Bicycle crashes in South Australia

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Abstract

Characteristics of pedal cycle crashes (as reported to the police) in South Australia, and how they have changed over the period 1981-2004, are examined, with analysis of both the frequency and the severity of these crashes in different circumstances. In 1981, pedal cyclist casualties were mostly children and teenagers. In 2004, pedal cyclist casualties were mostly spread across the age range from 16 to 49. Child pedal cyclist casualties reached a maximum in 1982-1987, and have fallen sharply since. Adult pedal cyclist casualties reached a maximum in 1987-1990, and then fell. A more detailed examination is made of the situation in the period 2001-2004. Data are given on several aspects of both child and adult casualties: time, place, site, events, the cyclist, and the motor vehicle and its driver.

Keywords

Bicycle crashes, Cycling safety, Pedal cyclist accidents, Child cyclists, Trends (cycle accidents)

Introduction

This paper will examine characteristics of pedal cycle crashes in South Australia, and how they have changed over the period 1981-2004. The organization of this paper is as follows. Some background will be given on cycling and South Australia, and then the dataset will be described. The trends over the period 1981-2004 will be identified, followed by presentation of data for pedal cyclist casualties aged 5-15 for the period 2001-2004, and then the same for those aged 16 years and over. Finally, there will be a Section of discussion.

The present paper is based on the more detailed account in [1], which has nearly 150 tables and graphs; other papers based on that report are [2]-[4]. For trends in traffic casualties in South Australia more broadly than only cyclists, see [5]. Variables that are commonly tabulated in yearbooks of road crash statistics receive only brief mention in the present paper, but there are a few comments, based on the data in [1].

Cycling and South Australia

There are good reasons for governments to give a degree of encouragement to cycling: there may be health benefits to the cyclist, and environmental benefits to society ([6], for example). In 2006, the government of South Australia published *Safety in Numbers. A Cycling Strategy for South Australia 2006-2010* [7]. This elaborates upon the benefits mentioned. The opening sentence puts safety centre stage: “Market research shows that many people choose not to cycle because they perceive cycling to be unsafe --- so the challenge lies in improving not only safety for the existing cyclists but the perception of safety for those not currently cycling”. The goal articulated in [7] is a doubling of cycling trips by 2015. Table 3.1 of [6] lists targets in other countries; the U.S.A. wishes to double the percentage of trips made by foot and pedal cycle, while reducing by 10 per cent the number of crashes involving pedestrians or cyclists.

A doubling of cycling trips would be a big change, and cyclist casualties may be substantially greater than they otherwise would have been. Nevertheless, the justification for promoting walking and cycling is usually that there are real benefits that outweigh any disadvantages: “Cycling has a positive role to play, to improve the environment, improve health and wellbeing through increased physical activity, reduce inequality, increase wealth and help create safer and more livable neighbourhoods” ([7], p. 3). To those who say that cycling is only for the young and fit, and only appropriate for short journeys, it might be replied that a low-powered motor can be fitted to a bicycle, and such motorised cycles share some of the benefits of pedal cycles.

The state of South Australia covers almost a million square kilometres, but most of it is empty of people. The total population is 1.5 million, of whom 1.1 million live in the Adelaide metropolitan area. Adelaide's terrain is predominantly flat and the climate is dry, and cycling is feasible even without some great commitment of principle. Public transport (mostly buses) is reasonably good. The private car, nevertheless, is the dominant mode of travel. According to household travel surveys, the numbers of person trips per day in Adelaide were 3.4 million in 1986 and also 3.4 million in 1999, the numbers as car driver being 1.8 and 2.0 million, and the numbers by bicycle being 0.089 and 0.040 million [8]. For their journey to work on census day 2001, 1.4 per cent of men and 0.4 per cent of women in South Australia cycled [9]. A survey conducted as a supplement to the Monthly Population Survey found that in metropolitan Adelaide in October 1997, 2.2 per cent of journeys to work and 4.5 per cent of journeys to school were by bicycle [10]. Optimists and pessimists will each put their own interpretations on these figures: convert even a small proportion of car drivers, and there will be a big impact on cycling --- yet even a doubling of cycling would have only a small proportionate effect on car driving.

The dataset, and comments on the analysis

The source of data is the Traffic Accident Reporting System (TARS) database, which originates from police reports. In 2001-2004, some 87 per cent of the pedal cycle crashes in the dataset involved a moving motor vehicle. A great number of cyclists who are injured without a motor vehicle being involved do not report their crash. Also, it is likely that underreporting of pedal cycle crashes that do involve a motor vehicle is more serious than for other motor vehicle crashes. Thus this paper concentrates on those characteristics for which it is improbable that another data source will be more suitable --- location (metropolitan or country, speed limit, intersection or mid-block), conditions that change (hour of day, lighting, weather), and the other vehicle involved. See [3] for discussion of other sources of data on pedal cycle crashes. Perhaps the most important concern with the data is that special features of cyclist fatalities may not be evident. For a discussion of errors, omissions, and limitations with police data (on road crashes generally, not specifically pedal cyclists), see [11], especially Chapter 4.

