95% CI 1.35-20.10).

Overall 8.5 percent of participants (n=46) reported use of medications to promote sleep. Relatively more cases (13.8 percent) and hospital controls (13.7 percent) reported use of these medications than population controls (4.8 percent). Cases were more likely to use them more often than once a week (58.3 percent of cases, compared to 33.3 percent of population controls and 36.8 percent of hospital controls reporting use of these medications). A univariate conditional logistic model estimated an odds ratio of 2.72 (95% CI 1.05-7.09) for the association between use of sleeping tablets and involvement in an injury producing crash.

One in three (33.6 percent, n=182) participants reported use of strong analgesia. Significantly more cases (44.8 percent) and hospital controls (48.2 percent) used these medications than population controls (24.1 percent). More than half the cases (51.3 percent) who used pain killers did so more often than once a week, compared to 25 percent of population controls and 38.8 percent of hospital controls. A univariate conditional logistic model estimated an odds ratio of 2.49 (95% CI, 1.42-4.38) for the association between use of strong analgesia and injurious road trauma (Table 8).

The associations with use of medication for sleep, depression and pain relief were not found in models using hospital controls. It is possible that use of these medications is a result, rather than a cause of, injury.

A total of 7.6 percent (n=41) participants reported use of marijuana. Relatively more cases (9.2 percent) and hospital controls (9.4 percent) reported its use than population controls (6.3 percent). Cases were more likely to use the drug more often than once a week (62.5 percent of cases, compared to 35.0 percent of population controls and 23.1 percent of hospital controls reporting use of marijuana). Overall 5.7 percent of cases, 2.2 percent of population controls and 2.2 percent of hospital controls reported use of marijuana more often than once a week. A univariate conditional logistic model estimated an odds ratio of 1.5 (95% CI, 0.57-3.96) for the association between marijuana use and injury producing road trauma.

Almost one in seven participants (14.9 percent, n=81) reported use of oral medication for allergies. There was little difference between the three groups in use of these medications (16.1 percent of cases, 15.8 percent of population controls and 12.2 percent of hospital controls). A univariate conditional logistic model estimated an odds ratio of 1.26 (95% CI, 0.63-2.55) for the association between use of anti-allergy medications and injurious road trauma.

3.3.7 Chronic illness

Participants were asked whether they had ever been told by a doctor or nurse that they had one or more of a number of specified medical conditions. High blood pressure was the most frequently reported condition, and there were no significant differences between groups (Table 21). A univariate conditional logistic regression model using an omnibus variable for all reported conditions found no significant association between chronic illness and driver involvement in road trauma (odds ratio 1.19, 95% CI 0.64-2.22).

Table 21. Reported chronic medical conditions by group.

Specified condition	Cases (%)		Population Controls		Hospital controls		TOTAL	
Diabetes	1	(1.2%)	3	(1.0%)	5	(3.6%)	9	(1.7%)
High blood pressure	14	(16.1%)	56	(17.7%)	24	(17.3%)	94	(17.3%)
Angina	1	(1.2%)	7	(2.2%)	2	(1.4%)	10	(1.9%)
A heart attack	3	(3.5%)	5	(1.6%)	4	(2.9%)	12	(2.1%)
A stroke	2	(2.3%)	3	(1.0%)	3	(2.2%)	8	(1.5%)
Epilepsy	1	(1.2%)	2	(0.6%)	2	(1.4%)	5	(0.9%)
Nervous or depressive conditions	8	(9.2%)	24	(7.8%)	6	(4.3%)	38	(7.0%)
All reported conditions	30	(34.5%)	100	(31.6%)	46	(33.1%)	176	(32.5%)
All participants	87	(100.0%)	316	(100.0%)	139	(100.0%)	542	(100.0%)

3.3.8 Driver attitudes

Most participants reported using a seat belt always or nearly always (87.1 percent) and there were no differences between each groups in this proportion (89.7 percent of cases, 88.0 percent of population controls and 83.5 percent of hospital controls).

Half of all participants (54.1 percent) reported travelling at about the same speed as the surrounding traffic. Slightly fewer cases (44.8 percent) reported driving at about the same speed as the surrounding traffic (as opposed to passing or being passed by other vehicles) than population (57.0 percent) or hospital controls (53.2 percent).

Most people felt speed limits to be, on average, just right (72.9 percent), with cases slightly more likely (78.2 percent) than population or hospital controls (71.2 percent and 73.4 percent respectively) to be satisfied with existing speed limits.

Section 4.

