DEPARTMENT OF TRANSPORT

FEDERAL OFFICE OF ROAD SAFETY

DOCUMENT RETRIEVAL INFORMATION

Report No.	Date	Pages	ISBN	ISSN
CR 35	June 1985	46 + vi	0642 51019 9	CR = 0810-770X

Title and Subtitle: BICYCLE CRASHES IN THE AUSTRALIAN CAPITAL TERRITORY

Author: STEPHEN WHATELY

Performing Organisation: PEDAL POWER ACT INCORPORATED
PO BOX E305
QUEEN VICTORIA TERRACE
ACT 2600

Sponsor: FEDERAL OFFICE OF ROAD SAFETY
PO BOX 594
CIVIC SQUARE ACT 2608

Available from
FEDERAL OFFICE OF ROAD SAFETY

Price/Availability/Format

Abstract:

This retrospective study focusses on bicycle crashes which resulted in admission to hospitals in the Australian Capital Territory between July 1979 and June 1983. Hospital in-patient morbidity statistics were supplemented by information from a mailed questionnaire and police accident reports. The report includes analysis and discussion of results, conclusions and recommendations for countermeasures.

Keywords: Cycle accidents, cycle riding behaviour, cycle paths, cycle safety education

NOTES:

(1) FORS research reports are disseminated in the interests of information exchange.

(2) The views expressed are those of the author and do not necessarily represent those of the Commonwealth Government.

(3) The Federal Office of Road Safety publishes two series of research reports
   (a) reports generated as a result of research done within the FORS are published in the OR series;
   (b) reports of research conducted by other organisations on behalf of the FORS are published in the CR series.

ACKNOWLEDGEMENTS

This study would not have been possible without the co-operation and generous support of the ACT Health Authority. The author is especially grateful to Dr Rosemary Knight and Ms Beth Tyerman, whose advice and assistance were invaluable, and Mr Robert Cheshire, Director of the Research, Planning and Evaluation unit.

Thanks are also due to the following people and organisations:

- Mr Bill Danaher of the Federal Office of Road Safety;
- the ACT Interhospitals Committee;
- the medical records staff and General Superintendents at the Royal Canberra, Woden Valley and Calvary Hospitals;
- colleagues from Pedal Power ACT Incorporated and the Bicycle Federation of Australia, especially Dr John Mathieson.

SUMMARY

This report investigates the nature and extent of bicycle crashes in the Australian Capital Territory, with the emphasis on crashes resulting in death or admission to an ACT hospital.

Hospital in-patient morbidity statistics for the period July 1979 to June 1983 were supplemented by information from police accident reports and a mailed questionnaire. Information was collected on the time and place of crash, crash causation, main injury, and cyclist characteristics.

Collisions with motor vehicles accounted for 19% of bicycle crashes resulting in hospital admission. These crashes were more serious than other bicycle crashes and accounted for 35% of days spent in hospital by all bicycle casualties. Bicycle/motor vehicle collisions were as likely to occur on arterial roads as on minor or residential roads, and two-thirds were at intersections. For cyclists aged under 16 years, crashes with motor vehicles were predominantly their own fault, but for older cyclists it was the motorist who was usually to blame. Male cyclists were involved in 82% of bicycle/motor vehicle collisions and 70% of other bicycle crashes.

Cyclists aged under 11 years had less-serious injuries than older cyclists (only 12% of their crashes involved motor vehicles); they usually cycled on footpaths and cycleways; about half of their crashes were attributable to poor riding skills and problems with the riding surface; and about two-thirds of their crashes occurred while riding for "fun". For on-road crashes, 93% were on minor or residential roads.

Cyclists aged 11 to 20 years were involved in over half of all bicycle/motor vehicle collisions (25% of crashes for this age group). Their injuries were more severe than for younger cyclists; they were more likely to ride on roads than on footpaths or cycleways; they were generally using bicycles as a means of transport when they crashed; and almost a quarter of their crashes occurred while performing stunts or tricks. For on-road crashes, 39% were on sub-arterial roads, 39% were on residential or minor roads and 22% were on arterial roads.

Cyclists aged over 20 years were no more likely to have collisions with motor vehicles than were younger cyclists: 19% of their crashes involved motor vehicles. They cycled about half on roads and half on footpaths and cycleways, and about half of their on-road crashes occurred on arterial roads. Almost half of their crashes occurred while riding to or from work.

Behavioural problems are implicated in the great majority of serious bicycle crashes. The types of error common in bicycle crashes suggest that cyclists of all ages have a general weakness in bicycle handling skills, at times fail to use safe and defensive riding techniques, and, along with motorists, sometimes fail to observe road laws. This suggests that behavioural programs in the areas of education, law enforcement and encouragement could be paramount among crash countermeasures.

It was beyond the scope of this study to assess the influence on bicycle crashes of road and path design and of traffic management measures. It is noteworthy, however, that 20% of questionnaire respondents identified as a cause of their crash a problem with a paved riding surface.

CONTENTS

1 INTRODUCTION

1.1 PURPOSE AND METHOD OF STUDY

The purpose of this study is to determine the nature and extent of bicycle crashes in the Australian Capital Territory (ACT).

The proposal for this study originated from an examination of hospital morbidity statistics made available by the ACT Health Authority (formerly the Capital Territory Health Commission). These statistics showed that about 11% of all vehicle casualties admitted to ACT hospitals from 1979 to 1982 were bicyclists and that 80% of these did not involve a collision with a motor vehicle. This was in sharp contrast to police figures, which suggested that only 6% of vehicle casualties (hospital admissions) were cyclists. The disparity is mainly due to the fact that bicycle crashes not involving motor vehicles are rarely reported to the police, and often they do not meet the criteria for inclusion in official road traffic accident statistics.

Several important questions regarding the hospital statistics immediately arose, especially in relation to the majority of casualties who were not injured as the result of a collision with a motor vehicle: these included where the crashes were occurring; how serious were the injuries; what factors were significant in causing the crashes; and how the severity of bicyclists' injuries compared with those of other vehicle casualties.

It was considered that the answers to these questions could have major implications in assessing the suitability of current and future bicycle instructional programs, law enforcement techniques and engineering programs.

1.2 BACKGROUND ON THE ACT

The ACT is a small territory of some 2,500 square kilometres whose population of about 230,000 lives almost entirely within the urban area of Canberra, the national capital. The workforce has an unusually high proportion of white collar public sector workers and a correspondingly small proportion of the workforce in manufacturing industries.

Traffic regulations in the ACT are the same as those in other states and territories but there are some additional regulations governing bicycle riders. In the ACT cyclists may legally ride on all footpaths, except within 10 metres of the entrance to a shop which is open. On footpaths, right of way is effectively given to pedestrians by laws which require cyclists to ride with due care and attention.

As well as ordinary footpaths, many newer suburbs have a network of footpaths which lead to major destinations, such as schools and shopping centres. There is a further network of shared footpaths, referred to in the ACT and throughout this report as "cycleways", which were designed primarily with cyclists in mind and which are intended to serve the needs of both recreational and commuter cyclists. Frequently footpaths and cycleways pass under major roads.

Canberra's road network is also unusual. A well-defined road heirarchy is evident in most suburbs and through traffic is effectively channelled onto main roads, leaving residential streets only lightly trafficked. "T" intersections have been used in preference to crossroads, except in the older suburbs and on arterial roads. On the debit side, as far as cyclists are concerned, are the 80km/h speed limit on many arterial roads and the high speeds of cars on non-arterial roads: Canberra has the highest speeds on non-arterial roads of all Australian capital cities (Cowley, 1980).

2 METHOD

Information on all bicycle crashes which resulted in admission to hospital or death was obtained from:

- ACT Health Authority hospital morbidity data base;
- hospital medical records;
- road traffic accident reports; and
- questionnaires completed by former hospital patients.

2.1 THE SURVEY

To supplement the basic statistical data supplied by the ACT Health Authority, hospital patients who had been involved in bicycle crashes were surveyed, using a mailed questionnaire.

Prior to the main survey, questionnaires were sent to 43 patients to test both the survey instrument and the response rate, and to assess the workload on hospital medical records staff.

Questionnaires (Appendix 1) were then sent to the 430 people who, according to Health Authority data, had been admitted to the ACT's three public hospitals between July 1979 and June 1983 as a result of bicycle crashes. After a month a follow-up letter was sent to all non-respondents.

One of the main problems with a mailed questionnaire was how to elicit useful and accurate information on both the main cause of the crash and other contributing factors.

The questionnaire therefore included two multiple-choice questions to determine the main cause and contributing factors, together with two general questions asking for a sketch map and a brief description of how the crash occurred. The two multiple-choice questions were based on crash types identified in California by Wheatley and Cross in their paper "Causal Factors of Non-Motor- Vehicle-Related Bicycle Accidents" (1979).

Each questionnaire returned was checked for consistency and, in a small number of cases, alterations were made to responses.

2.2 ANALYSIS

A basic file was created using the Health Authority's hospital morbidity data base. To this was added information from the questionnaires, hospital medical records and police "Road Traffic Accident Report" forms.

A computer data base was established from this composite information and was analysed by the ACT Health Authority using SPSS (Statistical Package for the Social Sciences).

2.3 CONFIDENTIALITY

A fundamental concern throughout this study was the maintenance of confidentiality. The ACT Health Authority, the hospitals' administrations, the Interhospitals Committee, the Department of Territories and the researcher at all times followed procedures designed to ensure confidentiality and the anonymity of all persons involved in the study.

No names or addresses of patients were available to the researcher. Questionnaires were sent to patients by hospital medical records staff who were not associated with the research project, and were matched on return with other records using reference numbers.

Care was taken to aggregate data so that no patient's identity could be inferred.

The draft report was examined by the ACT Health Authority and the Interhospitals Committee.

