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**BICYCLE ACCIDENTS INVOLVING MOTOR VEHICLES**

**A 10 year study of child mortality and morbidity with an analysis  
of the role of alcohol in driver and cyclist.**

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**ABSTRACT**

A total population 10 year survey of bicycle/motor-vehicle collisions involving injured children (0-14 years) is reported from Queensland, Australia. Two thousand two hundred and ninety consecutive unselected cases have been analyzed. Pedal cyclists comprised 97.9 percent, and 2.1 percent were pillion ("doubling") passengers. Fatalities occurred in 3.7 percent of cases and 44.6 percent were hospitalized. Age-specific annual accident rates for child cyclists (5-14 years) were 56.1 per 100,000 population at risk; 83.6 per 100,000 population of bicycle owning children; and 280.5 per 100,000 population of children who ride regularly or occasionally to school (one in 357). Significant two agent (child and driver) accidents involving child cyclists tend not to injure the driver (passenger or pillion) of the other vehicle(s) involved. In 97.1 percent of cases, only the child cyclist (or the cyclist's pillion) was injured or killed. There was no current evidence that alcohol was a factor in the child cyclist's behaviour. Police were suspicious of alcohol use in only two cases of the 2,156 injured children and blood alcohol was not detected in either. Of all fatal cases, combining the circumstantial evidence and formal autopsy blood alcohol result, the incidence of alcohol drinking, in child (5-14 years) cyclists is approximately one percent on current evidence. This study showed that the best current estimates of drunkenness among drivers involved in child cyclist fatalities was 1.8 percent. Of this group the drivers were predominantly male (92 percent), young (50 percent under 25 years of age) and without a current driver's licence (22 percent). Ninety five percent of bicycle/motor-vehicle accidents involving drink drivers occurred in clear conditions, and child cyclists who were victims of drunken drivers had a high (50 percent) proportion of severe head and neck trauma. One-third had simple fractures indicating association with high energy exchange.

## INTRODUCTION

Trauma to children in the bicycle riding population remains a universal problem. Whereas a reduction in many forms of childhood trauma has been achieved in the last decade, the fatality rates of child cyclists involved in accidents have remained static (Nixon et al., 1987; Fife et al., 1986), or have increased (Armson and Pollard, 1986; Australian Bureau of Statistics, 1984; McKenna et al., 1984). In a large total population study in 1987, it was established (a) that 80 percent of bicycle rider fatalities involved a motor vehicle, and (b) that the most common bicycle accidents occurred to boys aged between 12-14 years, on straight roads, in clear weather conditions and in daylight, and within two hours of school finishing time (Nixon et al., 1987). The implication from that study was that cyclist and/or driver behaviour was a major causal factor. Although alcohol has been implicated in child passenger motor vehicle deaths (Margolis et al., 1986; McDermott, 1985), anecdotal evidence has suggested that alcohol is not a significant factor in bicycle/motor collisions involving child cyclists, but that association has remained unexamined. For this reason and because of the specific problem of child cyclist/motor-vehicle accidents, we have undertaken and reported here a major 10 year study of this problem in Queensland, Australia.

## METHODS

### Definitions - bicycle accidents:

A bicycle was defined as a two-wheeled pedal cycle. Only cyclists involved in collisions on public roads were included in the study. An "accident" was defined as an incident involving one or more pedal cyclists in collision with one or more moving motor vehicles. An "accident", for the purpose of this study, was defined as one of sufficient severity, or with

sufficient concern surrounding the circumstances, to require investigation by a police officer. Both fatal and non-fatal cases were included.

**Motor vehicle:**

A motor vehicle was defined as any powered vehicle using public roads, and included cars, trucks, buses, articulated vehicles and motor cycles. Accidents involving trains were excluded from this study.

**Children:**

A child was defined as a person under the age of 15 years. Child victims who were either cyclists providing power to the cycle or who were pillion or carried passengers ("doubling"), were included in case finding.