Discussion

4.1 Hospital and Police collected data

Routinely collected data for motor vehicle occupant injury in the WHA for the period 1986 to 1990 displayed a pattern of injury resembling the rural experience. There were significantly elevated mortality and hospital admission rates, especially for young men. Alcohol was relatively frequently involved, in some locations in particular. A number of local government areas (including the three comprising the WHA) exhibited strong and significant associations with serious injury for motor vehicle occupant casualties.

Overall, serious motor vehicle occupant injury was significantly associated with human (driver age, sex and alcohol use and casualty non-use of seat belts) and environmental (location and impact type, speed limit and high risk period) factors in particular.

Weather and road surface condition were not associated with serious injury. This is consistent with previous studies. Travel tends to be greater in better conditions, for example in summer compared to winter[18]. Driver response to poor conditions, on average, is to reduce speed with the result that, though there may be more crashes in wet and slippery conditions, they are less severe[19].

Vehicle age greater than 16 years was associated with serious injury, though the effect was small. Police collected data is insufficient to satisfactorily assess vehicle factors. There are multiple interacting issues, including driver behaviour, vehicle mass and correct maintenance of tyres and brakes[20].

Motor vehicle occupant injuries on two-way, undivided roads were more likely to lead to hospital admission or death. Exposure to these roads types, especially in areas with speed limits of 80 km per hour or more, accounted for much of the observed association with serious injury for crashes in the WHA. This was not simply a matter of there being more of these roads in certain LGAs. Two-way, undivided roads in the Blue Mountains, Hawkesbury, Baulkham Hills and, to a lesser extent, Penrith LGAs were strongly associated with serious injury in a motor vehicle crash in comparison to the reference LGA (Auburn). This association was particularly marked in areas with speed limits of 80 km per hour or more.

Injuries on these roads were more likely to be head-on or vehicle object collisions, which are associated with serious injury. They were more likely to be single vehicle crashes and more likely to involve a driver with an elevated blood alcohol.

The age and sex differentials in the frequency of alcohol related injury and the association between alcohol and motor vehicle injury imply an important interaction between exposure, driver behaviour and road environment. Our study suggests that, at least in western Sydney, although elevated driver blood alcohol is more frequent among young men in injury producing crashes, serious injury in a given crash is relatively more likely if the alcohol impaired driver is slightly older or female. Though young men should remain the primary target of drink driving prevention, women and older men should not be allowed to become complacent.

Elevated driver blood alcohol was more frequent in the LGAs with the strongest associations with serious injury. This does not imply that there were necessarily higher rates of drink driving in these areas. Alcohol impaired drivers were not only more likely to crash on the higher risk two way, undivided roads, but the resulting casualties were more likely to suffer severe or fatal injury. This, at least partly, may due to the increased susceptibility to injury of alcohol affected persons[21].

The risk in alcohol related crashes, however, also reflects the particular risk posed by the higher speed limit undivided roads to impaired drivers. These roads were found to be independently associated with more severe injury. Severe road traffic injury involving elevated driver blood alcohol has previously been found to be associated with high impact speeds and accident type (notably vehicle object collisions on two lane roads)[22].

Data relating to road traffic injury are collected for a variety of purposes none of which directly include the planning of prevention and control activity. Though police collected data contains important information on crash circumstances and characteristics a number of limitations have been identified. There is little or no information about injury severity and outcome or non-traffic information on crash circumstances. It has been estimated that Police data underestimate hospital admissions by about one third[20]. This especially involves single vehicle crashes and crashes involving bicyclists and motor cyclists. The quality of police data on alcohol involvement has also been questioned[23].

Hospital inpatient data does not include any crash specific information, but does give a better indication of the extent of road traffic injury than police data. Hospital admission data in itself is of limited value in planning and evaluating preventive activities. Linkage with police data would substantially increase the utility of each information system. In the absence of such linkage we made use of a variety of data sources in this investigation.

Travel on undivided roads in the higher speed limit areas involves lower traffic densities, higher speeds, different trip purpose and a higher prevalence of alcohol use. Nevertheless the differences observed in our study, and in the USA[19], are such that it appears that road design and traffic separation and calming techniques have the potential to substantially reduce serious road traffic injury. There is, in addition, evidence that improved edge line markings can reduce crash risk, for alcohol affected and unaffected drivers, on undivided roads[22].

4.2 Case-control study

The disappointing response rate points to a possible selection bias. It is apparent from a comparison of the driver age distribution in the RTA data (Figure 11) and the case age distribution (Figure 19) that drivers under 25 years of age were relatively underrepresented in the case control study.