Years. The period chosen, 2001-2004, is intended to be long enough to give a reasonable number of accidents, and short enough that it reflects recent conditions.

Casualties of unknown age. In order to be able to present the characteristics of child and adult pedal cyclist casualties separately, casualties of unknown age were excluded from the tabulations. In 2001-2004, these accounted for some 11.8 per cent of the total (and for casualties who were killed or admitted to hospital, the proportion was 7.5 per cent).

Age groups. Although the columns of most tables refer to different age groups, we do not think that comparison of these is very illuminating, and we do not generally comment. Instead, we consider that interest will principally lie in the total for all age groups, and then possibly in any of the columns on its own, not in making a comparison of one column with another. Having looked at the column for 5 to 15 year olds, one might then check whether the results for (say) children aged 5 to 7 are similar. Or having looked at the column for all adults, one might then check whether the results for 20 to 59 year olds are similar.

Location. Postcode groups 5000-5099, 5100-5199, and 5200-5999 will be referred to below; these postcode groups respectively refer to inner metro Adelaide (with a boundary that is between 8 and 16 km from the centre of Adelaide), outer metro Adelaide, and the rest of South Australia. (In metropolitan Adelaide, a four-digit postcode area is typically several sq km in area.)

Injury severity. The term "serious" injury will be used to mean one leading to admission to hospital or to death.

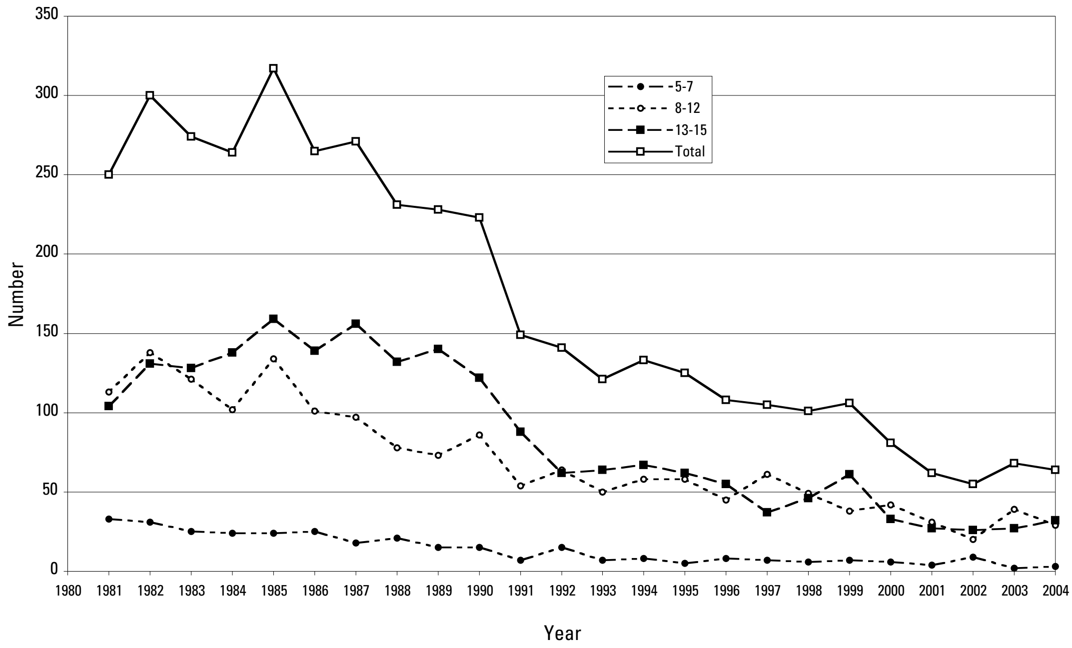

Figure 1: Child pedal cyclist casualties in South Australia 1981-2004.