3 RESULTS: HOSPITALISED CASUALTIES AND FATALITIES

3.1 STUDY POPULATION AND RESPONSE RATE

The initial study population size was 436, based on the ACT Health Authority's hospital morbidity data base. This number was subsequently reduced to 398 by eliminating those cases which:

- occurred outside the ACT (20);
- involved a tricycle, toy scooter or stationary exercise bike (6); or
- had been incorrectly coded to show bicycle involvement (6)

Cases requiring re-admission (6) were counted only once.

Overall, 237 questionnaires were completed and returned, and a further 60 were returned unopened or undelivered, mainly because patients had changed address since their crash. The effective response rate was therefore 64%, with the first mailing achieving a 44% response.

No significant differences were identified between questionnaire respondents and non-respondents. Both groups had similar characteristics with respect to age, sex, length of stay in hospital, motor vehicle involvement, main injury, month of year and day of week.

3.2 BICYCLE FATALITIES

In the study period, July 1979 to June 1983, there were seven cyclist fatalities. This number is too small to permit meaningful analysis, but for completeness the following information is presented.

- Six of the seven died from head injuries.
- Three did not appear on police records. These did not involve collisions with motor vehicles and at least two of them occurred on a footpath or cycleway.
- The remaining four which appeared on police records involved collisions with motor vehicles. Two of these were on arterial roads: both were at night; cyclists were aged about twenty; both motorists were charged. The other two were on residential streets: both were during daylight hours; cyclists were aged about ten; one collision was "hit and run", the other involved a speeding car.

3.3 BICYCLE CASUALTY TYPES

Table 1 BICYCLE CASUALTIES BY TYPE
Hospital admissions, July 1979 to June 1983, ACT

TYPE OF CASUALTY	FREQ		%
1. Bicycle rider: collision with a motor vehicle (1)	75		18.8
2. Bicycle rider: no collision with a moving motor vehicle. Includes collisions with pedestrians, bicycles and stationary or parked motor vehicles	305	323	81.2
3. Bicycle passenger	7		
4. Pedestrian injured in bicycle crash	11		

(1) Up to 5 casualties might have involved a stationary motor vehicle.

Throughout this report, crashes resulting in casualties of types 2, 3 and 4 (Table 1) have been referred to collectively as "Bicycle Alone" crashes, while those resulting in type 1 casualties have been be referred to as "Bicycle/Motor Vehicle" or "Bicycle/MV" crashes.

3.4 CHARACTERISTICS OF TIME AND PLACE

3.4.1 Month, Day of Week and Hour of Day of Crash

November, February and March had more crashes than other months, as shown in Table 2. The lower rates in the intervening months of December and January might reflect an exodus of Canberrans during the school summer holiday period. The lower rates of June to September probably reflect the reduced number of riders during Canberra's cold winter, when temperatures before 9am are frequently below 3°C.

Table 3 shows the day of week of admission to hospital. This, in the great majority of cases, was also the day of the crash.

Table 2

BICYCLE CASUALTIES BY MONTH OF YEAR
Hospital admissions
July 1979 to June 1983, ACT

Month	Freq	%
January	37	9.3
February	45	11.3
March	52	13.1
April	33	8.3
May	32	8.0
June	25	6.3
July	18	4.5
August	25	6.3
September	22	5.5
October	33	8.3
November	42	10.6
December	34	8.5
TOTAL	398	100.0

Table 3

BICYCLE CASUALTIES BY DAY OF WEEK
Hospital admissions
July 1979 to June 1983, ACT

Day	Freq	%
Monday	71	17.8
Tuesday	60	15.1
Wednesday	49	12.3
Thursday	59	14.8
Friday	56	14.1
Saturday	50	12.6
Sunday	53	13.3
TOTAL	398	100.0

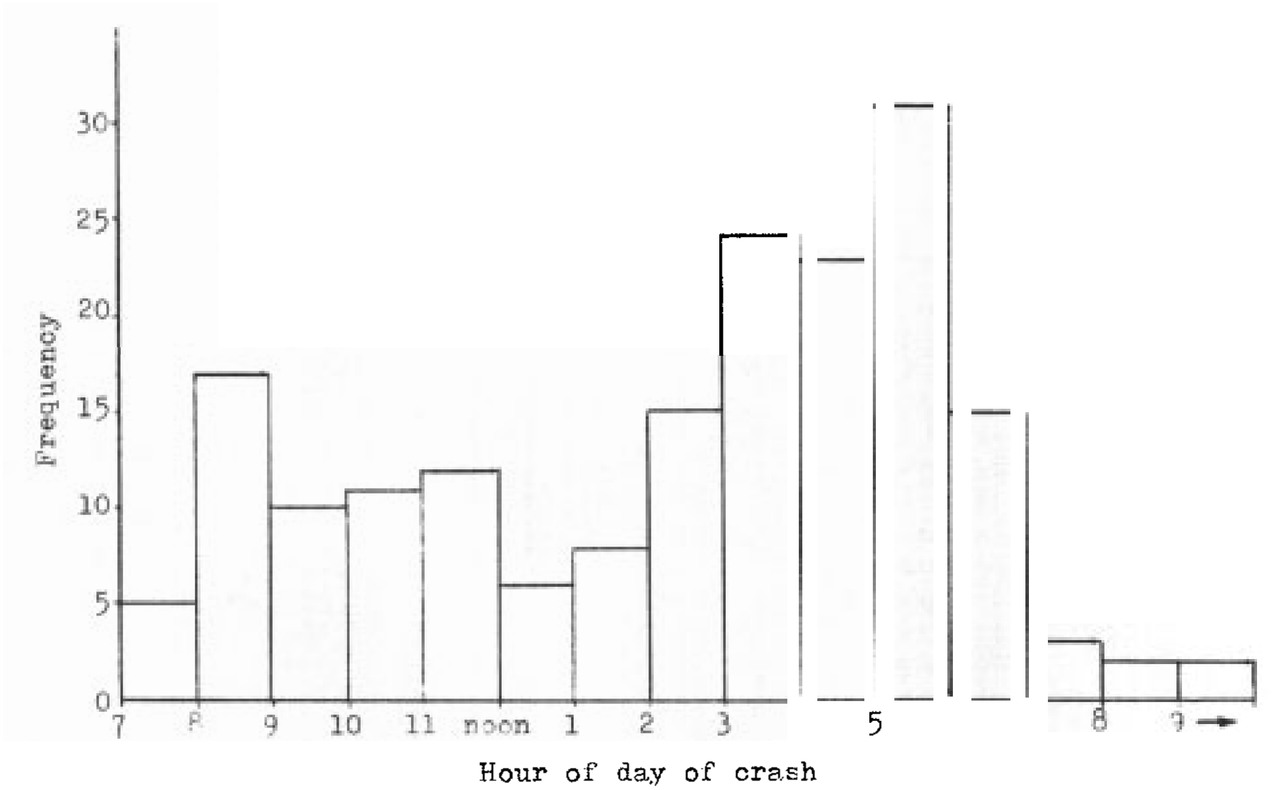

Figure 1: BICYCLE CASUALTIES BY HOUR OF DAY OF CRASH
Hospital admissions, July 1979 to June 1983, ACT

Figure 1 shows the distribution of crashes throughout the day. The most dangerous period was between 3pm and 6pm when 42% of crashes occurred. The hour from 5pm to 6pm accounted for 17% of all bicycle crashes and 21% of bicycle/motor vehicle collisions.

3.4.2 Weather and Lighting Conditions

The weather condition at the time of crash was described by respondents as: dry 95%, wet 3%, windy 3%.

The lighting condition at the time of crash was described as: daylight 87%, twilight 12%, dark 2%. For questionnaire respondents, crashes in twilight and darkness were no more likely to involve motor vehicles than daylight crashes.

3.4.3 Crash Location

Table 4 summarises information on crash location, and table 5 presents in rank order the same information as a percentage based on the total study population.

Table 4 BICYCLE CASUALTIES BY LOCATION OF CRASH AND VEHICLE INVOLVED
Hospital admissions, July 1979 to June 1983

LOCATION		BICYCLE / MV		BICYCLE ALONE		TOTAL	
ROAD	Midblock	17	23%	113	35%	130	33%
	Intersection	46	61%	28	9%	74	19%
	Entering (1)	12	16%	14	4%	26	6%
OFF-ROAD							
	Footpath			61	19%	61	15%
	Cycleway			32	10%	32	8%
	Feeder C/way (2)			22	7%	22	5%
	Other (3)			53	16%	53	13%
TOTAL		75(4)	100%	323(4)	100%	398	100%

Notes: (1) Entering from footpath, driveway, cycleway or nature strip, nearly all of which were midblock.

(2) Feeder cycleways are grade separated shared footpaths which join the trunk cycleway network.

(3) Includes driveway, park, dirt track, racing track, private yard, school grounds, place used for BMX riding.

(4) Location was unknown in 14 and 163 cases of "Bicycle/MV" and "Bicycle alone" crashes respectively. These unknown cases were distributed proportionally within each of the two categories.

Table 5 BICYCLE CASUALTIES BY LOCATION OF CRASH AND VEHICLE INVOLVED
Hospital admissions, July 1979 to June 1983, ACT

LOCATION		VEHICLE INVOLVED	PERCENTAGES
Road	Midblock	Bicycle alone	28%
Off-road	Footpath	Bicycle alone	15%
Off-road	Other	Bicycle alone	13%
Road	Intersection	Bicycle/MV	12%
Off-road	Cycleway	Bicycle alone	8%
Road	Intersection	Bicycle alone	7%
Off-road	Feeder cycleway	Bicycle alone	5%
Road	Entering	Bicycle alone	4%
Road	Midblock	Bicycle/MV	4%
Road	Entering	Bicycle/MV	3%

Overall, 58% of crashes were on-road (only one-third of these involved collisions with motor vehicles) and 42% were off-road crashes.