Recall bias is a potential problem in case-control studies. We attempted to equate cases and controls by delaying interviews until after hospital discharge and asking all groups about the same period (most recent one, six or twelve months). Of more concern in this study is that case's recent experience may have been influenced by the index motor vehicle crash (especially driving, drinking and drug taking behaviour). Cases were less likely than population controls (but not hospital controls) to report that the past month had been typical of the previous twelve months.

A number of methodological issues may have influenced our findings. The case definition was designed to identify serious injury and minimise the selection bias due to non ascertainment (from less serious injuries treated by general practitioners, for example). Risk factors may, however, be the same for severe and minor injury. Our exclusion criteria reduced the sample size and may in itself have introduced a bias if those not presenting to hospitals were, for example, younger and more likely to be alcohol affected.

The attempt to identify drivers involved in serious injury producing crashes meant that we had to contact some individuals indirectly, with an inevitable reduction in response. Most of the non-injured drivers were simply not traceable and may have represented a different population (younger, more mobile, lower socio-economic class). Alcohol use may have been associated with case non-ascertainment and this study may have underestimated the impact of drinking habits on crash involvement. Self reported alcohol consumption has potential for error and if misclassification of alcohol use was related to case status (as was likely) this would also lead to an underestimation of the role of alcohol.

Previous history of at least two injuries (odds ratio=3.58, 95 percent CI=1.61,7.99) and at least two road accidents (odds ratio=13.91, 95 percent CI=3.09,62.69) in the previous two years, were strongly associated with driver crash involvement. The role of recurrent crash involvement in traffic safety has been controversial since the notion of accident proneness was first introduced by Greenwood and Woods[24]. Previous driving violation record has been shown to be a useful predictor of future crash rates[25]. Others have found that drivers with higher than expected crash rates in one period are only average in the next and that previous crash history is of little value in predicting future crash involvement[26].

There are clearly differentials in crash involvement (younger males, for example) which reflect differential exposure to risk, behaviour and injury susceptibility. Previous injury and traffic accident history may be proxies for other factors including driving exposure and risk taking behaviour.

Driver inexperience was associated with crash involvement. Though the sample size was not sufficient to draw firm conclusions, it seems that a few years of driving experience is associated with crash involvement (odds ratio for drivers with 3 to 5 years experience=2.76, 95 percent CI=1.10,6.93, baseline 21 years or more, odds ratio=1). There is little evidence to suggest that this is a question of driving skill. Driver training and education have not been shown to have much influence on crash rates[27,28].

The overrepresentation of less experienced drivers may partly reflect exposure to higher risk situations and times and partly the self-paced nature of the driving task, in which drivers select their own levels of task difficulty[19]. The chosen level of task difficulty depends on the driver's evaluation of their own skill and traffic system demands. In our study drivers with a few years experience seemed to be making the most inappropriate decisions.

The measure of driving exposure used in our study suggested that driving infrequently or very often is associated with driver crash involvement. The odds ratio for the most frequent daytime driving exposure (odds ratio=0.20, 95 percent CI=0,03,1.19) did not reach statistical significance. A larger sample size may have clarified this. In a model adjusting for age, sex, and recent history of traffic accident, the no recent driving category was the most strongly associated with crash involvement. The strongest association with crash involvement and night driving exposure was for the category of most frequent driving (odds ratio=5.28, 95 percent CI=1.08,25.72, baseline no night time driving).

Drivers involved in crashes in the recent past (ie., cases) were less likely to have driven in the past month. With a case control study design it is difficult to draw definite conclusions about directionality of cause and effect. It is plausible that drivers involved in serious crashes are less likely to drive because of personal injury, damage to their car or licence suspension. This, unfortunately, tells us very little about the association between exposure and crash risk in the population.

Nevertheless, the strongest association with crash involvement and night driving exposure was for the category of most frequent driving (odds ratio=5.28, 95 percent CI=1.08,25.72, baseline no night driving). A positive association was also found when comparing cases and hospital controls, though it was not statistically significant (odds ratio=1.31, 95 percent CI=0.42,4.15). The inconsistency between finsings for day and night driving is difficult to interpret. It does appaear that a strong and positive association exists between driver crash involvement and frequent night driving. Any selection bias that excluded younger males in particular, may have attenuated this association.

Among those reporting that the past month had been typical of their behaviour, cases were more likely to have been random breath tested in the previous 12 months than population controls (odds ratio=3.78, 95 percent CI=0.52,27.56), but not hospital controls (odds ratio=1.25, 95 percent CI=0.73,2.13). This is more likely an index of exposure rather than an indication of the failure of random breath testing, ie cases and hospital controls were more likely to have driven in situations where random breath testing had taken place.