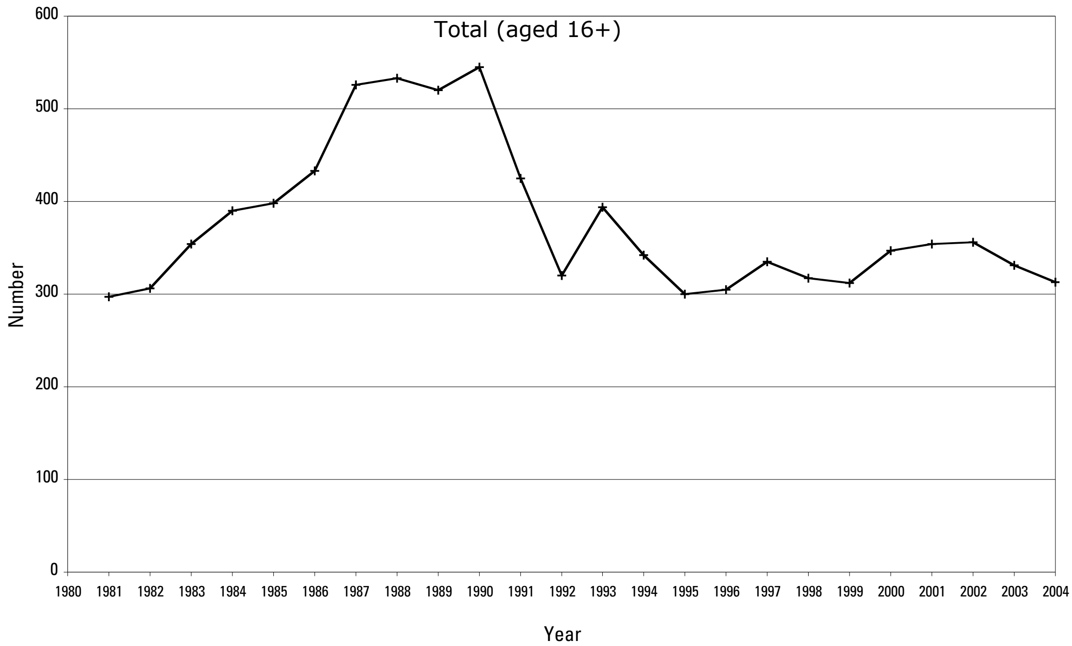

Figure 2: Adult pedal cyclist casualties in South Australia 1981-2004 (total).

Trends

Substantial changes in pedal cycle crashes have occurred between 1981 and 2004. In 1981, pedal cyclist casualties were mostly children and teenagers. In 2004, pedal cyclist casualties were mostly spread across the age range from 16 to 49. Figure 1 shows that child pedal cyclist casualties reached a maximum in 1982-1987, and have fallen sharply since. Figure 2 shows that adult pedal cyclist casualties reached a maximum in 1987-1990, and then fell. However, from the mid-1990s, there seems to have been an increase in pedal cyclist casualties aged 40-59. The wearing of helmets by pedal cyclists became compulsory on 1st July 1991. According to Marshall and White [12], this probably deterred some people from cycling and in addition prevented some injuries among those continuing to cycle; a complicating factor in the analysis was that the policy of hospitals in regards to people having possible concussion may have changed at about the same time.

Those aged 0-15, as a proportion of total pedal cyclist casualties, fell from 45 per cent in 1981-1984 to 16 per cent in 2001-2004, and those aged 30-59 increased from 17 per cent to 48 per cent ([1], [3]).

Children. Figure 1 shows the numbers of pedal cyclist casualties in South Australia aged 5-15, from 1981 to 2004; three age groups as well as the total are shown. Table 1 gives the numbers killed, grouped into four-year periods because otherwise the small numbers mean that random fluctuations dominate the picture. Those seriously injured (i.e., killed or admitted to hospital), as a proportion of total pedal cyclist casualties aged 5-15, fell from 34 per cent in 1981 to 22 per cent in 2004 ([1], [4]); however, most of the reduction occurred at the beginning of the period, over the years 1981 to 1985. Those killed, as a proportion of total pedal cyclist casualties aged 5-15, have fallen from 2.1 per cent in 1981-1984 to 1.2 per cent in 2001-2004; again, however, most of the reduction occurred early on, from the first four-year period to the second.

Table 1: Pedal cyclist casualties in South Australia 1981-2004, by grouped year of crash and whether there was death or injury to the rider (5-15 years).

Year	Rider		Total
	Injury	Fatality	
1981-1984	1065	23	1088
1985-1988	1072	12	1084
1989-1992	737	4	741
1993-1996	483	4	487
1997-2000	389	4	393
2001-2004	246	3	249
Total	3992	50	4042

Adults. Figure 2 shows the numbers of pedal cyclist casualties in South Australia aged 16 and over, from 1981 to 2004, and Figure 3 disaggregates the data into six age groups. The percentage who were killed or admitted to hospital fell during the 1980's, but was steady in the 1990's ([1], [4]). (A logistic regression to be reported later in this paper suggests there was a real reduction over the period 1995 to 2004 --- for a subset of crashes, with other some factors being allowed for by inclusion in the regression.) Table 2 gives the numbers killed, in four-year periods. In 2004, pedal cyclist casualties aged 16 and over had increased to 105 per cent of what they were in 1981; those seriously injured had fallen to 48 per cent of what they were in 1981. Those seriously injured, as a proportion of total pedal cyclist casualties aged 16 and over, fell from 31 per cent in 1981 to 14 per cent in 2004 ([1], [4]); however, there has been little change since 1993. Those killed, as a proportion of total pedal cyclist casualties aged 16 and over, have fallen from 1.4 per cent in 1981-1984 to 1.0 per cent in 2001-2004.