**Alcohol:**

At the roadside, breath testing for alcohol was undertaken by an "alcolyser" breath testing bag. If the test was positive, confirmation (evidential) testing was undertaken at the police station by either a Borkenstein 900 (or 900A) Breathalyser, or a blood test. The legal limit of blood alcohol for drivers and bicyclists in Queensland was 0.05g/100 ml (11 mmol/L).

**Injury:**

An injury was defined as trauma of sufficient severity to require first aid or medical intervention either at the accident site or subsequently at hospital.

**Case-finding:**

**Primary listing of road incidents:** Every case involving a traffic incident resulting in personal injury or significant damage to property on a public road is investigated by an officer of the Queensland Police Force. From these reports detailed summaries are sent (with protection for confidentiality) to the Main Roads Department (Queensland State

Government) for the purpose of planning engineering and accident prevention.

**Bicycle/motor vehicle collisions:** From this primary confidential listing, every case of a bicycle/motor-vehicle collision was identified and included in this study. Every case of such a bicycle accident in the 10 year period 1st July 1974 to 30th June 1984 was included in primary case-finding.

**Exclusions:** Cases were excluded if the child cyclist and/or pillion rider was not injured. The final list of identified cases (2,234 "accidents" involving 1,783 males and 472 females) thus comprised an unselected consecutive 10 year series of all significant child cyclist/motor vehicle crashes.

**Base population:** This project comprised a total population study of Queensland, Australia. Queensland had a population of 2.248 million people at the mid-survey point (June 1980). The demographic composition of the population included 566,000 (25.2 percent) of the population between 0 and 15 years of age. Bicycle accidents occur to children between the ages of 5-14 years. Children in this age bracket constituted 394,400 (17.6 percent) (202,600 males) of the general population. The incidence of bicycle ownership was 68 percent and 20 percent of children rode regularly or occasionally to school.

**Cyclists:** Cyclists ride on the main roads in Queensland. Few bikeways available for bicyclists.

**Data: For each case the following data were obtained:-**

date of accident; time of day; day of week; atmospheric conditions; prevailing light conditions; <sup>type?</sup> time of crash (angle, side-swipe, head on, rear end etc); injury sustained, outcome (fatality versus survival); place of accident; profile of child

victim (age and sex, cyclist or pillion passenger); type of motor vehicle; details of driver (age, sex); licenced state of driver (confirmed licence, learner's permit, endorsed, cancelled etc); contributing factors where available (alcohol, driver and/or rider error, speed and inexperience of the driver or rider as judged by the attending police); whether or not alcohol testing was undertaken. Testing for alcohol was undertaken with both child cyclists and adults involved in accidents where there was circumstantial evidence of alcohol consumption.

In selected cases, blood alcohol and breath testing for alcohol was undertaken. The decision to test the vehicle driver or the cyclist for alcohol was discretionary on the part of the attending police officer. Routine testing following bicycle/vehicle accidents is not undertaken. Such testing is undertaken if the attending police officer (a) suspects on clinical evidence that alcohol is involved, or (b) where there is a suspicion that a crime has been committed. Death or injury is not a criterion for alcohol testing where child cyclist/adult driver crashes have occurred.

## RESULTS

### Accident rates:

Table I shows the details of 2290 children identified in the study. Fatality rates for injured cyclists (excluding pillion passengers - those "doubling" or "dinking") were 3.7 percent with a hospitalization rate of 44.6 percent. An assessment of specific risk rates incorporating a qualified estimate of exposure (children who own bicycles and those who rode occasionally or regularly to school) is shown in Table II. Of children who

ride to school, the annual accident rate leading to serious injury is 1 in 357.

Accidents involving child cyclists occasionally injure car drivers (and passengers), and motor cyclists (and their pillions). The overall accident profile, is shown in Table III. Children cyclists (and their pillions) tended to be involved in accidents where the car or motorcycle drivers were not injured (2.9 percent of those being so involved).