Our study had insufficient power to detect significant associations between crash involvement and hazardous levels of alcohol consumption (Table 19), though the estimated odds ratios did indicate a positive association between excessive alcohol intake and driver crash involvement. The analysis suggests drivers consuming alcohol at hazardous or harmful levels are more likely to be involved in serious motor vehicle crashes, but that this is a small proportion of the driving population.

In contrast, binge drinking was common among all groups, with nearly half (48.2 percent) of those who had consumed some alcohol in the month prior to interview reporting at least one such episode. A slightly greater proportion of cases and hospital controls reported at least one episode consistent with our definition of binge drinking in the month prior to interview. Given that our study may have underestimated the role of alcohol consumption in crash involvement it seems that regular binge drinking among people whose overall consumption is not high may be a more substantial problem in motor vehicle injury causation than hazardous or harmful drinking.

Respondent's own, or a friend's, home were the most frequent sites of alcohol consumption. Drinking in a public bar at least once (compared to not at all) in the month prior to interview was associated with crash involvement (odds ratio=1.84, 95 percent CI=1.25,2.72). This is in contrast to the finding in a recent Western Australian study that people arrested for drink driving (whether because of crash involvement or random breath testing) where most likely to have been drinking at a private residence or public location[29].

The major reported impact of random breath testing for all groups was on drinking behaviour. A further 14 percent reported an influence on the amount of driving they did. Most (60 percent) reported no particular impact of RBT in the recent past. These people may have decided to never drink and drive regardless of the chance of being tested. They were not necessarily ignoring it, but they were not making decisions about driving and drinking with RBT in mind.

Cases were more likely than population controls to have used medication for sleep (odds ratio=2.72, 95 percent CI=1.05,7.09), depression (odds ratio=5.21, 95 percent CI=1.35,4.45) and strong analgesia (odds ratio=2.49, 95 percent CI=1.42,4.38). This did not hold for hospital controls. Whether use of these medications increases the likelihood of crashing, they are a proxy for other factors or they are more likely to be used by people following hospitalisation due to injury was not clear. A causal relationship was found in a recent r4/ort from the United States demonstrating an increased risk of injurious crash involvement for drivers over 65 years of age who are current users of benzodiazepines or antidepressants[30]. It seems likely in our study that the association for cases and hospital controls followed the injury and is a reflection of ongoing morbidity rather than proving a causal association.

Section 5.

Conclusions

The observed association with serious occupant injury for motor vehicle crashes in the WHA was largely confined to motor vehicle occupants.

This association, especially at higher speed limits, is not unique to western Sydney[18]. Though, in absolute terms, more injuries may occur in larger population centres (with important implications for service planning), our study has shown that exposure to certain road traffic systems results in a substantial excess in deaths and serious injury above what might be expected given the number of vehicles on these roads.

Ultimately the aim must be not only to reduce the number of crashes, but the type and speed of impact as well. Sealing (at least selected) road shoulders, introducing or extending overtaking lanes and various forms of edge line marking, for example, have been shown to reduce the rates of injury on undivided roads[22,31].

Exposures which are important risk factors in themselves (such as speed and drink driving) were shown to be of particular importance on two-way undivided roads. The higher than expected proportion of drivers with elevated blood alcohol in the WHA probably reflects the higher risk associated with driver impairment rather than a higher rate of drink driving. The road trauma problem should be approached by examining the interaction of many factors rather than attempting to single out one or two specific causes. Though care should be taken when interpreting the results of the case-control study they do indicate the importance of taking exposure to hazardous situations into account when examining the problem of serious road traffic injury.

There is a place for risk communication techniques in confronting the problem of drink driving and speeding in certain areas. The substantial literature on risk communication[32,33] proposes that risk is not simply an objective hazard but incorporates a subjective element, often termed outrage ('risk = hazard + outrage'). Increasing the perceived risk of adverse outcomes of drink driving and speeding should focus on the outrage component, using random breath testing and speed cameras. The aim should be to maximise the visibility of enforcement measures, rather than apprehension of offenders as such. There is evidence for the effectiveness of immediate, even limited, consequences, including on the spot fines and licence suspension[34].

Specific sites, and patterns, of alcohol consumption need to be targeted. This includes in particular occasional binge drinking by people who do not see themselves as 'problem' drinkers.