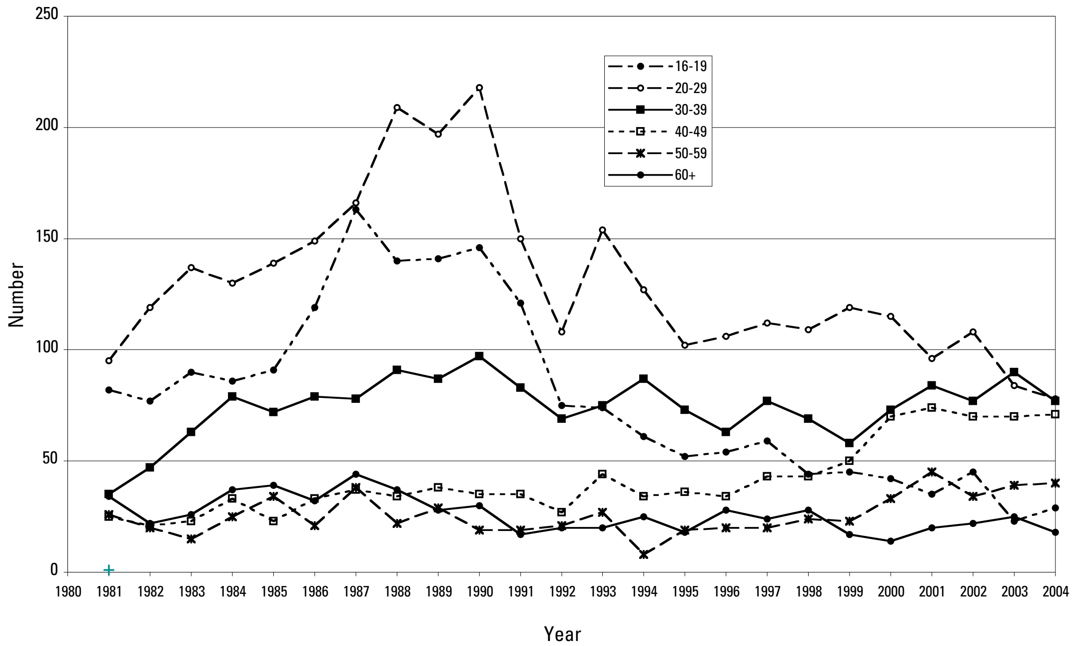

Figure 3: Adult pedal cyclist casualties in South Australia 1981-2004 (six age groups).

Table 2: Pedal cyclist casualties in South Australia 1981-2004 by grouped year of crash and whether there was death or injury to the rider (16 years and over).

Year	Rider		Total
	Injury	Fatality	
1981-1984	1328	19	1347
1985-1988	1872	18	1890
1989-1992	1783	27	1810
1993-1996	1320	21	1341
1997-2000	1303	8	1311
2001-2004	1340	14	1354
Total	8946	107	9053

Speed limit change. From 1 March 2003, the speed limit on most urban roads changed from 60 km/h to 50 km/h; it remained 60 km/h or higher on urban arterials. It might be asked whether a reduction in pedal cyclist casualties resulted. As to child pedal cyclist casualties, these are too few for a detectable effect to be expected, and, indeed, the numbers in 2003-2004 were not lower than in 2001-2002. As to adult pedal cyclist casualties, the answer is that the data are suggestive of a reduction. There is no decline in the years up to 2002, but then the numbers in 2003 and 2004 are slightly lower. (It is not helpful to look at month-by-month figures for a few months before and a few months after the change: it so happens that the number of casualties differs quite substantially between months, and March is the month with the highest number.) Kloeden et al. [13] discussed the effect on road casualties (not specifically pedal cyclists) of the speed limit reduction.

Bicycle trips. It has already been noted that, according to household travel surveys, the numbers of person trips per day by bicycle in Adelaide were 0.089 million in 1986 and 0.040 million in 1999 [8], a decrease of 55 per cent. The decline in pedal cyclist casualties was not as great, some 33 per cent. However, a simple comparison like this is not very meaningful --- the age pattern of cyclist casualties has changed considerably, and number of trips may not be a very good measure of cycling. In brief, what may have occurred is a substantial decrease in short cycling trips by children (and thus an increase in average trip length). Harrison [14] estimated that from 1988 to 1994 there was a decline of 38 per cent in the number of children cycling to school in South Australia. The decline in pedal cyclist casualties aged 5-15 from 1988 to 1994 was 42 per cent (Figure 1). Concerning children's journeys to school, see such papers as [15] (a review) and [16]-[19] (Australian research).

