MEDICAL PRACTICE

Contemporary Themes

Bicycle accidents in childhood

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Abstract

The results of a 10 year study of bicycle fatalities and an eight year study of serious non-fatalities are reported for urban Brisbane (population 1 000 000). There were 845 serious non-fatal bicycle accidents and 46 fatalities during the study. Boys were involved in 86% of accidents. Boys have an accident rate of 134·21 per 100 000 population at risk and a fatality rate of 5·06 per 100 000 at risk. Serious bicycle accidents have increased by 50% in this decade; but considering fatal cases alone, no secular trend was evident over the 10 year period of the study. This suggests that an increase in the overall rate of bicycle accidents has been in part compensated by less serious injuries. In 70% of fatalities children had head injuries, and 87% of fatalities followed a collision between a cyclist and a motor vehicle or a train. Bicycle accidents on the roads most commonly occur to boys aged between 12 and 14 years on a straight road at "mid-block" between 3 and 5 pm in clear weather conditions and in daylight.

It is concluded that injuries and fatalities after bicycle accidents can be reduced by protecting children's heads, separating child cyclists from other road traffic, or educating and training both cyclists and other road users in safe behaviour. The compulsory use of helmets and the restriction of access to the roads by child cyclists to reduce injuries are, however, still controversial in many areas.

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Introduction

Trauma in children caused by accidents such as poisonings,[1] fire,[2] and electrocutions, which once were commonplace, is not often seen now as a cause of death in children.[3] The incidence of childhood poisoning[1] and drowning[3] is decreasing in some areas after vigorous education and legislative programmes.[3]

Accidents with bicycles appear to be increasing in the United Kingdom,[4] New Zealand,[2] Canada,[5] and Australia[6]; and papers expressing concern about the seriousness of bicycle injuries from the United States,[7] Australia,[8] and England[9,10] have been published recently. In Australia between 1974 and 1982 the overall rate of bicycle fatalities for all ages remained unchanged. The fatality rate for children in the 5 to 16 year age group, however, doubled during that same period from 1·3 per 100 000 children at risk in 1975 to 2·8 per 100 000 in 1982.[11] It is widely believed that the failure to reduce the number of bicycle tragedies compared with the reduction in the incidence of other childhood trauma is due to the increasing popularity of bicycles[12] and possibly to the development of bicycles that are less safe ergonomically. Cited are special dangers from spokes,[13,14] high rise handlebars,[15-17] and bicycles with high centres of moment and centres of gravity. Other factors are rider error,[4] road conditions,[18] bicycle construction,[19] role of other road users,[20] bicycle attachments,[21] and car fittings.[22] We report the results of a detailed 10 year study of bicycle fatalities (with an unselected eight year study of serious non-fatalities) from Brisbane, Australia.

Methods

Every serious (non-fatal) bicycle injury to a child and known to the Queensland Police Department over an eight year period (1976-83) and all fatalities from bicycle accidents for the city of Brisbane over the 10 year period 1976-85 were analysed. Thus we studied a consecutive unselected series of all children who were injured in a bicycle accident. A bicycle accident was one that occurred on a public roadway, where a child suffered injuries serious enough to warrant medical attention, and where the police were called to investigate.

Data from two sources were used. The Engineering Branch, Queensland Department of Main Roads, keeps files of every bicycle accident that has been reported to the Queensland police. These give the age and sex, site, details of the accident, injuries, and conditions of the road, lighting, and weather. Accidents were included if they involved a bicycle on a public roadway and a child under the age of 15 and were reported during the years 1976 to 1983. Further details of fatal cases for the years 1976 to 1985 were obtained from a search of coroners' files of the Institute of Forensic Pathology and the Laboratory of Microbiology and Pathology, Brisbane.

The city of Brisbane is a subtropical metropolis with a population of one million people. Outdoor activities are common and cycling has increased in popularity. Data on bicycle ownership and usage were obtained from a survey of 1282 children in two state primary schools in Brisbane, with the cooperation and participation of the heads of the two schools: 872 (68%) owned a bicycle and 171 (19·6%) rode regularly or occasionally to school.

Results

During the eight years covered by this survey there were 845 serious accidents with children and bicycles in the city of Brisbane. Fourteen further cases of serious accidents are known to us, but in these the child cyclists were not injured although other parties to the accident were, and these have been excluded. A fatal accident involving two pedal cyclists on private property has also been excluded.