The issue of recurrent crash and traffic accident involvement may need further investigation. For whatever reason(s), previous traffic accident was strongly associated with crash involvement in the study period. This effect persisted even though cases and population controls were matched for street of residence (socio-economic status), and in models adjusting for age, sex, recent change in behaviour and driving exposure. It may reflect, for example, persisting exposure to high risk situations, incorrect judgement about task load in certain situations or drink driving. There is no evidence from previous, experience, however, that identifying these drivers is a cost effective means of reducing future road traffic injury.

The case control study was, in part, a pilot of the methodology. An alternative would have been to identify controls from drivers of vehicle passing a crash site immediately after the index crash or at the same time the following day or week. This methodology has been used elsewhere[35,36,37], but is expensive and resource intensive. Further, while having the advantage of meeting the criteria of controls being individuals who would be cases if they had crashed and controlling for local environment and conditions, it has the disadvantage of potentially over-matching for other exposures of interest. Cases and controls chosen from crashes on Saturday nights, for example, may be very similar in their pattern of alcohol consumption.

Our aim was not to assess a specific location or a particular vehicle but to examine the relative importance of a number of exposures hypothesised to be risk factors in the local population. A population based case control study, matching by address to control for difficult to measure socio-economic factors seemed an appropriate methodology.

Given limited resources a more satisfactory response may have been obtained with a hospital based study. Though less ideal than a population based study the potential bias in our assessment of key issues, notably the role of alcohol, limited the usefulness of our study. An alternative may be to match by general practitioner, interviewing cases in hospital and matched controls in the GP surgery within days to a week of the case interview.

The model of injury causation proposed by Haddon is a useful approach to the problem of serious motor vehicle injury. It emphasises the place of particular exposures in the overall 'injury event' and incorporates consideration of available countermeasures[4,5]. Locality based interventions based on knowledge of effective countermeasures and an epidemiologic approach to planning and evaluation is an essential prerequisite to further reductions in serious road trauma.

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Appendix A

The Questionnaire

WENTWORTH AND WESTERN SYDNEY HEALTH AREA
INJURY STUDY, 1[illegible]

1. HAVE YOU DRIVEN A MOTOR VEHICLE AT ANY TIME SINCE MAY THIS YEAR?

Yes..1

No..2

If No, thank respondent and terminate interview

2. ON HOW MANY OCCASIONS IN THE PAST TWO (2) YEARS HAVE YOU SUFFERED AN INJURY THAT REQUIRED A VISIT TO A DOCTOR, HOSPITAL OR DENTIST?

Not at all...1

Go to Question 4

Number of times ___.........................2

3. HOW MANY OF THESE INJURIES OCCURRED............

While playing sport ___.........................1

At home ___.........................2

Travelling in a car or truck ___.........................3

At work ___.........................4

Other ___.........................5

4. HOW MANY TRAFFIC ACCIDENTS, IF ANY, HAVE YOU BEEN IN, AS A DRIVER, IN THE LAST TWO (2) YEARS?

None at all 1

Number of times ___.........................2

5. HOW MANY YEARS HAVE YOU BEEN DRIVING?

_____ years (or year ______)

(Prompt for year licence obtained if uncertain)

6. WHAT IS THE CURRENT STATUS OF YOUR LICENCE?

Full licence..1

Learner's...2

P - Plate...3

Suspended..4

Expired...5

None..6

Other/unknown..7

7. NOT EVERYONE USES A SEATBELT EVERY TIME THEY DRIVE. WOULD IT BE FAIR TO SAY THAT YOU WEAR A SEAT BELT............?

Always..1

Nearly always...2

Sometimes...3

Rarely..4
or
Never...5

8. WHEN CHOOSING A SPEED AT WHICH TO DRIVE, DO YOU FIND THAT......

You travel at about the same speed
as the surrounding traffic...1

On average, other drivers pass you
more than you pass them..2

On average, you pass other drivers
more than they pass you..3

9. **DO YOU FIND THAT, ON AVERAGE, SET SPEED LIMITS ARE......**

About right...1

Too high...2

Too low...3

THE NEXT FEW QUESTIONS ARE ABOUT HOW OFTEN, AND WHERE, YOU DRIVE.