Child pedal cyclists aged 5-15, 2001-2004

This Section presents findings concerning pedal cyclist casualties aged 5-15 in the period 2001-2004. (The number aged 4 and younger is a total of 2 over the period 2001-2004, and 26 over the period 1981-2004.)

Time of crash. There are about the same number of casualties per day on weekends as on weekdays. The times of day when casualties are most frequent are those when most children are travelling to or from school: the hours beginning 08, 15, 16, 17. (As might be expected, the hourly pattern is different at weekends and in school holidays.) For details, see [1].

Place (postcode). Postcode groups 5000-5099, 5100-5199, and 5200-5999 account for respectively 49 per cent, 27 per cent, and 23 per cent of casualties. Most casualties live in the same postcode as that of the crash --- to a lesser extent for those aged 13-15 than for younger children. For details, see [1] and [2].

Site and events. Approximately the same numbers occurred at intersections and not at intersections (Table 3). Some 94 per cent of casualties occur on roads where the speed limit is 60 km/h or lower, and in 2004, more occurred on 50 km/h than on 60 km/h roads (Table 4 and its footnote). Crashes termed "right angle" were the most common [4].

Table 3: Number of pedal cyclist casualties aged 5-15 in South Australia 2001-2004, by road geometry and age group of casualty.

Road geometry	Age group (years)			Total
	5-7	8-12	13-15	
Intersection	7	57	57	121
Not at intersection	11	56	49	116
Unknown		6	6	12
Total	18	119	112	249

Table 4: Number of pedal cyclist casualties aged 5-15 in South Australia 2001-2004, by speed limit and age group of casualty.

Speed limit (km/h)	Age group (years)			Total
	5-7	8-12	13-15	
40		3	3	6
50	3	33	23	59
60	15	67	70	152
70		1	2	3
80		5	5	10
90			1	1
100		1	2	3
Unknown		9	6	15
Total	18	119	112	249

Note: 50 km/h default speed limit introduced in South Australia on 1 March 2003. In 2004, i.e., after this change, the numbers of child pedal cyclist casualties on 50 km/h and 60 km/h roads were respectively 29 and 23.

The pedal cyclist. Male casualties outnumber females by 6 to 1. Age group is given in Tables 3-7. The question is often asked whether the child was purposefully travelling or was playing, but unfortunately there is usually little or nothing relevant to this in datasets originating from police reports; see, however, Table 7.24 of [11] for some data from Norway.

The other vehicle and its driver. For Tables 5 to 7, the crashes have been restricted to those in which there was a single motor vehicle and a single pedal cycle. The numbers of casualties are consequently slightly fewer than in other Tables. Male and female drivers were in the approximate proportions 56 per cent and 44 per cent (Table 5). The distribution of their ages is shown in Table 6. Cars and car derivatives make up some 82 per cent of the total (Table 7). For serious casualties, the number of cases with other vehicle types involved was 19 per cent of the number with cars involved, as compared with 8 per cent for all severities of injury [1].

Outcome. Fatalities were 1 per cent of the total casualties, those admitted to hospital were 19 per cent, those treated at hospital were 58 per cent, and those treated but not at a hospital were 21 per cent. In many of the tables in [1] and [2], frequencies of both total and seriously-injured casualties are given, and thus proportions injured seriously can be calculated, as has been done in the following paragraph.

Proportion seriously injured. The proportions of child casualties killed or admitted to hospital were 44 per cent, 24 per cent, and 13 per cent in age groups 5-7, 8-12, and 13-15; and they were 18 per cent, 12 per cent, and 36 per cent for crashes in postcode groups 5000-5099, 5100-5199, and 5200-5999. The proportion killed or admitted to hospital was 20 per cent when the speed limit was 60 km/h or less, and was 35 per cent when the speed limit was 70 km/h or higher; it was 27 per cent for male drivers of the motor vehicle and 9 per cent for female drivers (see footnote to Table 5); it was much the same for the different driver age groups, but there are only low numbers in each age group; and it was 19 per cent when the motor vehicle dated from the 1980's, 22 per cent when it dated from the 1990's, and 20 per cent when it dated from the 2000's. See also [1] and [2].

Table 5: Pedal cyclist casualties aged 5-15 in South Australia 2001-2004: Number in single motor vehicle vs single bicycle crashes, by driver sex and rider age group.