Seven hundred and twenty eight (86%) children in this study were boys. Figure 1 shows the age distribution. All children in this study were aged over 4 at the time of the accident. Peak ages were 12, 13, and 14. For serious bicycle accidents boys outnumbered girls by six times.

FIG 1—The age distribution of 845 children who were in bicycle accidents on the road.

Data were available for 452 consecutive accidents occurring between 1976 and 1980 inclusive. The principal injuries in these accidents were: fractures, 155 (34%); lacerations and open wounds, 134 (30%; head injuries, 39 (9%); bruising and superficial injuries, 114 (25%); internal injuries, 2 (0·4%); sprains and dislocations, 8 (1·6%). Most of the accidents in this study were between a cyclist and a motor vehicle. Table I gives the type of accident and the survival rate for each type. The survival rates are lower when the accident was with large vehicles such as lorries, articulated vehicles, and trains. Taking into account population trends in the study area, non-fatal bicycle accidents have increased by 50% since 1980 ($p<0·05$).

TABLE I—*Survival rate for collisions between different types of motor vehicles and pedal cycles*

Type of accident	No of accidents (n=839)	% Of accidents	Survival rate
Bike with car or utility van	658	78·4	96·6
Bike alone	79	9·4	92·4
Bike with bus or lorry	35	4·2	82·9
Bike with motorcycle	31	3·7	96·8
Bike with parked vehicle	26	3·1	100·0
Bike with train	4	0·5	75·0
Other	6	0·7	100·0

Lighting conditions on the roads seemed to be relatively unimportant. Of 472 accidents, 424 (89·5%) occurred during daylight hours, 20 (4·2%) at dusk, 18 (3·8%) in the dark but with adequate lighting, and 10 (2·5%) in the dark; 451 (95·1%) accidents occurred in clear conditions, and 4·9% occurred in rain or fog.

Table II gives the type of road features or topography at which accidents occurred. It is perhaps surprising that half of the accidents occurred on a straight road and half at intersections. Child cyclists occasionally cause injuries to other people while remaining uninjured. In 5% of accidents with a child cyclist another person was injured: 39% were motorcyclists or motorcycle pillion riders.

TABLE II—*Type of road on which severe accidents occurred to children on bicycles*

Type of road	No	%
Crossroads	78	16·5
T junction	139	29·5
Y intersection	10	2·1
Bridge, culvert	4	0·8
Railway crossing	2	0·4
Roundabout	1	0·2
Straight road ("mid-block")	238	50·5
Total	472	100·0

Table III gives the rates for accidents and fatalities for the population aged 5 to 14 years and for subgroups of the population. Boys in the age group 10-14 show the highest absolute rate for both serious bicycle accidents and fatal bicycle accidents. Some reduction, however, has occurred in accidents in that older age group over the two time periods studied. No differences were observed between the days of the week and the pattern of bicycle accidents. Sixty five per cent of the accidents occurred between the hours of 3 pm and 6 pm, 45% occurring in the two hours after school was let out—between 3 pm and 5 pm.

TABLE III—*Bicycle accident rates per 100 000 children at risk*

	Age group (years)	1976-9	1980-3	Increase or decrease
		Accident rates		
Girls	5-9	9·34	8·17	–
Girls	10-14	18·17	28·81	+
Boys	5-9	53·85	74·17	+
Boys	10-14	138·26	134·21	–
Children	5-14	54·70	60·14	+
Boys	5-14	106·18	118·03	+
		Fatality rates		
Girls	5-9	0·58	1·09	+
Girls	10-14	0·58	3·14	+
Boys	5-9	1·64	2·61	+
Boys	10-14	6·06	5·06	–
Children	5-14	2·27	3·01	+
Boys	5-14	3·85	3·86	

FATALITIES

During the 10 years of the study of fatalities 46 children died on the roads in pedal cycle accidents in Brisbane (fig 2). There was no secular trend in the fatality rate in this study. Boys made up 78·3% of the fatal cases in this series. The youngest child killed was 5, and the modal age for fatal cases was 14 years.

Fatal accidents were most common when a child cyclist collided with a motor vehicle. Thirty six (78·3%) of all of the fatalities in this study involved a car, lorry, or bus as the other vehicle. Three accidents occurred at railway level crossings, and in six (13%) there was no other vehicle. One fatality resulted from a collision between a pedal cyclist and a motorcyclist. Thirty two (69·6%) of the children died from head injuries, and a further 12 died of multiple injuries. Two (4·3%) died of neck fractures. Of those killed, 58% were killed instantly. Of the remainder, most survived for one day (median five days, range 1-11 days). Table IV gives the causes of the fatal accidents.

