Child bicyclist traffic casualties in South Australia

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Abstract

Data are presented on characteristics of child pedal cycle casualties (as recorded by the police) in South Australia for the period 2001-2004, and how they have changed over the longer period 1981-2004. The factors considered in this paper include site and events, characteristics of the cyclist, characteristics of the motor vehicle and its driver, trends over the period 1981-2004, and injury severity. Some of these are frequently tabulated, and so particular attention is given to the site of the crash and characteristics of the motor vehicle and its driver. Findings include the following. Concerning trends, in 1981-1984, those aged 15 and younger made up 45 per cent of bicyclist casualties. In 2001-2004, this proportion had fallen to 16 per cent. Child pedal cyclist casualties reached a maximum in 1982-1987, and have fallen sharply since, from 317 in 1985 to 64 in 2004. Concerning injury severity, vehicles other than cars were involved in the case of 23 per cent of serious casualties, as compared with 18 per cent of total casualties. The percentages of child casualties killed or admitted to hospital were as follows: 44, 24, and 13 in age groups 5-7, 8-12, and 13-15; 20 and 35 for speed limits of 60 km/h or less, and 70 km/h or higher; 27 for male drivers of the motor vehicle and 9 for female drivers; and 19 when the motor vehicle dated from the 1980's, 22 when it dated from the 1990's, and 20 when it dated from the 2000's.

1. Introduction

We will describe certain characteristics of child pedal cycle crashes in South Australia. For further tables (of adult cyclist casualties as well as child), see Hutchinson et al. (2006). By way of preliminary, overviews are given in Tables 1 and 2.

- Table 1 refers to cycle casualties as a whole, showing how the distribution of ages has changed between 1981-1984 and 2001-2004.
- Table 2 refers to cycle casualties aged 5 to 15, showing the severity of injury (as represented by how the casualty was treated and whether the casualty died) in different postcode groups of South Australia and also by different age groups.

Person trips per day in Adelaide (population, about 1.1 million, the state population being about 1.5 million) were 3.4 million in 1986 and also 3.4 million in 1999, of which the numbers by bicycle were 0.089 and 0.040 million (Transport SA, 2002). The policy of the South Australian government towards cycling is described in DTEI

(2006). The goal is “More people cycling safely more often in South Australia, with an aim to double cycling trips by 2015”.

Wearing of helmets by pedal cyclists was promoted from November 1985, and has been compulsory since mid-1991. According to Marshall and White (1994), this probably led to both reduced cycling and reduced injuries among the majority who continued to cycle. More recently, there has been a trend towards lower speed limits. 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. There are too few child pedal cyclist casualties for a detectable effect among this specific subgroup of road users to be expected, and, indeed, the numbers in 2003-2004 were not lower than in 2001-2002. See Kloeden et al. (2004) for the effect on road casualties (not specifically pedal cyclists).

Meuleners et al. (2003) review pedal cycle safety research. For the design of cycling facilities, see Austroads (1999). Pedal cyclist *fatalities* in South Australia are sufficiently rare that a statistical account covering a small number of years would be unrevealing, but for a detailed account of 106 deaths between 1981 and 1993, using Coroner’s files as the data source, see Longo (1997). For the 373 cyclist deaths that occurred Australia-wide in 1996-2004, see ATSB (2006).

Table 1. Pedal cycle casualties in South Australia: Comparison of the distribution of rider age (percentages, of those of known age) in 1981-1984 and 2001-2004.

Cyclist age group (years)	Percentage in each age group (any severity of injury)		Percentage in each age group (those killed or admitted to hospital)	
	1981-1984	2001-2004	1981-1984	2001-2004
0-15	44.8	15.6	51.8	21.7
16-19	13.7	8.2	10.2	6.8
20-29	19.7	22.8	16.7	19.6
30-39	9.2	20.4	7.6	15.3
40-49	4.2	17.8	3.9	18.3
50-59	3.5	9.8	2.8	11.9
60-99	4.9	5.3	7.0	6.4
Total number [1]	2440	1605	684	235
Total number [2]	2678	1819	742	253

[1] Excluding those of unknown age.
[2] Including those of unknown age.