Sex of motor vehicle driver	Rider age group (years)			Total
	5-7	8-12	13-15	
Male	10	61	53	124
Female	8	48	41	97
Unknown		6	9	15
Total	18	115	103	236

Note: for serious pedal cyclist casualties, male and female drivers respectively numbered 34 and 9.

Table 6: Pedal cyclist casualties aged 5-15 in South Australia 2001-2004: Number in single motor vehicle vs single bicycle crashes, by driver age and rider age group.

Age group of motor vehicle driver	Rider age group (years)			Total
	5-7	8-12	13-15	
16-19	1	7	5	13
20-29	3	28	9	40
30-39	2	23	20	45
40-49	6	14	16	36
50-59	1	10	21	32
60-69	1	8	7	16
70-99		3	2	5
Unknown	4	22	23	49
Total	18	115	103	236

Table 7: Pedal cyclist casualties aged 5-15 in South Australia 2001-2004: Number in single motor vehicle vs single bicycle crashes, by type of motor vehicle and rider age group.

Type of motor vehicle	Rider age group (years)			Total
	5-7	8-12	13-15	
Car (and derivatives)	13	95	85	193
Other	2	6	8	16
Unknown	3	14	10	27
Total	18	115	103	236

Pedal cyclists aged 16 and over, 2001-2004

This Section presents findings concerning pedal cyclist casualties aged 16 and over in the period 2001-2004.

Time of crash. Casualties are slightly fewer in midsummer and midwinter than at other times of the year. There tend to be fewer casualties per day on weekends than on weekdays. The times of day when casualties are most frequent are those when most people are travelling to or from work: the hours beginning 07, 08, 09, 16, 17, 18. For details, see [1].

Place (postcode). Postcode groups 5000-5099, 5100-5199, and 5200-5999 account for respectively 80 per cent, 13 per cent, and 7 per cent of casualties. Most casualties live in a different postcode from that of the crash. For details, see [1] and [3].

Site and events. The majority of casualties occur at intersections (Table 8). Some 93 per cent of casualties occur on roads where the speed limit is 60 km/h or lower; in 2004, fewer occurred on 50 km/h than on 60 km/h roads (Table 9 and its footnote). Crashes termed "right angle" were the most common (Table 10). (As already mentioned, the database used is very largely one of motor vehicle crashes, and thus single vehicle crash types are grossly underrepresented.) Going straight ahead was the most common movement of both the pedal cycle and the motor vehicle (Table 11). In Table 11, the crashes have been restricted to those in which there was a single motor vehicle and a single pedal cycle, and thus the total number of casualties is slightly fewer than in Tables 8 to 10. It would be desirable to identify which road user was on which road, and made what manoeuvre and what error (if any), and tabulate the crash events accordingly. However, in view of the complex nature of an appreciable proportion of crashes, Tables 10 and 11 are already close to the limit of what is practicable with this dataset and most others that are based on routine police reports. Two publications from Austroads ([20], pp. 35-37; [21], pp. 40-46) give tabulations that employ a scheme of classification having more than 80 accident types, using data are from three Australian states (Victoria, New South Wales, Queensland).

The pedal cyclist. Male casualties outnumber females by 4 to 1. See [1] and [3].

The other vehicle and its driver. As in Table 11, crashes have been restricted to those in which there was a single motor vehicle and a single pedal cycle. Male and female drivers were in the approximate proportions 62 per cent and 38 per cent (Table 12). The distribution of their ages is shown in Table 13. Cars and car derivatives constitute some 77 per cent of the total (Table 14). For serious casualties, the number of cases with other vehicle types involved was 34 per cent of the number with cars involved, as compared with 14 per cent for all severities of injury.

Table 8: Number of pedal cyclist casualties aged 16 and over in South Australia 2001-2004, by road geometry and age group of casualty.

Road geometry	Age group (years)			Total
	16-19	20-59	60+	
Intersection	69	688	51	808
Not at intersection	60	431	30	521
Unknown	3	18	4	25
Total	132	1137	85	1354

Table 9: Number of pedal cyclist casualties aged 16 and over in South Australia 2001-2004, by speed limit and age group of casualty.

Speed limit (km/h)	Age group (years)			Total
	16-19	20-59	60+	
40		19	1	20
50	17	166	10	193
60	100	860	62	1022
70		13	1	14
80	4	33	4	41
90		5	1	6
100	4	15	3	22
110	1	5		6
Unknown	6	21	3	30
Total	132	1137	85	1354

Note: 50 km/h default speed limit introduced in South Australia on 1 March 2003. In 2004, i.e., after this change, the numbers of adult pedal cyclist casualties on 50 km/h and 60 km/h roads were respectively 112 and 168.