#### **Alcohol tests:**

**Cyclists:** In only two cases (of the 2,156 pedal cyclists involved who were not killed) was there a suspicion by the police that the child cyclist had been drinking, and was tested for blood alcohol (both cases proved negative). Of the 85 fatally injured child cyclists, testing for alcohol (at the time of autopsy) was undertaken on 15. One case was positive (a 14 year old boy with a blood alcohol of 0.14 who rode into the back of an articulated lorry at 7.00 p.m. in the dark on a Saturday night).

**Drivers:** Of the 2,241 bicycle/motor-vehicle accidents investigated by the police, alcohol testing of was undertaken in only 50 cases. In Queensland, at the present time, police retain discretion whether or not to test the driver for breath or blood alcohol, depending on the circumstances of the individual case. Table IV shows a comparison between rates of testing for drink drivers involved in all types of motor vehicle accidents, and rates for drivers involved in child cyclist accidents. Although very few (2.2 percent) of the drivers who knocked children from bicycles were tested, the detection for illegal blood alcohol level in these drivers is comparable to and certainly not higher than that for motor vehicle accidents in general.



Forty-one of the 50 tested (1.8% of all accidents) had a blood alcohol level over 0.05 g/100 ml. All had high blood levels (0.24 to 0.26) implying that some cases may have been missed. Drunken drivers were male (92 percent) and young (59 percent were under 25 years of age) (Table V). When the driver was drunk, the vehicle which hit the child was a car (71 percent), truck or utility truck (12 percent), motorcycle (12 percent) and bus or articulated vehicle (5 percent). Of the 42 children hit and injured by drunken drivers, 3 (7 percent) died, a further 19 (45 percent) were hospitalized.

Of the 41 drunk drivers, 9 (22 percent) had provisional, learner's or cancelled licences. In the accidents involving drunken drivers, 95 percent occurred in clear conditions with good visibility, and 75 percent occurred in daylight. Table VI shows the morbidity and mortality picture of children cyclists hit by drunken drivers. The higher degree of serious head and multiple trauma suggests that high energy impacts have occurred. Child victims of drunk drivers were hit predominantly on week days (57 percent), and within two hours of leaving school (42 percent). No child was injured by a drunken driver after 6.00 p.m. in this study.

## DISCUSSION

Alcohol has been shown to be associated with about 50 percent of fatal motor vehicle accidents (West and Hoare, 1980); 15 percent of motor vehicle accident deaths involving children and 11 percent of all motor vehicle injuries in the United States (Margolis et al., 1986). Estimates of 20 percent of adult cyclists involved in road accidents in Sweden (Lind and Wollin, 1986) and 22 percent of motor vehicle drivers involved in non-fatal casualty accidents in Queensland (Australian Bureau of Statistics, 1980) have been shown to have in excess of the legal blood alcohol limit. The drunk

driver detection rate in this present study of 1.7 percent of non-fatal injuries from bicycle/motor-vehicle crashes must be considered low. Either drunken motor vehicle drivers are less likely to hit pedal cyclists than they are to hit other motor vehicles, or testing for alcohol is not being done to any significant degree. In the present study testing was undertaken on some 2.2 percent of motorists in child bicyclist/motor-vehicle collisions, while some 27 percent of motorists involved in all motor vehicle accidents are tested (Australian Bureau of Statistics, 1980). It must be pointed out however that the proportions of those found to be over the legal limit are not dissimilar. Some 82 percent of those tested in cycle accidents were found to be over the limit compared to 88 percent of those involved in all traffic accidents. In this study the level of alcohol detected ranged from 0.10 to 0.22 from breath tests and 0.24 to 0.26 from blood tests. These levels are between two and five times the legal limit and suggest that testing may be initiated by obvious impairment of those tested.

The high rate of intoxicated drivers without legal driving licences (38 percent) indicates that over one-third of those who were prepared to drive vehicles while under the influence of alcohol (and were involved in an accident injuring a child cyclist) were also involved in a second illegal activity at the time of the accident.