10. **IN THE LAST FOUR WEEKS, ABOUT HOW OFTEN DID YOU DRIVE DURING DAYLIGHT HOURS, ON WEEKDAYS (IE.,MONDAY TO FRIDAY)?**

Interviewer - read out all options and ensure response fits one category only

Not at all...1

Go to Question 13

Once only..2

On two or three occasions only..3

On one day per week...4

About two days per week...5

About three days per week..6

About four days per week...7

Every weekday..8

11. **ABOUT HOW LONG, IN HOURS OR MINUTES, DID YOU SPEND DRIVING, DURING <u>DAYLIGHT HOURS</u>, ON THE <u>LAST WEEKDAY</u> ON WHICH YOU DROVE?**

Interviewer - prompt for one time (not a range)

__________ **hours**

<u>or</u> __________ **minutes**

12. **<u>ON THAT OCCASION</u>, WHERE DID YOU DRIVE TO AND HOW MANY PEOPLE WERE WITH YOU IN THE CAR?**

Place		Number in Car
House of friend or relative	1	______
Home	2	______
Licence premises (Hotel, restaurant, etc)	3	______
Work	4	______
No particular destination	5	______
Other	6	______

Specify...

13. **IN THE LAST FOUR WEEKS, ABOUT HOW OFTEN DID YOU DRIVE AT NIGHT (IE., IN DARKNESS) ON ANY DAY?**

Interviewer - read out all options and ensure response fits one category only

Not at all..1 ***Go to Question 17***

Once only..2

On two or three occasions only...3

On one day per week..4

About two days per week..5

About three days per week..6

About four days per week...7

About five days per week..8

About six days per week...9

Everyday...10

14. **ABOUT HOW MANY HOURS, OR MINUTES, DID YOU SPEND DRIVING ON THE <u>LAST NIGHT</u> ON WHICH YOU DROVE?**

Interviewer - prompt for one time (not a range)

__________ **hours**

or __________ **minutes**

15. HOW LONG HAS IT BEEN SINCE YOU DROVE AT NIGHT?

Interviewer - obtain the best estimate and state time in days or weeks

Number of days ______

Number of weeks ______

16. <u>ON THAT OCCASION</u>, WHERE DID YOU DRIVE TO AND HOW MANY PEOPLE WERE WITH YOU IN THE CAR?

Place	Number in Car
House of friend or relative....................1	______
Home..2	______
Licence premises (Hotel, restaurant, etc)...........................3	______
Work...4	______
No particular destination.......................5	______
Other...6	______

Specify..

17. WHAT TIME DID YOU ARRIVE HOME ON THIS OCCASION?

Interviewer - this refers to the occasion in Question 16. Prompt for one time and give according to 24 hour clock.

______

18. DID THE POSSIBILITY OF BEING RANDOM BREATH TESTED HAVE ANY EFFECT ON THE AMOUNT OF ALCOHOL YOU DRANK WHEN YOU WERE GOING TO DRIVE IN THE LAST 4 WEEKS?

Yes...1

No..2

Refused...9

19. **DID RANDOM BREATH TESTING HAVE ANY EFFECT ON HOW OFTEN YOU ACTUALLY DROVE A MOTOR VEHICLE IN THAT TIME?**

Yes..1

No..2

20. **HAVE THE LAST FOUR WEEKS BEEN TYPICAL OF YOUR HABITS OVER THE LAST YEAR?**

Yes..1

No..2

21. **HAVE YOU BEEN RANDOM BREATH TESTED AT ANY TIME IN THE PAST TWELVE MONTHS?**

Yes..1

Specify number of times ______

No..2

If No go to Question 18

22. **WERE YOU FOUND TO BE OVER THE LIMIT ON ANY OF THESE OCCASIONS?**

Yes..1

No..2

Refused..9

23. **MOST PEOPLE WHO DRINK ANY ALCOHOL AT ALL WILL HAVE DRIVEN AFTER DRINKING AT SOME TIME. WHICH OF THE FOLLOWING STATEMENTS WOULD, DO YOU THINK, BEST DESCRIBE THE AVERAGE DRIVER IN NSW AT PRESENT?**

They don't drink at any time..1

If driving they don't drink..2

If driving, they restrict what they drink to
two or three drinks per hour, or less.....................................3

If driving, they drink less than usual, but
will have more than three alcoholic drinks per hour............4

If driving, they don't restrict what they drink.......................5

24. **WHICH OF THE FOLLOWING STATEMENTS WOULD BEST DESCRIBE <u>YOU</u> WITH REGARD TO DRINKING AND DRIVING IN THE PAST SIX MONTHS?**

I don't drink at any time..1

If I am driving I don't drink..2

If I am driving, I restrict what I drink to
two or three drinks per hour or less..3

If I am driving, I drink less than usual, but
more than three alcoholic drinks per hour..........................4

If driving, I don't restrict what I drink..................................5

THE NEXT FEW QUESTIONS ARE ABOUT YOUR POSSIBLE USE OF VARIOUS MEDICATIONS OR DRUGS.