Table 10: Number of pedal cyclist casualties aged 16 and over in South Australia 2001-2004, by crash type and age group of casualty.

Crash type	Age group (years)			Total
	16-19	20-59	60+	
Rear end	11	96	9	116
Hit fixed object	5	36	2	43
Side swipe	25	222	21	268
Right angle	54	416	31	501
Head on	3	21	1	25
Hit pedestrian	1	4		5
Roll over	8	51	4	63
Right turn	8	142	8	158
Hit parked vehicle	10	55	2	67
Hit animal		6	2	8
Hit object on road	1	7		8
Left road out of control	2	8		10
Other	4	73	5	82
Total	132	1137	85	1354

Note: of the 153 right turn crashes that involved a single motor vehicle and a single bicycle, the bicycle was recorded as going straight ahead in 143 cases.

Table 11: Pedal cyclist casualties aged 16 and over in South Australia 2001-2004, restricted to the 1090 cases of single motor vehicle vs single bicycle crashes: Classification by movement of the pedal cycle and by movement of the motor vehicle.

Type of movement	Movement of pedal cycle	Movement of motor vehicle
Right turn	51	269
Left turn	8	143
Straight ahead	960	384
Other	71	294
Total	1090	1090

Note: of the 71 cases for which pedal cycle movement is shown here as "Other", 21 were recorded as "Swerving" and 20 as "Leaving private driveway"; and of the 294 cases for which the motor vehicle movement is shown here as "Other", 75 were recorded as "Stopped on carriageway", 69 as "Entering private driveway", and 57 as "Leaving private driveway".

Table 12: Pedal cyclist casualties aged 16 and over in South Australia 2001-2004: Number in single motor vehicle vs single bicycle crashes, by driver sex and rider age group.

Sex of motor vehicle driver	Rider age group (years)			Total
	16-19	20-59	60+	
Male	56	534	41	631
Female	34	328	25	387
Unknown	8	58	6	72
Total	98	920	72	1090

Note: for serious pedal cyclist casualties, male and female drivers respectively numbered 88 and 35.

Table 13: Pedal cyclist casualties aged 16 and over in South Australia 2001-2004: Number in single motor vehicle vs single bicycle crashes, by driver age and rider age group.

Age group of motor vehicle driver	Rider age group (years)			Total
	16-19	20-59	60+	
16-19	5	56	3	64
20-29	12	146	10	168
30-39	17	138	13	168
40-49	15	176	12	203
50-59	19	108	10	137
60-69	3	29	5	37
70-99	2	37	5	44
Unknown	25	230	14	269
Total	98	920	72	1090

Table 14: Pedal cyclist casualties aged 16 and over in South Australia 2001-2004: Number in single motor vehicle vs single bicycle crashes, by type of motor vehicle and rider age group.

Type of motor vehicle	Rider age group (years)			Total
	16-19	20-59	60+	
Car (and derivatives)	81	704	54	839
Other	4	105	7	116
Unknown	13	111	11	135
Total	98	920	72	1090

Outcome. Fatalities were 1 per cent of the total casualties, those admitted to hospital were 13 per cent, those treated at hospital were 53 per cent, and those treated but not at a hospital were 33 per cent. In many of the tables in [1] and [3], frequencies of both total and seriously-injured casualties are given, and thus proportions injured seriously can be calculated, as has been done in the following paragraph.

Proportion seriously injured. Percentages below refer to the proportions of adult casualties killed or admitted to hospital:

- 12 per cent, 13 per cent, and 18 per cent in age groups 16-19, 20-59, and 60+;
- 13 per cent for hours 04 to 22 (i.e., 4 am to 10:59 pm) and 33 per cent for hours 23 to 03;
- 12 per cent, 14 per cent, and 33 per cent for crashes in postcode groups 5000-5099, 5100-5199, and 5200-5999;
- 11 per cent at intersections and 17 per cent away from intersections;
- 12 per cent when the speed limit was 60 km/h or less, and 33 per cent when the speed limit was 70 km/h or higher;
- 22 per cent when the road surface was wet and 13 per cent when it was dry;
- 11 per cent, 11 per cent, 16 per cent, and 18 per cent in right angle, side swipe, right turn, and rear end crashes (these were the most frequent types);
- 13 per cent, 6 per cent, 16 per cent, and 9 per cent when the motor vehicle was turning right, turning left, going straight ahead, and making other movement;
- 14 per cent for male drivers of the motor vehicle and 9 per cent for female drivers;
- 17 per cent, 15 per cent, 15 per cent, 14 per cent, 10 per cent, and 11 per cent for motor vehicle driver age groups 16-19, 20-29, 30-39, 40-49, 50-59, and 60-99;
- 10 per cent for cars (or derivatives) and 26 per cent for other vehicles;
- 13 per cent when the motor vehicle dated from the 1980's, 13 per cent when it dated from the 1990's, and 13 per cent when it dated from the 2000's.