Table 2. Numbers of pedal cycle casualties aged 5-15 in South Australia 2001-2004: Cyclist injury severity by postcode group of crash and by age group.

Cyclist injury severity	Postcode group [1]			Age group (years) [2]			Total
	5000 - 5099	5100 - 5199	5200 - 5999	5-7	8-12	13-15	
Treated by doctor	30	13	10	1	33	19	53
Treated at hospital	71	47	27	9	58	78	145
Admitted to hospital	21	7	20	7	26	15	48
Fatality	1	1	1	1	2		3
Total	123	68	58	18	119	112	249
Percentage fatal or admitted	18	12	36	44	24	13	20

[1] Concerning the postcode groups, see Section 2.
[2] These groupings of ages are as in *Road Crashes in South Australia 2002*.

As with much other road accident research, debates could arise because we have not given consideration to exposure data (how much cycling is done, or how long cyclists spend on the road) --- differences or changes in accident numbers could be due to differences or changes in rates per kilometre, or could be due to differences or changes in the number of kilometres. Except at a crude, aggregated, level, it is rare for comparisons of accident data with travel surveys to be fully satisfactory even for motor vehicle crashes; survey difficulties are greatly exacerbated in the case of bicycle travel, see Litman et al. (n.d., Section I.3). Nevertheless, data on bicycle travel were collected in the Metropolitan Adelaide Household Travel Survey of 1999 (Transport SA, 2002), and it would be interesting to know what a comparison of the accident and exposure databases might produce. Extensive observational studies of cycling, such as that of Drummond and Jee (1988) in Melbourne, are quite rare.

The present paper is fairly broad in scope, but there is a degree of emphasis on variables that are not often tabulated as a matter of routine rather than those that are often found in statistical yearbooks. Section 2 will introduce the tables of findings, which will then be given in six sections of results, dealing respectively with the crash site and events, the background circumstances, the pedal cyclist, the motor vehicle and its driver, trends, and injury severity. Finally, there is a discussion section.

2. Preparation of the tables

In South Australia, the database of police reports of road crashes is called the Traffic Accident Reporting System (TARS). This provided the data in the present paper. The main tables of results will have the following features.

- The period of time used in most of the tables is 2001-2004. This is a balance between one that extends so far back that it may not reflect today's conditions, and one that is so short that the numbers of crashes are low and random year to year variation is all that can be perceived.
- The tables refer to pedal cyclist casualties aged 5 to 15. (There are very few aged 0 to 4.) Casualties of unknown age were excluded from the tables. 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 7.1 per cent).

- Most tables will distinguish between three postcode groups of the crash location. Postcodes are grouped as follows: 5000-5099, 5100-5199, 5200-5999. The first of these is an area centred on the city of Adelaide having a boundary that is between 8 and 16 km from the centre of Adelaide, the second is outer Metropolitan Adelaide, and the third is the rest of South Australia (nearly a million square kilometres). The intention was not chiefly to compare the postcode groups, but rather to classify by site variables, vehicle variables, and so on, within the different postcode groups.
- Most tables refer to all casualties, and also the subset who were killed or admitted to hospital (termed "serious"). Note that any finding about differences in the proportion of seriously injured casualties potentially has at least two interpretations: either one group does tend to be less seriously injured, or the minor crashes in that group are more likely to be reported to the police than in the other group.

It should be noted that police reports of pedal cycle crashes substantially understate the totality of pedal cyclist trauma: many cyclists are hurt without a motor vehicle being involved, and for these, hospital records are a better source of information. (Meuleners et al. (2003) give data from both the police and hospital admissions in Western Australia, and Voukelatos et al. (2003) report on police and hospital data in New South Wales.) Nevertheless, for crashes that do involve a motor vehicle, and especially for information about the crash circumstances and the motor vehicle, police reports are the best source of routinely-collected data. For discussion of errors, omissions, and limitations with police data (on road accidents generally, not specifically pedal cyclists), see Hutchinson (1987, especially Chapter 4).