For on-road crashes, location was strongly related to motor vehicle involvement. Two-thirds of bicycle/MV crashes occurred at intersections, one-twelfth of which were "entering" from a footpath or driveway. The remaining third were midblock crashes and one-third of these were "entering" collisions. For on-road crashes <u>not</u> involving a motor vehicle, only 18% were at intersections while 73% were midblock. Most of the 9% "entering" bicycle only crashes were also midblock.

Roads on which crashes occurred were subjectively classified as: arterial, sub-arterial/distributor/collector and minor/residential. Over half of the crashes were on minor/residential roads.

Table 6 shows that the type of road was strongly related to vehicle involvement ($X^2 = 19.4$, df = 2, $p < .001$). Crashes on arterial roads were more likely to involve motor vehicles (79%) than crashes on minor roads (32%).

Table 6 BICYCLE CASUALTIES (ON-ROAD CRASHES) BY TYPE OF ROAD AND VEHICLE INVOLVED
Hospital admissions, July 1979 to June 1983, ACT

TYPE OF ROAD	BICYCLE / MV		BICYCLE ALONE		TOTAL	
Arterial	23	38%	6	10%	29	25%
Sub-arterial	16	27%	9	16%	25	21%
Minor	21	35%	43	74%	64	54%
TOTAL	60	100%	58	100%	118	100%

3.5 CHARACTERISTICS OF BICYCLIST

3.5.1 Sex

Overall, 72% of bicycle crashes involved male cyclists. This is consistent with the figure of 71% for Western Australia (Lugg 1982).

Males were more likely to be involved in bicycle/MV collisions than females ($X_c^2 = 4.1$, df = 1, $p < .05$). Table 7 shows that males accounted for 82% of bicycle/MV collisions, which also is consistent with Western Australia's 83%.

Table 7 BICYCLE CASUALTIES BY SEX AND VEHICLE INVOLVED
Hospital admissions, July 1979 to June 1983, ACT

SEX	BICYCLE / MV		BICYCLE ALONE		TOTAL	
Male	62	82%	227	70%	289	72%
Female	13	18%	96	30%	109	28%
TOTAL	75	100%	323	100%	398	100%

For on-road crashes, males were more likely to have their crashes on arterial roads than females ($X^2 = 8.4$, df = 2, $p < .05$). Females, on the other hand, had 77% of their crashes on minor roads (Table 8).

Table 8 BICYCLE CASUALTIES (ON-ROAD CRASHES) BY SEX AND TYPE OF ROAD
Hospitals admissions, July 1979 to June 1983, ACT
Questionnaire respondents only

SEX	TYPE OF ROAD			TOTAL
	Arterial	Sub-arterial	Minor	
Male	18	15	32	65
Female	0	5	17	22
TOTAL	18	20	49	87

3.5.2 Age

Three quarters of all crashes involved a cyclist under the age of 19. Cyclists aged between 5 and 16 accounted for 66% of the total and the 5 to 9 age group for 29%. Only 23% were over 20 years of age (Figure 2).

The primary school age group (5 to 11 years) accounted for 39% of the total, the secondary school age group (12 to 17 years) for 28%.

Figure 2 also illustrates that males were significantly over-represented in the 11 to 15 year age group, while cyclists aged 21 to 30 and under 11 had significantly higher proportions of females than other age groups ($X^2 = 20.2$, df = 8, $p < .01$).

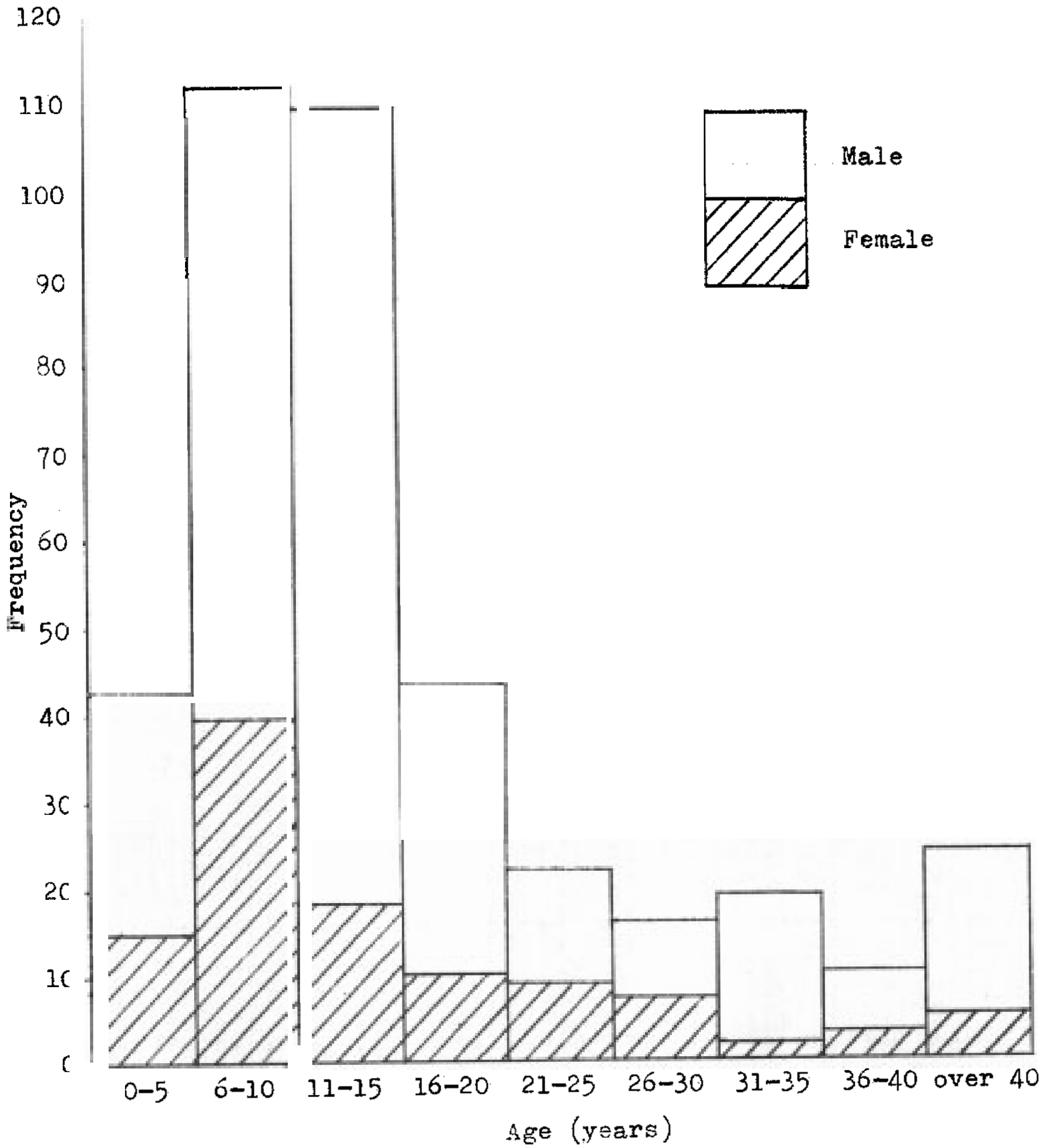

Figure 2 BICYCLE CASUALTIES BY AGE AND SEX

Hospital admissions, July 1979 to June 1983, ACT.

Table 9 shows that a significant relationship exists between cyclist age and motor vehicle involvement ($X^2 = 9.02$, df = 2, $p < .05$). More than half of bicycle/motor vehicle crashes involved cyclists in the age range 11 to 20 years, the remainder being roughly equally divided between the 0 to 10 and over-20 age groups.

Motor vehicle involvement for each age group was:

- 12% of crashes in the under 11 age group
- 26% of crashes in the 11 to 20 age group
- 19% of crashes in the over 20 age group

Table 9 BICYCLE CASUALTIES BY AGE AND VEHICLE INVOLVED
Hospital admissions, July 1979 to June 1983, ACT

AGE	BICYCLE / MV		BICYCLE ALONE		TOTAL	
0-10 years	19	25%	136	42%	155	30%
11-20 years	39	52%	113	35%	152	38%
over 20	17	23%	74	23%	91	23%
TOTAL	75	100%	323	100%	398	100%

For on-road crashes, the type of road was related to the age of the cyclist ($X^2 = 35.2$, df = 4, $p < .001$). Table 10 shows that:

- crashes on sub-arterial roads were much more likely to involve cyclists aged 11 to 20 years than other ages;
- crashes on arterial roads were more likely to involve cyclists over 20 years than younger cyclists;
- crashes on minor roads were more likely to involve cyclists younger than 11 years.

Table 10 BICYCLE CASUALTIES (ON-ROAD CRASHES) BY AGE AND TYPE OF ROAD
Hospital admissions, July 1979 to June 1983, ACT

TYPE OF ROAD	AGE (years) 0 - 10	11 - 20	over 20	TOTAL	
Arterial	0	8	10	18	21%
Sub-arterial	2	15	3	20	23%
Minor	28	15	6	49	56%
TOTAL	30	38	19	87	100%

3.5.3 Purpose of Trip

Riding "for fun" was by far the most commonly reported trip purpose (42%). The second most common trip was riding to/from school (15%). Trips serving mainly a transportation function accounted for 56% of the total, the remainder of trips being for recreation ("fun" and "other", as shown in Table 11).

Table 11 BICYCLE CASUALTIES BY PURPOSE OF TRIP
Hospital admissions, July 1979 to June 1983, ACT

PURPOSE	FREQUENCY	%
fun	77	42
to/from school	28	15
to/from friend's house	23	12
to/from work	22	12
to/from shops	20	11
other specific destination (1)	9	5
other (2)	5	3
TOTAL	184	100

Notes: (1) Includes trips to library, swimming pool, oval.
(2) Includes training or exercise, track racing and learning to ride.

The relationship betwen trip purpose and age, shown in Table 12, was found to be significant ($X^2 = 96.9$, df = 8, $p < .001$). This was to be expected as all school trips were for cyclists under 21, and 91% of work trips involved cyclists over the age of 15.

However, it is also significant that 60% of "fun" riding crashes involved cyclists under 11 years, although this age group accounted for only 39% of the sample. In addition, for trips to specific destinations other than schools and workplaces, the 11-20 age group was significantly over-represented having 54% of the crashes while the under 11's were under-represented with 31%.

Table 12 BICYCLE CASUALTIES BY PURPOSE OF TRIP AND AGE
Hospital admissions, July 1979 to June 1983, ACT

AGE	PURPOSE OF TRIP										TOTAL	
	School		Work		Fun		Other Destination		Other			
0 -10 years	9	32%	0	0%	46	60%	16	31%	0	0%	71	38%
11-20 years	19	68%	4	18%	22	28%	28	54%	0	0%	73	40%
over 20	0	0%	18	82%	9	12%	8	15%	5	100%	40	22%
TOTAL	28	100%	22	100%	77	100%	52	100%	5	100%	184	100%

Trip purpose and vehicle involvement were significantly related, as shown in Table 13 ($X^2 = 22.5$, df = 4, $p < .001$). Although 54% of the crashes during recreational trips were on roads, only 4% involved motor vehicles. For crashes on transportational trips, 64% were on roads and 46% of these were bicycle/MV crashes.

Table 13 BICYCLE CASUALTIES BY PURPOSE OF TRIP AND VEHICLE INVOLVED
Hospital admissions, July 1979 to June 1983, ACT

PURPOSE OF TRIP	BICYCLE / MV	BICYCLE ALONE	TOTAL
fun	3	74	77
to/from school	6	22	28
to/from work	8	14	22
other destination	16	36	52
other purpose	0	5	5
TOTAL	33	151	184

3.5.4 Experience of Cyclist

Two-thirds of crashes involved cyclists who had more than three years of cycling experience, as shown in Table 14. Males involved in crashes had significantly more cycling experience than females: 75% of male cyclists compared with 47% of females had more than three years experience ($X^2_c = 10.9$, df = 1, $p < .001$).

Table 14 BICYCLE CASUALTIES BY CYCLING EXPERIENCE AND SEX
Hospital admissions, July 1979 to June 1983, ACT

EXPERIENCE	MALE	FEMALE	TOTAL	
less than 3 months	6	3	9	5%
3 months to 1 year	10	10	20	11%
1 to 3 years	18	10	28	16%
more than 3 years	102	20	122	68%
TOTAL	136	43	179	100%

Cycling experience and trip purpose were also significantly related ($X^2_c = 6.7$, df = 1, $p < .01$). For crashes during recreational trips, 58% of cyclists had more than three years experience, but for transportational trips this figure was higher at 77%.

3.5.5 On-road or Off-road Riding

Of cyclists responding to the questionnaire, 29% usually cycled on roads, 31% usually on footpaths and cycleways, and 40% cycled about half the time on roads and half the time on footpaths and cycleways. This suggests that roughly half of trips, but not necessarily distances, were usually on roads and half were usually off roads.

There is a significant relationship between age and whether the cyclist usually rode on or off roads ($X^2 = 18.4$, df = 6, $p < .01$). Table 15 shows that only 17% of under 11 casualties usually cycled on roads, compared to 36% of older cyclists. For the 11-15 age group only 13% usually cycled off-road, compared to 38% of all other ages.

Table 15 BICYCLE CASUALTIES BY RIDING HABIT AND AGE
Hospital admissions, July 1979 to June 1983, ACT

RIDING HABIT	AGE (YEARS) 0-10		11-15		16-20		over 20		TOTAL	
usually on roads	11	17%	21	40%	5	28%	13	45%	50	29%
usually on footpaths and cycleways	30	47%	7	13%	4	22%	12	32%	53	31%
about half and half	23	36%	25	47%	9	50%	13	34%	70	40%
TOTAL	64	100%	53	100%	18	100%	48	100%	173	100%

Another significant relationship (see Table 16) was found to exist between the experience of the rider and whether the cyclist usually rode on or off roads ($X^2 = 25.5$, df = 4, $p < .001$). For those with less than three years cycling experience, 56% usually rode on cycleways and footpaths. For those with more than 3 years experience, only 19% usually rode on footpaths and cycleways.

Table 16 BICYCLE CASUALTIES BY RIDING HABIT AND EXPERIENCE
Hospital admissions, July 1979 to June 1983, ACT

RIDING HABIT	RIDING EXPERIENCE less than 1 year		1 - 3 years		more than 3 years		TOTAL	
usually on roads	4	15%	3	11%	43	36%	50	29%
usually on footpaths and cycleways	15	55%	15	56%	22	19%	52	30%
about half and half	8	30%	9	33%	53	45%	70	41%
TOTAL	27	100%	27	100%	118	100%	172	100%

It is significant that 86% of on-road crashes involved cyclists who usually cycled on roads, but only 53% of crashes on footpaths and cycleways involved cyclists who usually rode on footpaths and cycleways ($X^2 = 47.9$, $df = 8$, $p < .001$).

3.5.6 Use of Helmets

The overall rate of helmet use was 8%, but varied from 28% for the over 20 age group to a mere 1% for the under 11's ($X^2 = 25.7$, $df = 2$, $p < .001$), refer Table 17. It is noteworthy that all helmet users were males ($X_c^2 = 4.1$, $df = 1$, $p < .05$).

Table 17 BICYCLE CASUALTIES BY USE OF HELMET AND AGE
Hospital admission, July 1979 to June 1983, ACT

USE OF HELMET	AGE (YEARS) 1 - 10		11 - 20		Over 20		TOTAL	
No helmet	69	99%	70	96%	29	73%	168	92%
Helmet	1	1%	3	4%	11	27%	15	8%
TOTAL	70	100%	73	100%	40	100%	183	100%

3.6 CHARACTERISTICS OF CRASH CAUSATION

3.6.1 Major Causes of Crash

Table 18 shows the main cause of crash, as assessed by respondents to the questionnaire. Respondents were invited to select more than one cause if necessary, hence from 183 responding cyclists there were 253 responses.

The right-hand column of Table 18 gives the percentage of cyclists identifying each cause. For example, 22.4% of respondents had a collision or near collision with a motor vehicle.

Table 18 BICYCLE CASUALTIES BY MAIN CAUSE OF CRASH
Hospital admission, July 1979 to June 1983, ACT

MAJOR CAUSE	FREQUENCY	% OF RESPONSES	% OF RESPONDENTS
Collision or near collision with			
motor vehicle	41	16.2	22.4
other bicycle	11	4.3	6.0
pedestrian	5	2.0	2.7
animal	5	2.0	2.7
other	15	5.9	8.2
Problem with the riding surface			
wet pavement	2	0.8	1.1
sand/gravel/dirt on pavement	20	7.9	10.9
crack/bump/hole in pavement	12	4.7	6.6
other	22	8.7	12.0
Doing stunts or tricks	25	9.9	13.7
Bicycle handling problem			
braking	25	9.9	13.7
turning	15	5.9	8.2
steering	24	9.5	13.1
Object catching in moving part of bicycle	10	4.0	5.5
Mechanical fault	21	8.3	11.5
TOTAL	253	100.0%	138.3%

3.6.2 Factors Contributing to Crash

Table 19 shows factors which, according to respondents, contributed to their crash. Of the 183 bicycle riders and passengers who responded to the questionnaire, 146 identified one or more contributing factors. The right hand column of the table shows the percentage of respondents affected by each factor. For example, riding too fast was a contributing factor in 32% of crashes.

Table 19 BICYCLE CASUALTIES BY CONTRIBUTING FACTORS
Hospital admission, July 1979 to June 1983, ACT

CONTRIBUTING FACTOR	FREQUENCY	% OF RESPONSES	% OF RESPONDENTS
Riding too fast	59	21.8	32.2
Riding downhill	51	18.8	27.9
New or unfamiliar bike	32	11.8	17.5
Not looking ahead	23	8.5	12.6
Unfamiliar location	16	5.9	8.7
Traffic violation - other person	16	5.9	8.7
- self	8	2.9	4.4
Talking to or looking at riding companion	15	5.5	8.2
Carrying object in hand(s)	9	3.3	4.9
Double dinking	7	2.6	3.8
Unable to see far enough ahead			
- too dark	1	0.4	0.5
- bushes in way	4	1.5	2.2
- other obstacle	7	2.6	3.8
Car passed too close	5	1.8	2.7
Other	18	6.7	9.9
TOTAL	271	100.0	148.0

Traffic violations were further investigated for bicycle/motor vehicle crashes. Sufficient information was obtained from ACT police reports to make a general assessment of whether the bicyclist and/or the motorist had violated traffic regulations. This assessment was based on "right of way" at intersections, blood alcohol content, speeding and absence of bicycle lights at night.

For the study period, 63 bicycle/motor vehicle crashes resulting in hospital admission were identified from police reports and in 52 cases there appeared to be clear-cut traffic violations. In 6 of these cases both the cyclist and the motorist had committed violations.

Table 20 shows that young cyclists were more likely to have contributed to their collisions with motor vehicles by traffic violations than older cyclists ($X^2 = 13.9$, df = 3, $p < .005$). Cyclists under 16 years of age committed 86% of traffic violations in their crashes, while older cyclists committed 41% of the noted traffic violations.

Table 20 TRAFFIC VIOLATIONS FOR POLICE-REPORTED BICYCLE/MOTOR VEHICLE CRASHES, BY AGE AND VEHICLE OPERATOR
Hospital admissions, July 1979 to June 1983, ACT

AGE (Years)	VIOLATION BY CYCLIST	VIOLATION BY MOTORIST	TOTAL
0 - 10	11	0	11
11 - 15	13	4	17
16 - 20	6	7	13
over 20	5	9	14
TOTAL	35	20	55

3.6.3 Relationships between Main Cause and Other Variables

To facilitate comparison of the main cause of crash with other variables, cases in which respondents identified more than one main cause were examined and a single main cause was assigned. If, for example, a crash involved both a braking problem and a patch of gravel on a corner, the main cause was attributed to the riding surface, on the assumption that the braking problem was precipitated by the gravel patch rather than merely being exacerbated by it. There was difficulty in assigning a principal cause in only 6% of cases.

There was one exception to this assignment method: all bicycle/motor vehicle collisions were classified as such, regardless of any precipitating causes.

The results of this analysis are shown in Tables 21 and 22. These tables indicate the significant relationships between main cause and age ($X^2=22.9$, df = 12, $p < .05$), sex ($X^2=13.5$, df = 6, $p < .05$) and purpose of trip ($X^2=44.1$, df = 6, $p < .001$):

Collisions with motor vehicles were more likely to involve to male cyclists aged 11 to 20 years.

Bicycle/motor vehicle collisions were much more likely to occur on transportational bicycle trips (91%) than on recreational trips.

Riding too fast and/or downhill was the most frequent contributing factor in crashes not involving motor vehicles.

If problems occurred with the riding surface, the under 11 age group was more likely to have been involved, whilst the 11 to 20 age group was less likely to have been involved.

Nearly all crashes caused by stunt or trick riding involved males up to the age of 20.
72% of this group were males aged between 8 and 15 years.

Although 45% of bicycle handling problems involved males aged 6 to 15, a higher proportion of females had handling problems than did males. Handling problems were significantly more likely to occur on recreational bicycle trips than on transportational trips.

If bicycle handling problems occurred, a new or unfamiliar bicycle was involved in 42% of cases for which braking was the main problem.

Table 21 BICYCLE CASUALTIES BY MAIN CAUSE AND SIGNIFICANT FACTORS (1)
Hospital admissions, July 1979 to June 1983, ACT

MAIN CAUSE	FREQ	MEDIAN AGE (YEARS)	AVERAGE LENGTH OF STAY (DAYS)	SEX % MALE	PURPOSE OF TRIP	CONTRIBUTING FACTORS AS ASSESSED BY RESPONDENTS (2) (≥ 15% of cases)			
BICYCLE/MOTOR VEHICLE COLLISION	33	15	11.0	85% male	91% transportation 9% recreation	45% Traffic violation by other person	21% Traffic violation by self	15% Riding too fast and/or downhill	15% Not searching ahead (3)
OTHER COLLISION OR NEAR COLLISION	32	13	2.6	81% male	50% transportation 50% recreation	38% Riding too fast and/or downhill	31% Not searching ahead (3)	22% Vision obscured	
PROBLEM WITH RIDING SURFACE	32	11	4.7	69% male	50% transportation 50% recreation	56% Riding too fast and/or downhill	34% Bicycle handling problem	19% Bicycle new or unfamiliar	16% Not searching ahead (3)
PERFORMING STUNTS OR TRICKS	25	12	2.9	92% male	20% transportation 80% recreation	40% Riding too fast and/or downhill	28% Riding surface problem	16% Bicycle new or unfamiliar	
BICYCLE HANDLING PROBLEM Braking Turning Steering	31	10	5.9	61% male	42% transportation 58% recreation	68% Riding too fast and/or downhill 19% Collision or near collision	42% Bicycle new or unfamiliar 16% Unfamiliar location	26% Not searching ahead (3) 16% Other handling problem	23% riding surface problem
OBJECT CATCHING IN MOVING PART	10	12	5.1	50% male	100% transportation 0% recreation	20% Riding too fast and/or downhill	20% Carrying things in hand(s)		
MECHANICAL FAULT	12	14	3.3	75% male	67% transportation 33% recreation	33% Riding too fast and/or downhill	33% Riding surface problem	25% Bicycle handling problem	
OVERALL	175	12	5.4	70% male	56% transportation 44% recreation				

Notes: (1) The table excludes pedestrians injured in bicycle crashes.
It should be noted that for each main cause the sample size in quite small.

(2) "Contributing factors" are presented in rank order for each main cause and are not mutually exclusive. Percentages are not additive.

(3) "Not searching ahead" includes the categories "not looking ahead" and "talking to or looking at riding companion" (see Table 20).

Table 22 BICYCLE CASUALTIES BY SINGLE MAIN CAUSE OF CRASH AND AGE
Hospital admissions, July 1979 to June 1983, ACT

MAIN CAUSE	AGE (YEARS)					TOTAL
	0-5	6-10	11-15	16-20	Over 20	
Bicycle/MV collision	0	8	11	7	7	33
Other collision or near collision	2	9	9	4	8	32
Problem with riding surface	4	12	3	4	9	32
Performing stunts or tricks	1	7	14	2	1	25
Bicycle handling problem	5	11	8	1	6	31
Object catching in moving part	1	3	5	0	1	10
Mechanical fault	1	4	2	0	5	12
TOTAL	14	54	52	18	37	175

3.7 CHARACTERISTICS OF INJURY

3.7.1 Length of Stay in Hospital

The length of stay in hospital is a useful but rough guide to injury severity. It is calculated as the difference between the dates of discharge and admission. If the patient was admitted and discharged on the same day, this was recorded as a stay of one day.

Length of stay was significantly related to the age and sex of the cyclist, and whether a motor vehicle was involved in the crash.

The under 11 age group stayed in hospital for significantly shorter periods than older cyclists ($X^2 = 17.9$, df = 8, $p < .05$). Their average stay was 4.9 days compared with 6.1 days for older cyclists. Table 23 shows that 42% of admissions for the under 11 age group were for only one day, which accounts for 52% of all one day stays.

Table 23 BICYCLE CASUALTIES BY LENGTH OF STAY AND AGE
Hospital admissions, July 1979 to June 1983, ACT

LENGTH OF STAY	AGE (YEARS) 0 - 10		11 - 20		Over 20		TOTAL	
1 day	65	42%	40	26%	21	23%	126	32%
2 to 3 days	44	28%	45	30%	26	29%	115	29%
4 to 7 days	27	17%	37	24%	28	31%	92	23%
8 to 14 days	10	7%	18	12%	12	13%	40	10%
over 14 days	9	6%	12	8%	4	4%	25	6%
TOTAL	155	100%	152	100%	91	100%	398	100%
AVERAGE	4.9 days		6.0 days		6.1 days		5.6 days	

Females were likely to have shorter hospital stays than males: their average length of stay was 4.5 days compared with 6.0 days for males. Only 9% of their stays were longer than one week whereas for males this figure was 19% (X^2_c = 4.8, df = 1, $p < .05$).

Bicycle/motor vehicle crashes were likely to result in considerably longer stays than "bicycle alone" crashes, as shown in Table 24 (X^2 = 30.0, df = 4, $p < .001$). For bicycle/motor vehicle crashes, 34% of casualties were hospitalised for more than one week, compared with 12% when no motor vehicle was involved. Average lengths of stay were 10.5 days and 4.5 days respectively.

Table 24 BICYCLE CASUALTIES BY LENGTH OF STAY AND VEHICLE INVOLVED
Hospital admissions, July 1979 to June 1983, ACT

LENGTH OF STAY	BICYCLE / MV		BICYCLE ALONE		TOTAL	
1 day	14	19%	112	35%	126	32%
2 to 3 days	18	24%	97	30%	115	29%
4 to 7 days	17	23%	75	23%	92	23%
8 to 14 days	16	21%	24	7%	40	10%
over 14 days	10	13%	15	5%	25	6%
TOTAL	75	100%	323	100%	398	100%
AVERAGE	10.5 days		4.5 days		5.6 days	

3.7.2 Main Injury

The main injury was obtained from the Health Authority's hospital morbidity data base. Although many casualties had more than one injury, only the most severe or life-threatening is considered in this study.

Injuries have been classified according to the eight categories shown in Table 25. The category "concussion etc" covers the range from minor to severe concussion and includes a few cases of intracranial haemorrhage and nine cases of head injury 'not otherwise specified'. "Internal injury" includes injuries in the thoracic, abdominal and pelvic regions, but excludes fractures and surface injuries. The category "other injuries" includes dislocations, sprains, lacerations, contusions, abrasions, minor disorders and complications.

The main injury is significantly related to motor vehicle involvement ($X^2 = 21.8$, df = 7, $p < .005$). Table 25 shows that bicycle/motor vehicle crashes were more likely to result in skull fractures, fractured legs and "other" fractures than were crashes not involving motor vehicles. Conversely, bicycle alone crashes were more likely to result in fractured arms, concussion and "other" injuries.

The length of stay in hospital is significantly related to the type of main injury ($X^2 = 28.5$, df = 7, $p < .001$). The average length of stay for each main injury, as shown in Table 25, gives a rough measure of the overall severity associated with that injury. Hence, although leg fractures and internal injuries accounted for only 12% and 8% of cases respectively, they accounted for 34% and 15% of hospital days and had average lengths of stay of 16.4 days and 10.2 days respectively. Head injuries, on the other hand, accounted for 46% of all cases but for only 27% of days spent in hospital, with an average length of stay of only 3.3 days.

Other significant features of main injury versus length of stay were:

- 56% of concussion cases required only one day (or less) in hospital;
- 30% of lower limb fractures required more than two weeks in hospital;
- 97% of "other" injuries required a maximum of one week in hospital;
- 50% of internal injuries required between one and two weeks in hospital.

25 BICYCLE CASUALTIES BY MAIN INJURY, VEHICLE INVOLVED AND LENGTH OF STAY
Hospital admissions, July 1979 to June 1983, ACT

MAIN INJURY	BICYCLE / MV				BICYCLE ALONE				TOTAL			
	Frequency		Ave length of stay (days)	% of stay (B/MV)	Frequency		Ave length of stay (days)	% of stay (B alone)	Frequency		Ave length of stay (days)	% of total stay
kull fracture	16	21%	7.6	16%	28	9%	3.2	6%	44	11%	4.8	9%
acial fracture	5	7%	6.2	4%	28	9%	3.3	6%	33	8%	3.7	6%
oncussion etc	15	20%	6.5	12%	94	29%	1.9	12%	109	27%	2.5	12%
rm fracture	6	8%	9.5	7%	46	14%	4.3	15%	52	13%	4.9	11%
eg fracture	14	19%	22.7	41%	33	10%	13.7	31%	47	12%	16.4	34%
ther fracture	7	9%	6.0	5%	15	5%	4.2	4%	22	6%	4.8	5%
nternal injury	6	8%	17.2	13%	26	8%	8.6	16%	32	8%	10.2	15%
ther injuries	6	8%	2.7	2%	53	16%	3.1	11%	59	15%	3.0	8%
OTAL	75	100%	10.5	100%	323	100%	4.5	100%	398	100%	5.6	100%

The following table ranks the main injury and vehicle involved according to the percentage of all days spent in hospital by bicycle casualties.

Table 26 BICYCLE CASUALTIES BY MAIN INJURY, VEHICLE INVOLVED AND HOSPITAL STAY
Hospital admissions, July 1979 to June 1983, ACT

MAIN INJURY	VEHICLE INVOLVED	PERCENT TOTAL DAYS IN HOSPITAL
leg fracture	bicycle alone	20%
leg fracture	bicycle/MV	14%
internal injury	bicycle alone	10%
arm fracture	bicycle alone	9%
concussion etc	bicycle alone	8%
other injury	bicycle alone	7%
skull fracture	bicycle/MV	5%
internal injury	bicycle/MV	5%
concussion etc	bicycle/MV	4%
facial fracture	bicycle alone	4%
skull fracture	bicycle alone	4%
other fracture	bicycle alone	3%
arm fracture	bicycle/MV	3%
other fracture	bicycle/MV	2%
facial fracture	bicycle/MV	1%
other injury	bicycle/MV	1%

4 RESULTS: NON-HOSPITALISED CASUALTIES

Very little information is available on bicycle crashes which result in injuries requiring medical treatment but not hospital admission. However, 221 such crashes, involving on-road collisions with motor vehicles, were documented in police accident reports for the study period. **This chapter** examines these 221 crashes.

Table 27 BICYCLE/MOTOR VEHICLE CASUALTIES BY AGE, SEX, TYPE OF ROAD (1), LOCATION AND FAULT(2)
Police-reported injury crashes not resulting in hospital admission
July 1979 to June 1983, ACT

	AGE (YEARS)					TOTAL	
	0-5	6-10	11-15	16-20	Over 20		
SEX							
Male	4	22	57	28	53	164	74%
Female	0	8	17	11	21	57	26%
ROAD (1)							
Arterial	0	2	22	18	40	82	37%
Sub-arterial	0	8	28	15	21	72	33%
Minor	4	20	24	6	13	67	30%
LOCATION							
Intersection	0	15	32	21	46	114	51%
Midblock	1	6	20	16	27	70	32%
Entering (3)	3	9	22	2	1	37	17%
FAULT (2)							
Bicyclist	3	23	54	16	12	108	49%
Motorist	0	1	12	16	50	78	36%
Doubtful	1	6	8	7	12	34	15%
TOTAL	4	30	74	39	74	221	
	2%	14%	33%	18%	33%	100%	

(1) Refer 3.5.3
(2) Refer 3.7.2
(3) Entering road from footpath, driveway, cycleway or nature strip.

Crash locations are shown in Table 27. It is noteworthy that 59% of cyclists involved in "entering" crashes were aged 11 to 15 years and a further 32% were aged under 11. For the under 11 age group, 35% of crashes were a result of "entering", compared with only 13% for older cyclists. "Entering" crashes were about equally divided between intersections and midblock.

For midblock crashes, 28% involved a cyclist riding into a stationary (usually parked) motor vehicle, 22% were "entering" from a footpath, driveway or nature strip, and 5% involved opening car doors.

Younger cyclists had most of their crashes on minor roads and were very often to blame for their crashes. **As the age of the cyclist increases, there** is a transition from minor to arterial roads and from cyclist fault to motorist fault: for cyclists aged over 20, half their crashes were on arterial roads and motorists were at fault in at least two-thirds of their crashes. **This pattern is very similar to that for crashes resulting in** hospital admission (see Tables 10 and 20).

Injuries sustained by non-hospitalised casualties were:

abrasions, bruises, sprains and minor complaints	47%
lacerations	35%
fractures	13%
unspecified	5%

Table 28 compares additional information on non-hospitalised bicycle casualties with hospitalised casualties.

In addition to the 221 cases of on-road bicycle/MV crashes discussed above, police reports also identified:

20 crashes at footpath/driveway intersections, nearly all of which were due to a motor vehicle reversing from a driveway, and half of which involved cyclists aged 13 to 15 years;

8 crashes on footpaths or cycleways (no motor vehicle);

6 on-road crashes (no motor vehicle);

5 crashes in car parks (motor vehicle involved).

Hence, 8% of police-reported injury crashes (not hospital admission) occurred at footpath/driveway intersections.

Table 28 BICYCLE/MOTOR VEHICLE CASUALTIES BY AGE, SEX, TEMPORAL DISTRIBUTION, LIGHT AND WEATHER CONDITIONS
Police-reported non-hospitalised casualties compared with hospitalised casualties, July 1979 to June 1983, ACT

		Police-reported Non-hospitalised	Admitted to Hospital
SAMPLE SIZE		221	75
AGE	0-10 years	33%	23%
	11-20 years	16%	25%
	Over 20	51%	52%
SEX	Male	74%	82%
	Female	26%	18%
TIME OF DAY			
	8am to 9am	20% (3/4 were aged 11-20)	
	3pm to 6pm	35%	
	5pm to 6pm	12%	21%
DAY OF WEEK			
	Weekday	83%	81%
	Weekend	17%	19%
TIME OF YEAR			
	Month with highest frequency	March 14%	March 20%
	March quarter	31%	31%
	June quarter	28%	25%
	September quarter	16%	19%
	December quarter	25%	25%
LIGHT CONDITIONS			
	Daylight	91%	84%
	Twilight	3%	7%
	Dark	6%	9%
WEATHER CONDITIONS			
	Dry	93%	95%
	Raining or wet surface	7%	5%

5 DISCUSSION

Interpretation of results is difficult without exposure data or information on the characteristics of the general cycling population, and is further complicated because a number of factors, such as cyclist conspicuity, were not investigated. On the subject of conspicuity, it should be mentioned that other studies have found that a lack of visibility or conspicuity of cyclists appears to be implicated in up to half of all bicycle/motor vehicle collisions (Mathieson 1984).

5.1 AGE PROFILES

The casualty profiles for the different age groups (Table 29) summarise many of the significant results of this study and should be considered carefully in the development of any bicycle safety programs. The profiles are consistent with the following observed patterns of behaviour for child and adult cyclists.

Younger children are still very dependent on their home environment and rarely venture unaccompanied beyond their immediate neighbourhood. They have little or no need to ride further than their local school. Most of their riding would be for fun rather than to specific destinations, so they would ride mainly on the footpaths or residential streets near home.

Older children, especially adolescents, are more independent and spend an increasing proportion of their time away from the home. The bicycle becomes their major form of personal transport, and is used to visit friends, to go to the swimming pool, library, shops or school, to attend sports training and matches, or simply to go for a ride. These trips would normally be longer than those undertaken by younger children, and would involve a greater use of subarterial and arterial roads.

Adult cyclists use the bicycle mainly as transport to work or for recreation. Trips to work are often up to 10 kilometre long and consequently adult cyclists will tend to select routes which minimise both travel time and effort. Major roads, together with the more direct sections of convenient cycleway, will often be chosen.

Table 29 AGE PROFILES FOR BICYCLE CASUALTIES
Hospital admissions, July 1979 to June 1983, ACT

Under 11 years	11 to 20 years	Over 20 years
. Accounted for 39% of bicycle casualties.	. Accounted for 38% of bicycle casualties.	. Accounted for 23% of bicycle casualties.
. Only 12% of these crashes were with motor vehicles. Nearly all of these involved traffic violations by the cyclist.	. 26% of these crashes involved motor vehicles. Cyclists aged 11-15 were very often at fault but 16-20 years old were to blame in only half of their crashes.	. 19% of these crashes were with motor vehicles, motorists were usually at fault.
. Average length of stay was 4.9 days (3.6 days if no motor vehicle involved).	. Average length of stay was 6.0 days (4.5 days if no motor vehicle involved).	. Average length of stay was 6.1 days, regardless of motor vehicle involvement.
. 47% usually cycled on footpaths and cycleways, 17% usually on roads, 36% half and half.	. 37% usually cycled on roads, 15% usually on footpaths and cycleways, 48% half and half.	45% usually cycled on roads, 32% usually on footpaths and cycleways, 23% half and half.
. 93% of on-road crashes were on minor roads.	39% of on-road crashes were on subarterial roads, 39% on minor roads.	. 53% of on-road crashes were on arterial roads.
. Main causes of crash (for respondents) were: bicycle handling problem 24% problem with riding surface 24% "other" collision 16%	. Main causes of crash (for respondents) were: performing stunts 27% (nearly all were under 16 years) bicycle/MV collision 21% "other" collision 17% bicycle handling problem 15% (nearly all were under 16 years)	. Main causes of crash (for respondents) were: problem with riding surface 24% "other" collision 22% bicycle/MV collision 19% bicycle handling problem 16%
. Purposes of trip were: fun 65% "other" destination 22% school 13%	. Purposes of trip were: "other" destination 38% fun 30% school 26%	. Purposes of trip were: work 45% fun 23% "other" destination 20%

Table 30 SEX PROFILES FOR BICYCLE CASUALTIES
Hospital admissions, July 1979 to June 1983, ACT

MALES	FEMALES
. Accounted for 82% of bicycle/ MV collisions, but only 70% of "bicycle alone" crashes.	. Accounted for 18% of bicycle/ MV collisions, but 30% of "bicycle alone" crashes.
. Average length of stay was 6.0 days.	. Average length of stay was was 4.5 days.
. 75% had more than 3 years experience.	. 47% had more than 3 years experience.
. For on-road crashes: 27% were on arterial roads 49% were on minor roads	. For on-road crashes: none were on arterial roads 77% were on minor roads
. The 11-15 age group was especially over-represented with males.	. The under 11 age group had a significantly higher proportion of females than did other age groups.

5.2 SEX PROFILES

The information summarised in Table 30 suggests a number of possible interpretations, however the expalantion possibly most consistent with the data relates to relative exposure rates and sex role stereotyping.

There has been generally more acceptance and encouragement in our society for males to participate in strenuous or hazardous activities than for females. The preponderance of male bicycle casualties might therefore reflect a greater use of bicycles by males than females, possibly because bicycle riding is commonly perceived as a strenuous, high-risk activity.

5.3 PROFILES FOR VEHICLE INVOLVEMENT

The average hospital stay was longer for cyclists injured in collisions with motor vehicles was much longer than for cyclists injured in bicycle alone crashes. This suggests that injuries sustained in bicycle/motor vehicle crashes were more serious and is consistent with the higher speeds and energy levels involved in these crashes.

Bicycle/motor vehicle crashes occurred about as frequently on arterial roads as minor roads and were usually at intersections. Only about half of bicycle alone crashes were on roads and the majority of these were on minor roads at midblock.

Table 31 BICYCLE CASUALTY PROFILES FOR VEHICLE INVOLVEMENT
Hospital admissions, July 1979 to June 1983, ACT

BICYCLE/MOTOR VEHICLE	BICYCLE ALONE
. Accounted for 19% of all bicycle crashes.	. Accounted for 81% of all bicycle crashes.
. 71% were during recreational trips.	. 95% were during recreational trips.
. 52% involved cyclists aged 11 to 20.	. 42% involved cyclists aged under 11 years.
. Average length of stay was 10.5 days.	. Average length of stay was 4.5 days.
. 38% were on arterial roads 35% were on minor roads 27% were on subarterial roads	. For on-road crashes: 74% were on minor roads 16% were on subarterial roads 10% were on arterial roads
. 66% were at intersections	. For on-road crashes: 73% were at midblock.
. Main injuries were: Skull fracture 21% Concussion etc 20% Leg fracture 19%	. Main injuries were: Concussion etc 29% "Other" injuries 16% Arm fracture 14%
	. 52% were off-road crashes, two-thirds of which were on footpaths and cycleways.

5.4 COMPARISONS WITH OTHER STUDIES

A number of important bicycle accident studies have been undertaken in Australia during the last decade. Unfortunately, very few of the results of these studies can be compared directly with the current study because of the incompatibility of data, however there are a number of trends which are fairly consistent. These include the very high representation of children, especially in the 10 to 14 age group; the high ratio of male to female casualties (about 5 : 2); the likelihood of bicycle/motor vehicle collisions occurring at intersections (60% to 70%); and the small proportion of crashes which involve collisions with motor vehicles.

One study, carried out by the Public Health Department of Western Australia (Lugg 1982), produced a number of results which can be compared directly with the current study. These are summarised in Table 32.

The similarities between the Western Australian and ACT data are striking. **In particular it is interesting to note that the overall casualty** rates and the proportions of crashes which involve other road vehicles are almost identical. Although the average lengths of stay in hospital are comparable, the pattern of main injuries is dissimilar.

Table 32 BICYCLE CASUALTY COMPARISON BETWEEN ACT AND WESTERN AUSTRALIA
Hospital admissions - ACT, July 1979 to June 1982
WA, periods as specified

VARIABLE	ACT		WA	
AGE (1)				
	Freq	Rate (2)	Freq	Rate (2)
0- 9 years	136	78	723	110
10-19 years	168	102	769	109
20 + years	94	17	236	9
Overall		45		43
VEHICLE INVOLVEMENT (3)				
Bicycle alone	79%		79%	
Bicycle with other road vehicle	21%		21%	
SEX (3)				
Bicycle alone				
Male	70%		70%	
Female	30%		30%	
Bicycle with other road vehicle (4)				
Male	82%		84%	
Female	18%		16%	
DAY OF WEEK (5)				
Weekday	74%		66%	
Weekend	26%		34%	
MONTH OF YEAR (5) (highest frequencies)				
	March	13.1%	March	12.2%
	February	11.3%	February	10.2%
	November	10.6%	November	9.3%
AVERAGE LENGTH OF STAY (5)	5.6 days		5.8 days	
MAIN INJURY (3) (highest frequencies)				
Bicycle alone	Concussion	29%	Concussion	41%
	"Other"	16%	"Other"	26%
	Arm fracture	14%	Arm fracture	16%
Bicycle with other road vehicle	Skull fracture	21%	Concussion	41%
	Concussion	20%	Leg fracture	18%
	Leg fracture	19%	"Other"	15%

(1) WA data is for period 1980 to 1982
(2) Age specific rate per 100,000 persons
(3) WA data is for period 1979 to 1983
(4) ACT data made compatible with WA data, c.f. section 3.4
(5) WA data is for period 1971 to 1980

6 CONCLUSIONS

The absence of data on both exposure rates and characteristics of the general cycling population limits the conclusions that can be drawn from the results of this study. Nevertheless, some general conclusions about non-fatal bicycle crashes can be made which have important implications for countermeasure programs.

6.1 CYCLIST BEHAVIOUR

Collisions with motor vehicles for which the motorist is responsible account for only a small proportion of crashes which result in hospital admission. The great majority of serious non-fatal bicycle crashes for cyclists of <u>all</u> ages are caused by cyclist error.

The high incidence of cyclist error suggests a general weakness in cycling skills, including:

- poor basic handling skills (balancing, steering, braking and turning);
- ignorance of or disregard for traffic regulations;
- inability to recognise and avoid hazards;
- ignorance of safe techniques for riding in traffic (for example, correct positioning in traffic, safe turning and diverging procedures, ability to match speed with conditions); and
- ignorance of defensive riding techniques (for example, emergency turns and stops, anticipation of other people's errors).

Cyclist error is highlighted in Table 21, which summarises the main causes of bicycle crashes and the factors contributing to them.

Cyclist behaviour was found to be significantly related to age and cycling experience. For example, 56% of cyclists with less than three years cycling experience usually rode on cycleways and footpaths, but for those with <u>more</u> than three years experience only 19% usually rode on cycleways and footpaths.

6.2 MOTOR VEHICLE INVOLVEMENT

Characteristics of bicycle/motor vehicle crashes differ significantly from those of bicycle alone crashes, as summarised in Table 31. The main differences are the length of stay in hospital (Table 24), the types of injury sustained (Table 25), the age and sex of the cyclist (Tables 7 and 9), the type of road on which the crash occurs (Table 6), whether the crash occurs at an intersection or midblock (Table 4), and the purpose of the trip (Table 13).

In over 80% of bicycle/motor vehicle crashes, apparently clear-cut traffic violations had been committed. Cyclists aged under 16 committed 86% of traffic violations in their crashes, but for crashes involving older cyclists, 59% of violations were by the motorist.

It can be concluded that countermeasures for bicycle/motor vehicle crashes could differ significantly from countermeasures for bicycle alone crashes, should be age-related, and should be directed at both cyclists and motorists.

6.3 CYCLISTS' INJURIES

Head injuries accounted for 46% of all main injuries sustained by cyclists admitted to hospital, however they accounted for only 27% of days spent in hospital (Table 25). Leg fractures and internal injuries, on the other hand, accounted for only 20% of injuries but for 49% of days spent in hospital.

Crash prevention is clearly the most important way to eliminate injury, however the use of good quality bicycle helmets could eliminate or reduce the severity of most head injuries.

6.4 CRASH LOCATIONS

Serious bicycle crashes occurred almost anywhere: they were as frequent on minor roads as on arterial roads and were almost as frequent off-road as on-road. Without exposure data, however, it is not possible to conclude anything about crash rates at specific locations.

7 RECOMMENDATIONS

7.1 RIDER TRAINING

The great majority of serious non-fatal bicycle crashes for cyclists of all ages are caused by cyclist error. It is therefore recommended that effective education programs be directed at child cyclists, teenage cyclists, adult cyclists and at parents of child cyclists. The role of parents in instructing their children, both in "pre-rider training" and during the first years of cycling is one of great potential but one which has been almost totally ignored.

Rider training should be recognised as being as necessary and important to cyclists as driver training is to motorists. This should be reflected in the quality, style and promotion of rider training courses and manuals.

Development of rider training materials should take account of the age-related factors summarised in Table 29.

7.2 LAW ENFORCEMENT

Cyclists account for at least 15% of all casualties admitted to hospitals in the ACT as a result of vehicle crashes. An effective traffic law enforcement program directed at cyclists could play a major part in reducing the number of seriously injured cyclists.

Effective enforcement of traffic regulations relating to cyclists would complement rider training programs, would improve cyclist behaviour, and therefore could reduce the overall bicycle crash rate.

It is particularly important to reduce the number of bicycle/motor vehicle collisions, which account for 35% of days spent in hospital by bicycle casualties. Enforcement has a clear role in the reduction of these crashes, as nearly all of them can be attributed to apparently clear-cut traffic violations.

Currently in the ACT there is no bicycle enforcement program, despite the existence of a "Bicycle Infringement Notice" (BIN) since mid 1984. The use of the BIN has been minimal, with about five notices being issued per month.

7.3 ENCOURAGEMENT

Promotion of rider training, helmet use and enforcement should be, at least in the short term, an important element in bicycle programs.

Widespread use of good quality bicycle helmets, although likely to have little effect on the crash rate, could reduce by up to 38% the number of hospitalised bicycle casualties and by up to 21% the number of days spent in hospital. (These figures relate to the main injury categories of skull fracture and concussion, but not facial fracture.)

7.4 ENGINEERING

Serious bicycle crashes occur as frequently on minor roads as on arterial roads, and are almost as frequent off-road as on roads. It is therefore recommended that a variety of engineering procedures be employed. These could include local area traffic management schemes, aimed at reducing the volume and speed of motor vehicles on minor/residential streets; improved design of footpaths and cycleways; and provision of on-road bicycle facilities, such as widened kerbside lanes.

The need for better maintenance of a smooth, clean riding surface, both on-road and off-road, was highlighted by the fact that 20% of questionnaire respondents believed that problems with a paved riding surface contributed to their crash.

7.5 FURTHER RESEARCH

It is recommended that further research be carried out into cyclist fatalities and the characteristics of the general cycling population. Information from the Federal Office of Road Safety's National Mass Data System would provide data for these studies.

A national fatality study would examine variables such as those identified in the present study, but would also investigate details of the crash site, road user movements, cyclist/bicycle conspicuity, characteristics of the motorist, and blood alcohol content. This information would be vital in the development of all future bicycle safety programs.

Research into characteristics of the general cycling population would determine exposure rates for cyclists, that is, the total time and distance travelled by cyclists during a given period. This information, together with bicycle crash statistics, would enable for the first time in Australia the calculation of relative risk factors associated with cycling. Cyclist characteristics to be examined would include age, sex, cycling experience, relative use of different classes of roads and footpaths/cycleways, purpose of trip and use of helmets. This information could be distinct for each city or district and would require periodic revision because of changes in the size, age structure and habits of the cycling population.

REFERENCES AND BIBLIOGRAPHY

Allen, J.S. (1984), How Dangerous is Bicycling?, Bicycling (USA), Rodale Press, p16-19, March.

Bryant, J.F.M. (1981), Cyclist Visibility, State Bicycle Committee of Victoria.

Capital Territory Health Commission (1984), Hospital Morbidity Statistics, Pedal Cycle Accidents 1979 to 1982, unpublished report.

Child Safety Centre (1984), Analysis of Bicycle Accidents Seen at the Royal Alexandra Hospital for Children, January - December 1983, Royal Alexandra Hospital for Children.

Cowley, J.E. (1980), The 1979/80 ACRUPTC Survey of Vehicle Free Speeds in Capital Cities of Australia, Department of Transport Australia.

Cross, K.D. and Fisher, G. (1977), A Study of Bicycle/Motor Vehicle Accidents: Identification of Problem Types and Countermeasure Approaches, Anacapa Sciences Inc., Santa Barbara.

Dorsch, M.M., Woodward, A.J. and Somers, R.L. (1984), Do Bicycle Safety Helmets Reduce the Severity of Head Injury in Real Crashes?, American Association for Automotive Medicine.

Forester, J. (1983), Bicycle Transportation, MIT Press.

Forester, J. (1984), Effective Cycling, MIT Press.

Geelong Bikeplan (1980), Bicycle Accidents, Technical Bulletin 2, Geelong Bikeplan.

Gonski, L., Southcombe, W. and Cohen, D. (1979), Bicycle Accidents in Childhood, Medical Journal of Australia, 66(2), pp270-271.

Lugg, M.M. (1982), Hospital Morbidity Statistics, Pedal Cycle Accidents 1971-1980, Public Health Department of WA, together with unpublished updates to 1983.

Mathieson, J.G. (1984), Bicycle Safety in Australia: A Comprehensive Overview, Bicycle Federation of Australia/Newcastle Cycleways Movement.

Triggs, T.J., Meehan, J.W. and Harris, W.G. (1981), An Analysis of Reported Bicycle Road Accidents in Victoria, 1977-1980, Monash Human Factors Group, Monash University.

Wheatley, P.L. and Cross, K.D. (1979), Casual Factors of Non-Motor-Vehicle-Related Bicycle Accidents, Transportation Research Record 743, Transport Research Board.

APPENDIX 1

SURVEY QUESTIONNAIRE

CONFIDENTIAL

BICYCLE ACCIDENT QUESTIONNAIRE

1. Year of accident 19....

2. Age at time of accident ...... years

3. Sex female [ ]
   male [ ]

4. What were the lighting conditions at the time of the accident?

   daylight [ ]
   twilight [ ]
   dark [ ]
   other (please specify) [ ]
   ....

   If possible, give time of the accident to the nearest hour ...... am ...... pm

5. What was the weather like when the accident occurred? (Tick more than one box if necessary.)

   wet [ ]
   dry [ ]
   windy [ ]
   foggy [ ]

6. Where did the accident occur? (Tick more than one box if applicable.)

   road - midblock [ ]
   road - intersection [ ]
   footpath [ ]
   cycleway [ ]
   carpark [ ]
   driveway [ ]
   in private yard [ ]
   place used for BMC riding [ ]
   other (please specify) [ ]
   ....

7. At the time of your accident, did you ride

   usually on roads [ ]
   usually on cycleways and footpaths [ ]
   about half on roads and half on cycleways and footpaths [ ]

8. How long did it take to recover from your injuries? (Tick one box only)

   less than one week [ ]
   1 week to 1 month [ ]
   1 month to 3 months [ ]
   more than 3 months [ ]
   permanent disability (please specify) [ ]
   ....

9. Please state your main injury.

   ....

10. At the time of the accident were you a

   bicycle rider [ ]
   bicycle passenger [ ]
   pedestrian [ ] GO TO Q. 17

11. At the time of the accident, how long had you been riding a bicycle?

   less than three months [ ]
   3 months to 1 year [ ]
   1 year to 3 years [ ]
   more than 3 years [ ]

12. What was the purpose of the bicycle trip?

   riding to/from school [ ]
   riding to/from work [ ]
   riding to/from shops [ ]
   riding to/from friend's house [ ]
   riding for fun [ ]
   other (please specify) [ ]
   ....

13. What type of bicycle were you riding at the time of the accident?

BMX [ ]
standard [ ]
other (please specify) [ ]
....

14. At the time of the accident were you wearing

no helmet [ ]
'hairnet' or racing helmet [ ]
hard shell helmet [ ]

15. Was your accident the result of (tick more than one box if necessary):

- a collision, or near collision, with

another bicycle [ ]
a motor vehicle [ ]
a pedestrian [ ]
an animal [ ]
other object (please specify) [ ]
....

- a problem with the riding surface

wet pavement [ ]
sand, gravel or dirt on paved surface [ ]
crack, bump or hole in paved surface [ ]
other (please specify) [ ]
....

- doing stunts or tricks [ ]

- difficulty in handling bicycle

braking [ ]
turning [ ]
steering [ ]

- object catching in moving part of bicycle [ ]
(please specify) ....
....

- bicycle mechanical fault (please specify) [ ]
....

16. Did any of the following help cause the accident? (Tick more than one box if necessary)

riding too fast [ ]
riding downhill [ ]
new or unfamiliar bike [ ]
not looking ahead [ ]
talking to or looking at riding companion [ ]
motor vehicle passed too close [ ]
traffic violation: other person [ ]
self [ ]
please specify ....
....
unfamiliar location [ ]
unable to see far enough ahead
too dark [ ]
bushes in the way [ ]
other obstacle (please specify) [ ]
....
double dinking [ ]
carrying object in hand(s) [ ]
other (please specify) [ ]
....

17. Please draw a sketch map of the accident scene. Name any streets. Show north and show the path of the bicycle and any other vehicle or pedestrian involved in the accident.

18. Please give a brief description of how the accident occurred.

19. Are there any comments you would like to make?

APPENDIX 2

BICYCLE CRASHES IN PERSPECTIVE

Ideally, bicycle crash statistics should be presented in conjunction with exposure rates so that a relative risk factor can be calculated for bicyclists, compared to other vehicle users and pedestrians. Unfortunately no useful exposure data are available.

Nevertheless a useful perspective can be gained by comparing the lengths of stay in hospital for the various categories of vehicle casualties, as in Table 33. Length of stay is both a useful estimator of injury severity and an important factor to consider when allocating funds between competing crash countermeasure programs.

Table 1 CASUALTY TYPE FOR CRASHES INVOLVING VEHICLES (ACT AND REGION) Hospital admissions by type and length of stay, January 1980 to June 1983, ACT

CASUALTY TYPE	FREQ	%	Average length of stay (days)	Total days stay	% of Total days stay
Driver/passenger of motor vehicle other than motorcycle	788	31.1	14.6	11505	34.6
Driver/passenger of motorcycle	550	21.7	14.3	7865	23.6
Bicycle: collision with motor vehicle	73	2.9	11.6	847	2.5
no collision with motor vehicle	305	12.1	4.6	1399	4.0
Pedestrian	159	6.3	20.3	3228	9.7
Other	13	0.5	12.3	160	0.4
Unspecified motor vehicle crash	642	25.4	13.0	8346	25.1
TOTAL	2530	100.0	13.2	33350	100.0

The preceeding table shows that 15% of vehicle casualties admitted to ACT hospitals were bicyclists. However, the table includes casualties from crashes which occurred both inside and outside the ACT. The table is a useful guide to the regional pattern of vehicle casualties but is not necessarily a guide to the pattern of ACT casualties. In this context it is relevant to note that:

- Canberra's hospitals satisfy a regional demand rather than simply that imposed by the local ACT population;

- about one-third of the casualties included in the table usually resided outside the ACT;

- the ACT is surrounded by a network of heavily-trafficked national and state highways;

- ACT police statistics show that within the ACT, only 829 road crash casualties were admitted to hospitals in the period January 1980 to June 1983.