See also [1] and [3].

Proportion seriously injured (further analysis). As mentioned earlier, the great majority of crashes occur in metropolitan Adelaide, on roads where the speed limit is 60 km/h or less, and the motor vehicle is a car (or derivative). Suppose that crashes are restricted to those conditions, to those in which there was a single motor vehicle and a single pedal cycle, to the four most common crash types and the three most common motor vehicle movements, to the hours 04 to 22 and dry road surface conditions, and finally that further minor exclusions are made (relating to certain variables not being unknown). Let the sample of crashes be increased by including the years 1995 to 2004. A logistic regression was then carried out with (logit of) probability of the injury being serious as the dependent variable.

- *Results*. There were three significant regressors: year (the later, the lower the probability of the injury being serious), intersection versus non-intersection (non-intersection corresponding to higher probability of the injury being serious), and sex of the motor vehicle driver (male corresponding to higher probability of the injury being serious). Crash type, direction of motor vehicle movement, age group of casualty and age group of motor vehicle driver were not significant. (These statements regarding statistical significance are based on a simplistic approach, with no allowance for the multiplicity of tests.)
- *Intersection, crash type, and vehicle movement*. The statistical significance of these variables was quite sensitive to which other variables were in the equation. Our interpretation is that there is some real effect (on the probability of the injury being serious) of speed of motor vehicle (tending to be slower at intersections) and of relative velocity of the motor vehicle and the pedal cycle (tending to be less when they are moving in the same direction), but that whether this shows up as statistical significance of one or more of the available variables depends on exactly which of these are in the equation.
- *Estimated sizes of effects*. Suppose that in a particular set of circumstances, with a male motor vehicle driver, and in a particular year, the proportion of adult casualties killed or admitted to hospital was 14 per cent. Then the estimated sizes of effects are such that a female driver would reduce the proportion to 10 per cent, and after a year the 14 per cent would have fallen to 13 per cent. (Complications with crash type and vehicle movement mean that there is no similar simple way of comparing intersection with non-intersection.)

Discussion

Trends 1981-2004. A substantial reduction in the number of child casualties took place over the period. Comparing 1981 and 2004, there was not much change in the number of adult casualties, but this statement conceals an increase during the 1980's followed by a sharp fall from 1990 to 1992. Consequently, a marked change has occurred in the age distribution of pedal cyclist casualties: in 1981, they were mostly children and teenagers, but in 2004 they were mostly spread across the age range from 16 to 49.

Children, 2001-2004. It seems likely that the numbers of crashes in different categories mainly reflects exposure to traffic. But data on distance cycled, or time spent cycling, or motor vehicles encountered, are not available, and hence it is not possible to calculate and compare crash rates. Concerning proportion seriously injured, some sizeable effects were evident (e.g., concerning type of motor vehicle, and speed limit), but the numbers of seriously injured child casualties were too few to say very much.

Adults, 2001-2004. As for children, it seems likely that the numbers of crashes in different categories reflect exposure to traffic. Concerning proportion seriously injured, the higher numbers permit more to be said than for children. Some effects were credible in simple comparisons (e.g., concerning type of motor vehicle, speed limit, and hour of day). The crashes were then restricted to a relatively homogeneous set, and a logistic regression performed in an attempt to find more subtle effects. There were three findings. (a) The proportion seriously injured has been falling by approximately 1 per cent per year in recent years. We do not know whether this is a road safety effect (e.g., reduction of speeds) or whether changes at hospitals (e.g., improvements to methods of imaging or to treatment) have led to some patients not being admitted in recent years who previously would have been. (b) The effect of the vehicle driver being female rather than male is to reduce the proportion seriously injured by approximately 4 per cent. An obvious possibility is that male drivers tend to drive a little faster than female drivers, leading to higher severity of injury, but we have no direct evidence that this is the explanation. (c) The combination of intersection versus non-intersection, crash type, and direction of motor vehicle movement was also relevant: we interpreted the pattern of results as reflecting the association of higher speed with higher injury severity.

Vehicle speed is known to be very important in both the causation of crashes and in increasing the severity of injuries, and the majority of our findings should be interpreted in that light. The most important exception is perhaps the higher proportion of cyclists seriously injured when the motor vehicle is something other than a car. One factor, as is well known, is that cyclists (and pedestrians) can fall under the unenclosed rear wheels of trucks and be run over. What part of the cyclist is then injured (whether the head or body, with catastrophic results, or a limb), and whether there are other mechanisms responsible for the higher proportion of serious injury, are not known to us. Answering such questions would require more detailed information than is in routine police reports.

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