3. Results: Site and events

Tables 3 to 6 respectively tabulate the following variables: whether or not the accident took place at a junction; speed limit; the nature of the site; and type of crash.

Approximately equal numbers of casualties occur at and away from junctions (Table 3). Table 4 gives the speed limit in force. Note that, from 1 March 2003, the default speed limit became 50 km/h instead of 60 km/h. (Urban arterial roads commonly have a higher limit.) 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. Speed limit, whether there is a junction, whether the road is divided, complexity of the junction, nature of traffic control: any of these factors may be of interest, singly or in combination. We attempted to combine these factors in a way that gives a useful summary of the site --- not too little detail, and not so much that it is overwhelming --- and the categories we chose are in Table 5. As to type of crash, those termed "right angle" were the most common (Table 6). Types of crashes are devised with motor vehicles chiefly in mind. Further, an appreciable number of crashes are complicated or do not fall easily into one category or another.

Table 3. Numbers of pedal cycle casualties aged 5-15 and over in South Australia 2001-2004, by postcode group of crash and road geometry.

Road geometry	All severities				Of whom, these numbers were serious			
	Postcode group			Total	Postcode group			Total
	5000-5099	5100-5199	5200-5999		5000-5099	5100-5199	5200-5999	
Junction	62	30	29	121	13	3	9	25
Not at junction	57	35	24	116	9	5	11	25
Unknown	4	3	5	12			1	1
Total	123	68	58	249	22	8	21	51

Table 4. Numbers of pedal cycle casualties aged 5-15 in South Australia 2001-2004, by postcode group of crash and speed limit.

Speed limit (km/h)	All severities				Of whom, these numbers were serious			
	Postcode group			Total	Postcode group			Total
	5000-5099	5100-5199	5200-5999		5000-5099	5100-5199	5200-5999	
40	6			6				
50	29	13	17	59	8	3	5	16
60	79	42	31	152	12	4	12	28
70-80	3	8	2	13	1	1	1	3
90-110		1	3	4			3	3
Unknown	6	4	5	15	1			1
Total	123	68	58	249	22	8	21	51

Note. 50 km/h default speed limit introduced in South Australia on 1 March 2003.
Table 5. Numbers of pedal cycle casualties aged 5-15 in South Australia 2001-2004, by postcode group of crash and the nature of the site.

Speed limit (km/h), whether at junction, and details	All severities				Of whom, these numbers were serious			
	Postcode group			Total	Postcode group			Total
	5000-5099	5100-5199	5200-5999		5000-5099	5100-5199	5200-5999	
0-60, no junction, divided road	19	8		27	4	1		5
0-60, no junction, not divided road	36	22	19	77	5	3	7	15
0-60, junction, traffic signals,	3	1		4	1			1

T- or Y-junction								
0-60, junction, traffic signals, crossroads	10	3	1	14	2			2
0-60, junction, priority, T- or Y-junction	30	19	11	60	6	3	4	13
0-60, junction, priority, crossroads	15		13	28	2		4	6
0-60, junction, roundabout	2	2	3	7	1			1
70+, no junction	1	4	4	9		1	3	4
70+, junction	2	5	1	8	1		1	2
Other and unknown	5	4	6	15			2	2
Total	123	68	58	249	22	8	21	51

Table 6. Numbers of pedal cycle casualties aged 5-15 in South Australia 2001-2004, by postcode group of crash and crash type.

Crash type	All severities				Of whom, these numbers were serious			
	Postcode group			Total	Postcode group			Total
	5000-5099	5100-5199	5200-5999		5000-5099	5100-5199	5200-5999	
Rear end	6	5	1	12	1		1	2
Hit fixed object	2	2		4				
Side swipe	14	8	7	29	3	2	1	6
Right angle	83	46	45	174	12	3	17	32
Head on	5	3	3	11	1	1	2	4
Roll over	1	1		2		1		1
Right turn	7	1	1	9	2	1		3
Hit parked vehicle	2	1	1	4	1			1
Hit object on road	1			1				
Other	2	1		3	2			2
Total	123	68	58	249	22	8	21	51

From Table 4, it may be found that the proportion of child casualties 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.