25. **HAVE YOU USED ANY OF THE FOLLOWING AT ANY TIME IN THE PAST SIX (6) MONTHS?**

a) Medications for Diabetes.

Yes..1

No..2

If yes,

Less often than once a week..3

More often than once a week..4

Specify number of days or nights per week _______

b) Tablets for a nervous condition or depression

Yes..1

No..2

If yes,

Less often than once a week..3

More often than once a week..4

Specify number of days or nights per week _______

c) Tablets to help you sleep

Yes..1

No..2

If yes,

Less often than once a week..3

More often than once a week..4

Specify number of days or nights per week _______

d) Marijuana

Yes..1

No...2

If yes,

Less often than once a week...3

More often than once a week..4

Specify number of days or nights per week _______

e) Tablets for hay fever or other allergies

Interviewer - this does not include nasal sprays or medications for asthma

Yes..1

No...2

If yes,

Less often than once a week...3

More often than once a week..4

Specify number of days or nights per week _______

h) Strong pain relievers (eg codeine, Panadeine)

Yes..1

No...2

If yes,

Less often than once a week...3

More often than once a week..4

Specify number of days or nights per week _______

26. HAVE YOU EVER BEEN TOLD BY A DOCTOR OR NURSE THAT YOU HAVE ANY OF THE FOLLOWING?

	YES	NO	DON'T KNOW/CAN'T SAY
Diabetes	1	2	7
High blood pressure	1	2	7
Angina	1	2	7
Had a heart attack	1	2	7
Had a stroke	1	2	7
Had epilepsy	1	2	7
Any nervous conditions or depression	1	2	7

THE NEXT FEW QUESTIONS ARE ABOUT ALCOHOL CONSUMPTION.

27. HAVE YOU DRUNK ANY ALCOHOL AT ALL IN THE PAST SIX MONTHS?

Yes..1

No 2

Refused...9

If No or Refused go to Question 40

28. HOW OFTEN HAVE YOU DRUNK ALCOHOL IN THE LAST SIX MONTHS?

Interviewer, read out options and prompt for closest single option

Less than once per month (ie., five times or less)..............1

Go to Question 37

About once per month...2

Go to Question 37

About two or three times per month...................................3

About one day per week..4

About two days per week...5

About three days per week..6

About four days per week..7

About five days per week...8

About six days per week..9

Everyday...10

29. ON THE OCCASIONS WHEN YOU DRANK ALCOHOL IN THE LAST SIX MONTHS, HOW MANY DRINKS DID YOU USUALLY HAVE?

Interviewer, prompt to obtain one number only

Number of drinks ______

30. CONSIDERING ALL TYPES OF ALCOHOLIC DRINKS, HOW MANY TIMES DURING THE PAST SIX MONTHS DID YOU HAVE........

males...........8 drinks or more females...........6 drinks or more

ON THE ONE OCCASION? ***Interviewer, prompt for closest single option***

Not in the last six months..1

Less than once per month (ie., five times or less)...............2

About once per month..3

About two or three times per month...................................4

About one day per week...5

About two days per week..6

About three days per week..7

About four days per week...8

About five days per week..9

About six days per week...10

Everyday..11

31. WHEN WAS THE LAST TIME YOU HAD A DRINK CONTAINING ALCOHOL?

Interviewer, obtain the best estimate and state time since in days or weeks

Number of days ______

Number of weeks ______

32. ON THAT OCCASION, WHAT DID YOU HAVE AND HOW MUCH?

Interviewer - Specify number of standard drinks. See prompt card.

Beer - Light ______
Beer - Regular ______
Wine ______
Fortified wine ______
Spirits ______
Other ______

Specify ______

33. **WHAT WAS THE PERIOD BETWEEN THE LAST TIME AND THE <u>SECOND</u> LAST TIME YOU HAD A DRINK CONTAINING ALCOHOL?**

Interviewer - Obtain the best estimate and state time since in days or weeks

Number of days ______

Number of weeks ______

34. **ON THAT OCCASION, WHAT DID YOU HAVE AND HOW MUCH?**

Interviewer - Specify number of standard drinks. See prompt card.

Beer - Light ______
Beer - Regular ______
Wine ______
Fortified wine ______
Spirits ______
Other ______

Specify ____________

35. **WHAT WAS THE PERIOD BETWEEN THE SECOND LAST TIME AND THE <u>THIRD</u> LAST TIME YOU HAD A DRINK CONTAINING ALCOHOL?**

Interviewer - Obtain the best estimate and state in days or weeks

Number of days ______

Number of weeks ______

36. **ON THAT OCCASION, WHAT DID YOU HAVE AND HOW MUCH?**

Interviewer - Specify number of standard drinks. See prompt card.