Eighty seven per cent of all fatalities in this series involved a motor vehicle or a train. As well as can be determined, the cyclist was at error in at least half of all fatal accidents.

TABLE IV—*Causes of fatal bicycle accidents in children*

	No	%
Fell from bicycle on to road	6	13·0
Fell from bicycle under motor vehicle	4	8·7
Hit by motor vehicle—cyclist innocent	6	13·0
Hit by motor vehicle—cyclist error	19	41·3
Hit by moving vehicle—cause uncertain	8	17·4
Hit by train—cyclist error	3	6·5

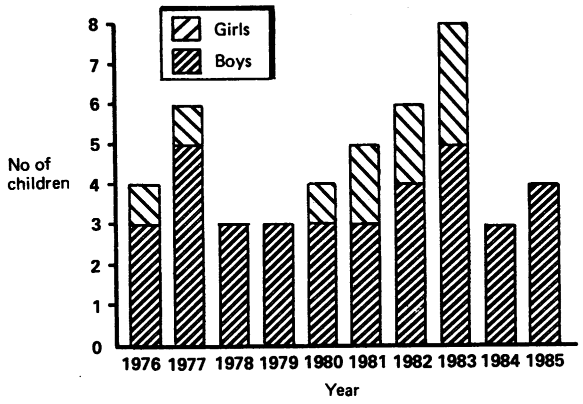

FIG 2—Fatal child cyclist accidents (46 children) in the city of Brisbane 1976-85.

Discussion

McDermott and Klug showed that the children in pedal cyclist accidents suffered more frequent and more severe head injuries than did motorcyclists.[8] In this study 70% of children who died did so as a result of head injuries. Of the survivors, 9% suffered head injuries. Though it was not known whether protective devices were used, Armson and Pollard, in a study from the same area, reported that the children injured on the roads had not used helmets.[6] Clearly, protection from head injury in the present study was inadequate. An alternative approach to enforcement may be to limit the age of people who may use pedal cycles on the roadway in the same way that motor vehicle use is limited. Until about age 12 the child's development is not sufficiently advanced to coordinate bike skills, road rules, and the ability to interpret and predict the changing traffic situation. The group most at risk, however, are 12-14 year old boys, and therefore preventing children under 12 from riding on the roads would not prevent injuries in this vulnerable age group.

Other means of reducing bicycle injuries are through design and education. In the case of pedal cycle accidents design features such as wheel size, type of handlebar, and position of gear levers have been implicated in particular types of injuries to children.[21-23] Furthermore, road design and the construction of bicycle pathways to separate bicycles from other traffic might be considered. Eighty seven per cent of the fatal acidents in this study occurred between a bicycle and another vehicle. Although bikeways separate bicycles from other traffic effectively, it seems unlikely that a complete separation will ever take place in motor vehicle oriented cities.

Education is widely used to reduce accidents. Child riders may be trained in bike control skills as well as in the rules of the road. The stage of development of the rider will largely determine the ability to apply such education in changing traffic. A second target for education is the other road users. Motorists can be made aware of the vulnerability of cyclists, but it is not clear which elements of driver behaviour need to be changed to improve the lot of pedal cyclists.

We thank the Child Accident Prevention Foundation of Australia, whose financial support made this project possible.

References

1 Pearn J, Nixon J, Ansford A, Corcoran A. Accidental poisoning in childhood: five year urban population study with 15 year analysis of fatality. *Br Med J* 1984;**288**:44-6.
2 McKenna S, Borman B, Fleming H. Pedal cycle accidents. *NZ Med J* 1984;**97**:657-8.
3 Nixon J, Pearn J, Corcoran A. Fifteen years of child drowning. *Accident Analysis and Prevention* 1986;**18**:199-203.
4 Anonymous. Motor cycle and bicycle accidents. *Br Med J* 1979;i:39-41.
5 Guichon DMP, Myles ST. Bicycle injuries: one-year sample in Calgary. *J Trauma* 1975;**15**:504-6.
6 Armson CJ, Pollard CW. Child cyclist injuries: a prospective study. *Med J Aust* 1986;**44**:144-6.
7 Fife D, Davis J, Tate L, Wells JK, Mohan D, Williams A. Fatal injuries to bicyclists: the experience of Dade Country, Florida. *J Trauma* 1983;**23**:745-55.
8 McDermott FT, Klug GL. Differences in head injuries of pedal cyclist and motorcyclist casualties in Victoria. *Med J Aust* 1982;ii:30-2.
9 Illingworth CM. 227 road accidents to children. *Acta Paediatr Scand* 1979;**68**:869-73.
10 Illingworth CM, Noble D, Bell D, Kemn I, Roche C, Pascoe J. 150 bicycle injuries in children: a comparison with accidents due to other causes. *Injury* 1981;**13**:7-9.
11 Australian Bureau of Statistics, Queensland Office. *Road traffic accidents, 1983*. Queensland: ABS, 12 July 1984. (Catalogue No 94043.)
12 Faigel HC. Bicycles and safety revisited. *Clin Pediatr* 1977;**53**:807-13.
13 Anonymous. Bicycle spoke injuries [Editorial]. *Br Med J* 1969;iv:182.
14 Kravitz HL. Preventing injuries from bicycle spokes. *Pediatr Ann* 1977;**6**:713-6.
15 Waller JA. Bicycle ownership, use, and injury patterns among elementary school children. *Pediatrics* 1971;**47**:1042-50.
16 Craft AW, Shaw DA, Cartlidge NEF. Bicycle injuries in children. *Br Med J* 1973;iv:146-7.
17 Howell TR. Accidents and those bizarre bicycles. *Pediatrics* 1968;**42**:214.
18 Walter JPW. Bicycle accidents. *Br Med J* 1979;i:265.
19 Jackson RH. Hazards to children in traffic. *Arch Dis Child* 1978;**53**:807-13.
20 Williams AF. Factors in the initiation of bicycle-motor vehicle collisions. *Am J Dis Child* 1976;**130**:370-7.
21 Jackson RH, Craft AW. Bicycle saddle and torsion of the testis. *Lancet* 1978;i:983-4.
22 Fife D, Davis J, Tate L. Two fatal bicyclist injuries from extended rear view mirrors. *J Trauma* 1983;**23**:756-7.
23 Thorson J. Pedal cycle accidents. *Scand J Soc Med* 1974;**2**:121-8.

(Accepted 6 March 1987)

Is a cardiac pacemaker likely to be adversely affected by radar equipment on board a ship or aeroplane?

Although there is good theoretical and experimental evidence (W D Toff *et al*, unpublished data) to support the hypothesis that electromagnetic radiation emanating from radar and radio installations on ships and aircraft might affect pacemaker function, the experience is that, in practice, such effects do not pose a clinical problem. Modern pacemakers are well shielded against electromagnetic radiation and interference is thought to originate from current induction in the electrode.[1] Unipolar systems are more susceptible than bipolar ones but protective circuitry allows much interference to the recognised reversion to fixed rate pacing at a preset rate occurring. Under such circumstances this form of interference is relatively safe. The more hazardous situation is of inhibition of demand pacemakers by induction in the pacing lead by currents simulating cardiac potentials. Pacemaker users are not often completely dependent on their pacemakers; fewer than a fifth develop symptoms or fail to develop an adequate escape rhythm in response to abrupt inhibition.[2] Any interference effects are thus likely to be subclinical. Many interference sources are only intermittently active and high field strengths are restricted to limited areas at close range and likely to be encountered only transiently, if at all, by passengers. Work is in progress to determine the margins of safety in this poorly documented area (W D Toff *et al*, unpublished work). Variations in a subject's posture and orientation to an electromagnetic field may affect interference susceptibility which may also vary between different units, even of the same model and manufacture.[3] Some degree of shielding may be afforded by the body and thus habitus and implant site may also affect the response. Patients should be advised of the small theoretical risk of interference and if they are concerned should move away from possible sources. If regular or occupational exposure is contemplated the risks may assume greater importance and should be appraised on an individual basis.—MICHAEL JOY and WILLIAM D TOFF, consultant physicians, Chertsey.

1 Irnich W. Interference in pacemakers. *PACE* 1984;**7**:1021-48.
2 Rokas S, Crick JCP, Sowton E. Does pacemaker dependence exist? *Br Heart J* 1981;**45**:340.
3 Butrous GS, Male JC, Webber RS, *et al*. The effect of power frequency high intensity electric fields on implanted cardiac pacemakers. *PACE* 1983;**6**:1282-92.