4. Results: Background circumstances

Concerning month, day of week, and hour of day, these variables are very often found in statistical yearbooks. Tables are not given in the present paper, but can be found in Hutchinson et al. (2006).

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.)

5. Results: The pedal cyclist

Male casualties outnumber females about 6 to 1 (Table 7). There is evidence from Toronto that boys both cycle more than girls and have more accidents per hour cycling (Hu et al., 1995). Reviewing all forms of unintentional injury of children, Schwebel and Gaines (2007) concluded that sex differences had a number of causes --- the personality traits of boys as compared with girls, the expression of these traits in behaviours, the circumstances in which the behaviours took place, and both innate and learned factors played a part.

The distribution of ages is skewed towards the older children (Table 8). In the Toronto study by Hu et al., accidents per hour of cycling for boys peaked at age 11-12 years.

For child cyclists (and for child pedestrians also), there is often interest in what the child was doing at the time of the crash --- in particular, whether the child was purposefully travelling or was playing. However, data originating from police reports, in South Australia or elsewhere, usually have little or nothing about this. (But see Hutchinson, 1987, Table 7.24, for data from Norway.)

Table 7. Numbers of pedal cycle casualties aged 5-15 in South Australia 2001-2004, by postcode group of crash and rider sex.

Cyclist sex	All severities				Of whom, these numbers were serious			
	Postcode group			Total	Postcode group			Total
	5000-5099	5100-5199	5200-5999		5000-5099	5100-5199	5200-5999	
Male	106	60	48	214	19	8	14	41
Female	17	8	10	35	3		7	10
Total	123	68	58	249	22	8	21	51

Table 8. Numbers of pedal cycle casualties aged 5-15 in South Australia 2001-2004, by postcode group of crash and age group of casualty.

Cyclist age group (years)	All severities				Of whom, these numbers were serious			
	Postcode group [1]			Total [2]	Postcode group			Total
	5000-5099	5100-5199	5200-5999		5000-5099	5100-5199	5200-5999	
5-7	5	6	7	18	1	2	5	8
8-12	57	28	34	119	13	4	11	28
13-15	61	34	17	112	8	2	5	15
Total	123	68	58	249	22	8	21	51

[1] The 123 casualties in postcodes 5000-5099 were further split as follows: 6 in postcode 5000 (Adelaide city), 20 in postcodes 5001-5019 (NW), 22 in postcodes 5020-5039 (W), 35 in postcodes 5040-5059 (S), 20 in postcodes 5060-5079 (E), and 20 in postcodes 5080-5099 (NE).
[2] Classifying the casualties by years of age (5, 6, ... 15), the 249 casualties were split as follows: 8, 6, 4 (totalling 18), 12, 17, 29, 23, 38 (totalling 119), 35, 41, 36 (totalling 112).

6. Results: The motor vehicle and its driver

For the data discussed in this Section, 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 in Tables 9 to 11 (respectively concerning the type of vehicle, the sex of its driver, and the age of its driver) than in other tables.

Cars and car derivatives make up about 82 per cent of the total (Table 9).

For serious casualties, cars (including car derivatives) and other vehicle types were involved in relative proportions 100:19, but for total casualties the relative proportions were 100:8. The proportion of child casualties killed or admitted to hospital 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. From Table 10, it may be found that the proportions of child casualties killed or admitted to hospital were respectively 27 per cent for male drivers of the motor vehicle and 9 per cent for female drivers.

Following up that rather surprising difference, Table 12 gives data for 1985-2004 (the period 1981-1984 was excluded because the percentage of seriously injured casualties was higher then). It is likely that speed is the reason that the motor vehicle driver being male and being young, and the speed limit being high, all tend to increase the cyclist's severity of injury.

It might be asked whether the apparent differences in Table 12 are statistically significant. A straightforward approach to statistical testing would lead to the conclusion that the effects of sex, age, and speed limit are all significant. However, a straightforward approach is not necessarily correct. For one thing, the three factors might interact. (It appears in Table 12 that the combination of the vehicle driver being male and the speed limit being high leads to particularly high probabilities of serious injury.) For another, there is often a greater degree of variability in crash data than is implied by the usual assumptions (see Hutchinson and Mayne, 1977).

Table 9. Pedal cycle casualties aged 5-15 in South Australia 2001-2004: Number in single motor vehicle vs. single bicycle crashes, by postcode group of crash and type of motor vehicle.

Type of motor vehicle	All severities				Of whom, these numbers were serious			
	Postcode group			Total	Postcode group			Total
	5000-5099	5100-5199	5200-5999		5000-5099	5100-5199	5200-5999	
Car [1]	99	52	42	193	16	6	15	37
Other	6	3	7	16	1	1	5	7
Unknown	12	9	6	27	4			4
Total	117	64	55	236	21	7	20	48

[1] Cars and car derivatives.

Table 10. Pedal cycle casualties aged 5-15 in South Australia 2001-2004: Number in single motor vehicle vs. single bicycle crashes, by postcode group of crash and sex of motor vehicle driver.

Sex of motor vehicle driver	All severities				Of whom, these numbers were serious			
	Postcode group			Total	Postcode group			Total
	5000-5099	5100-5199	5200-5999		5000-5099	5100-5199	5200-5999	
Male	54	30	40	124	13	4	17	34
Female	54	29	14	97	3	3	3	9
Unknown	9	5	1	15	5			5
Total	117	64	55	236	21	7	20	48

Table 11. Pedal cycle casualties aged 5-15 in South Australia 2001-2004: Number in single motor vehicle vs. single bicycle crashes, by postcode group of crash and age of motor vehicle driver.

Age group of motor vehicle driver	All severities				Of whom, these numbers were serious			
	Postcode group			Total	Postcode group			Total
	5000-5099	5100-5199	5200-5999		5000-5099	5100-5199	5200-5999	
16-19	5	5	3	13	1	1	1	3
20-29	22	7	11	40	4		3	7
30-39	18	15	12	45	3	2	5	10
40-49	16	12	8	36	2	2	5	9
50-59	20	6	6	32	1	1	2	4
60-69	6	4	6	16	1	1	4	6
70-99	3	1	1	5				0
Unknown	27	14	8	49	9			9
Total	117	64	55	236	21	7	20	48

Table 12. Single motor vehicle vs. single bicycle crashes in South Australia 1985-2004: Percentages of pedal cycle casualties aged 5-15 who were killed or admitted to hospital, within each combination of categories of sex of motor vehicle driver, age of motor vehicle driver, and speed limit.

Speed limit	Sex and age of motor vehicle driver			
	Male		Female	
	16-29	30+	16-29	30+
0-60	28	24	27	19
70+	52	48	17	31

Note. Cases for which driver age (most commonly) or the other variables were unknown were omitted in constructing this table. As unknown information occurs disproportionately for minor injuries, the percentages here are higher than they would otherwise be.

7. Results: Trends

Those aged 0-15, as a proportion of total pedal cyclist casualties, have fallen from 45 per cent in 1981-1984 to 16 per cent in 2001-2004 (see Table 1)

Child pedal cyclist casualties reached a maximum in about the period 1982-1987, and have fallen sharply since. In 2004, pedal cyclist casualties aged 5-15 had fallen to 26 per cent of what they were in 1981. In 2004, seriously injured pedal cyclist casualties aged 5-15 had fallen to 16 per cent of what they were in 1981.

For the emergency department of one hospital in New Zealand, Moyes (2007) has recently reported a 58% decrease (population-based rate) in child bicyclist casualties resulting from a motor vehicle accident between the period 1982-1986 and the period 1998-2005. (There was an increase of 49% in the rate of the much larger number of injuries from an accident not involving a motor vehicle.) Moyes also noted that from 1988 to 2002 there was a campaign to discourage children under 9 years old from cycling to school.

The fall in pedal cyclist casualties is very welcome, but part of it is surely due to less use of the bicycle for travel and less use of the bicycle for play --- and some people are uneasy that so many children are driven everywhere rather than walk or cycle independently, and that so much of children's time is screen time rather than active time. Relevant references include Fotel and Thomsen (2004), McDonald (2007), Morris et al. (2001), Olds (2005), Orsini and O'Brien (2006), and Peddie and Somerville (2006). The policy of the South Australian government to encourage cycling is for reasons of health as well as sustainability (DTEI, 2006).

Those seriously injured, as a proportion of total pedal cyclist casualties aged 5-15, fell from 34 per cent in 1981 to 22 per cent in 2004; 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 at the beginning of the period, from the period 1981-1984 to the period 1985-1988. A multi-hospital study in the U.K. (Roberts et al., 1996) found a very substantial reduction in the probability of death of injured young people admitted to hospital over the period 1989 to 1995: for those aged 5-14, there was a 13 per cent per year reduction in the odds of death, adjustment having been made for severity of injury.

8. Results: Injury severity

The percentage seriously injured is included in Table 2. We should note, though, that we are unable to say whether the percentage admitted to hospital should be interpreted as a measure of severity of injury that can be compared across age groups. It is possible that being admitted to hospital has different implications for younger children than it does for older children.

Other results on injury severity have been noted in the final two paragraphs of Section 3, the final three paragraphs of Section 6, and the final two paragraphs of Section 7.

9. Discussion

We referred earlier to Meuleners et al. (2003) for a review of pedal cycle safety research, and to Austroads (1999) for the design of cycling facilities. Among accident countermeasures, Meuleners et al. (pp. 9-11) emphasised road facilities for cyclists, conspicuity of cyclists, training of cyclists, and wearing of cycle helmets. (It is worth noting that in recent years, advances have been made in the understanding of children's decision-making and action in road crossing tasks. In particular, virtual environments make it possible to conduct experiments whose results it is plausible to generalise to the real world. See, for example, Plumert et al., 2004, and literature cited there.) Another often-advocated countermeasure is making it more difficult for both cyclists and pedestrians to go under the wheels of heavy goods vehicles by fitting side guards. Cars are much more commonly involved than heavy goods vehicles in collisions with cyclists, and there has been some work done on the dynamics of car-bicycle collisions (e.g., Maki et al., 2003). But there has been considerably less than on car-pedestrian collisions, and this is deserving of greater attention in the future.

Separation of vulnerable road users from motor traffic is a time-honoured strategy, and the obvious action in the case of cyclists would be to get them off the main roads and on to the footpaths. We have given some discussion of this in Section 5.1 of Hutchinson et al. (2006). It is of relevance to the present paper, even though in South Australia cyclists under the age of 12 are already permitted to ride on footpaths, as improvements to footpaths to make it easier to cycle (and walk) on them would benefit children as well as adults.

But for child pedal cyclists, for adult pedal cyclists, and for all other road users, we would like to highlight speed control: reduce speed limits and enforce them. In the last ten years or so, an increasingly strong belief has developed that a worthwhile reduction in risk accompanies even small reductions in speed. Case-control studies (Kloeden et al., 1997, 2001, 2002) were influential in this. We would expect both reduction of the speed limit from 60 km/h on urban arterials to 50 km/h, and from 50 km/h on local streets to 30 or 40 km/h, to be among the most effective ways of improving cyclist safety. Kloeden, Woolley, and McLean (2004) analysed what happened after the reduction in default speed limit from 60 km/h to 50 km/h in South Australia on 1st March 2003, and Kloeden, McLean, and Lindsay (2004) looked ahead to what might happen if the limit on urban arterials were reduced to 50 km/h. However, those papers considered all road casualties, not specifically cyclists.

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