It is illegal to carry pillion passengers on bicycles in Queensland. The number of 49 pillion passengers injured suggests that the practice, even if not widespread, is a hazardous one. In fourteen of the cases of injured bicycle pillion passengers, the bicycle rider was not injured. Motor cyclists and their pillion passengers seemed particularly vulnerable in bicycle/motor cycle collisions.

This study has shown that about one percent of children involved in bicycle/motor-vehicle accidents will themselves have been using alcohol. Hill

et al. (1987), in a study of Australian school children, recorded that 23 percent of males and 14 percent of females had drunk alcohol in the week prior to the study being undertaken. Hill et al. (1987), report that by the time children leave school their patterns of smoking and drinking behaviour reflect those of the adult population.

Mandatory testing of all drivers involved in bicycle/motor-vehicle accidents is likely to reveal a number of drivers within the 0.05-0.10 range who are not being detected at the present time. Victoria has had compulsory blood alcohol tests on road casualties age 15 years or more since 1974. This compulsory testing has identified probationary drivers as being an especially high risk group, being over-represented both in driver casualties and in alcohol related accidents. Following a review of alternative preventive measures, McDermott has concluded that the most promising deterrent is the driver's perception of a high chance of being detected while drinking and driving, followed with certain severe penalties. In the case of bicycle/motor-vehicle accidents, there appears scope to both increase detection and driver awareness of detection as a first step in the prevention of these accidents.

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TABLE I - A total population (Queensland) 10 year (1974-1984) survey of bicycle/motor-vehicle collisions. All injured children were between 5-14 years. Total Queensland population of 5-14 year olds was 394,400 at the mid-survey point (1980).

	Dead	Hospitalized	Treated at Site or at A/E Dept	Total
Pedal cyclists	85	1,000	1,156	2,241 (97.9%)
Pillion Passengers	1	19	29	49
Total	86 (3.7%)	1,019 (44.6%)	1,185 (51.7%)	2,290 (100%)

TABLE II - Age-specific annual risk figures for significant trauma from bicycle/motor-vehicle collisions. Total population study rates derived from 2,241 injured child cyclists, Queensland, Australia.

Population	56.1/100,000 age specific at risk
Children who own bicycles	83.6/100,000 age specific at risk
Children who rode occasionally or regularly to school	280.5/100,000 age specific at risk

TABLE III - Pattern of significant injury in accidents involving child cyclists. Of the total 2,361 cases total mortality was 4.0%; cases hospitalized comprised 44.0%.

Child cyclists	2,241	
Pillion passengers of child cyclists	49	
Drivers and passengers of cars/trucks/buses	15	
Motor cyclists and pillions	46	
Adult pedal cyclists and pillions	10	
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TOTAL	2,361	(100.0%)
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TABLE IV - Testing for blood alcohol in motor vehicle drivers involved in child cyclist/motor-vehicle collisions in a society where such testing is discretionary. Data on "all accidents" from the Australian Bureau of Statistics Queensland Road Traffic Accidents (Catalogue 9404.3 of 1979/80), and data on child cyclist accidents from a current study.

	All accidents (1980)	Accidents involving child cyclist/ vehicle collisions
Casualty incidence	7,688	2,241
Number of alcohol tests	2,084 (27.1%)	50 (2.2%)
Number of illegal levels (0.05)	1,840 (88.3%)	41 (82.0%)

TABLE V - Age and sex of 41 drunken drivers whose vehicle hit a child cyclist.

	17-25 yrs	26-45 yrs	46-70 yrs	Unknown
Males	17	12	8	1
Females	3	0	0	0
	20	12	8	1

TABLE VI - Mortality and morbidity profile of 25 children cyclists hit by drunken drivers.

	NO OF CASES	TRAUMA		
		Head and Neck	Multiple	Other
Dead	3	3	-	-
Hospitalized	12	5	6	1
Treated at accident site	10	-	-	10
	25	8	6	11