Beer - Light ______
Beer - Regular ______
Wine ______
Fortified wine ______
Spirits ______
Other ______

Specify ____________

<u>NOW GO TO QUESTION 39</u>

37. ON THE OCCASIONS WHEN YOU DRANK ALCOHOL IN THE LAST SIX MONTHS, HOW MANY DRINKS DID YOU USUALLY HAVE?

Interviewer, prompt to obtain one number only

Number of drinks ______

38. CONSIDERING ALL TYPES OF ALCOHOLIC DRINKS, HOW MANY TIMES DURING THE PAST SIX MONTHS DID YOU HAVE.......

males...........8 drinks or more   females...........6 drinks or more

ON THE ONE OCCASION? ***Interviewer, prompt for closest single option***

Not in the last six months..1

Less than once per month (ie., five times or less)..................2

About once per month..3

About two or three times per month...4

About one day per week...5

About two days per week..6

About three days per week...7

About four days per week...8

About five days per week...9

About six days per week..10

Everyday...11

39. HAS THERE EVER BEEN A TIME IN YOUR LIFE WHEN YOU THOUGHT YOU WERE DRINKING TOO MUCH FOR YOUR OWN GOOD?

Yes...1

No..2

40. WE ARE ALSO INTERESTED IN WHERE PEOPLE TEND TO BE WHEN DRINKING ALCOHOL. THINKING ABOUT THE LAST 4 WEEKS HOW MANY TIMES DID YOU DRINK ALCOHOL IN ANY OF THE FOLLOWING PLACES?

Interviewer - Read out all options and prompt for one number

(a) In your own home ______

(b) At the home of friends or relatives ______

(c) In a bar, tavern or pub ______

(d) In a restaurant ______

(e) At a public function or event (eg, concert, movie, theatre, sport) ______

(f) Other ______

TO COMPLETE THE INTERVIEW I WOULD LIKE TO ASK YOU A FEW QUESTIONS ABOUT YOURSELF.

41. HOW OLD ARE YOU?

Age in years ....

Interviewer - obtain age range if not possible to obtain exact age

Less than 20 years..1.

20 to 29 years..2.

30 to 39 years..3.

40 to 49 years..4.

50 to 59 years..5.

60 to 69 years..6.

70 to 79 years..7.

Greater than 79 years..8.

42. SEX OF RESPONDENT

Interviewer to record on the basis of speaking voice. Ask if unsure.

Male..1.
Female..2.

43. THIS QUESTION REFERS TO YOUR MARITAL STATUS. ARE YOU.......

Married..1.
De facto..2.
Separated..3.
Divorced..4.
Widowed..5.
Never married..6.

44. WERE YOU BORN IN AUSTRALIA?

Yes 1

If Yes, go to Question 47

No 2

45. IN WHAT YEAR DID YOU ARRIVE IN AUSTRALIA?

State year arrived ______________________

46. IN WHICH COUNTRY WERE YOU BORN?

UK/Ireland 1

Lebanon 2

Italy 3

Yugoslavia 4

New Zealand 5

Philippines 6

Malta 7

Other 8

Specify ______________________

47. WHAT MAIN LANGUAGE DO YOU SPEAK AT HOME?

English 1
Arabic 2
Maltese 3
Italian 4
Greek 5
Filipino..6
Other 7

Specify ______________________

48. ARE YOU A TORRES STRAIT ISLANDER OR AN ABORIGINAL PERSON?

Yes..1

No 2

THE NEXT FEW QUESTIONS ARE ABOUT YOUR EDUCATION.

49. HAVE YOU OBTAINED A TRADE OR ANY OTHER QUALIFICATION SINCE LEAVING SCHOOL?

Yes 1

No 2

If No, go to Question 51

50. WHAT IS THE HIGHEST QUALIFICATION THAT YOU HAVE OBTAINED SINCE LEAVING SCHOOL?

Bachelor degree or higher 1
Trade/Apprenticeship 2
Certificate/Diploma 3
Other 4

51. ARE YOU CURRENTLY WORKING IN PAID EMPLOYMENT?

Yes 1

If YES please specify

....

If Yes thank respondent and terminate interview

No 2

If No go to Question 52

52. IF YOU ARE NOT IN PAID EMPLOYMENT, ARE YOU.....

Retired 1

Seeking paid employment 2

Full-time student 3

Other 4

Specify ______________________

THANK RESPONDENT
AND TERMINATE INTERVIEW

Interviewer name: ____________________ Date of Interview: