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Cycling to school — a significant health risk?

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Abstract

***Objectives*—The risk of injury to children riding bicycles has been previously documented. However, the specific risk arising from the use of bicycles as a mode of transportation to and from school is unknown. This study examines the incidence of bicycle related injuries among school age children.**

***Methods*—A comprehensive prospective injury registration system was established in Stavanger, Norway. Data were obtained from this system to identify bicycle related injuries occurring from 1990–3 to children aged 10–15. The incidence of injuries was computed for two groups of children: (1) children cycling to school and (2) children cycling for other purposes.**

***Results*—352 children received medical treatment for bicycle related injuries, 12·6/1000 bicycle riders; 108 (30%) of the 352 children were injured while cycling to or from school. The incidence of bicycle related injuries was significantly higher for boys than girls. Seventy seven per cent of the injuries occurred in a non-collision accident, 9% in a collision with another bicycle, and 14% in a collision with a motor vehicle. Twenty per cent of the injured children sustained upper head injuries and 13% required inpatient treatment. Average maximum abbreviated injury severity (MAIS) score was similar for the injuries sustained during travel to/from school and other injuries.**

***Conclusions*—Bicycle related injuries occurring during travel to or from school are a significant contributor to the total incidence of bicycle related injuries. Increased attention among parents, school officials, public health officials, and medical professionals should be paid to this health risk.**

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Bicycle riding is among the most popular activities engaged in by children in developed countries. Even in Norway, a country with mountainous terrain and a cold climate for several months of the year, bicycle riding is almost universal among children. A 1992 national survey found that 96% of the children aged 7–14 in Norway rode bicycles.[1] The act of riding a bicycle, however, is not without risk. Bicycle related accidents are a significant source of injuries among children.[2–5] Accordingly, the safety of bicycle riding is an important issue that continues to receive attention.

Children use bicycles both as a toy and as a mode of transport for purposeful trips,[6] and accidents may occur under either condition. Among the most common of the purposeful trips is travel to and from school. Data suggest that as many as 35% of Norwegian children aged 7–14 years ride their bicycles to school.[1]

Because the safety of children during school travel is a major concern to public authorities, parents, and health care professionals, understanding the degree of risk children are exposed to while cycling to school is important. Yet little information is available about this issue. We were unable to locate a single epidemiological study of bicycle injuries exclusively incurred by children while travelling to school. Two investigations, however, suggest the potential scope of the problem. A retrospective case series from New Zealand, found that 19 out of 62 bicycle accidents (31%) resulting in bicycle damage and/or personal injury among children aged 14–15 years occurred during school trips.[4] A recent US study found that among children aged 5–14, 27% of injuries from bicycle motor vehicle collisions were incurred by children cycling to school.[6]

In sum, school related travel may be an important aspect of the epidemiology of bicycle injuries among children. The aim of this study is to describe the occurrence, causes, and consequences of bicycle related injuries among children aged 10–15 years during travel to or from school. As part of this analysis, we compared two types of bicycle injuies: (1) injuries sustained by children while cycling to or from school, and (2) injuries sustained by children using bicycles for purposes other than travelling to school.

Methods

POPULATION AND CASES

The study population consists of all children aged 10 to 15 years who were resident in Stavanger, Norway, from 1990–3. On average, 7256 children aged 10–15 years lived in Stavanger during the four year study period, representing 29 023 children years. Stavanger is a coastal town of approximately 100 000 located in the south western part of Norway. It enjoys a mild climate compared with the rest of the country and is comparable in many respects with many mid-size metropolitan areas in other industralized countries.

Cases for this study were identified from prospective, ongoing registration of all injuries treated by the Central Hospital and Emergency Clinic in Stavanger. These two institutions provide inpatient and outpatient medical care to the total population. No other medical

facilities exist in the town that can treat serious acute injuries. An injury is identified if it resulted from an accident that was followed by some use of medical services (hospital or emergency clinic). Injuries include all cases treated for diagnoses with ICD-9-CM codes from 800 to 999, except codes 905-909 (late consequences of injuries). The registration is provided according to the common classification and protocol for registration of injuries in the Nordic countries (NOMESCO classification) that includes extensive information about the circumstances in which the injury occurred.[7]

We identified all cases of bicycle related injuries among children aged 10 to 15 years that occurred in Stavanger from 1990–3 and selected these cases for study. In Stavanger, children aged less than 10 years are not allowed to cycle to school, and no cases of school cycling injuries involved children under 10.

Bicycle related injuries were defined as an injury event involving a child riding a bicycle. A total of 356 injured children were so identified, but key information was missing for four cases, reducing the study population to 352. The following information was obtained for all 352 cases: age and sex of the injured child, date and time when the accident occurred, type of the other vehicle involved in the accident (for collisions), purpose of the trip, medical diagnosis, maximum abbreviated injury severity (MAIS) score,[8] and whether the child was hospitalized. If an injured child had multiple visits to the hospital or clinic for the same injury, only the first visit was included in the analysis. We determined through the Norwegian death register that no bicycle fatalities occurred among the children in Stavanger.

CALCULATION OF INCIDENCE

We divided cases into two groups with respect to purpose of travel: (1) injuries sustained by children bicycling to or from school, and (2) other bicycling injuries. Further, we divided children into two age groups: 10 to 12 years, and 13 to 15 years. Incidence was calculated as the number of injuries divided by the number of riders in each age group. The number of riders was calculated by multiplying the size of the respective population group by 96%, the proportion of Norwegian children riding bicycles as reported by the national (1992) survey described earlier.[1] In that survey, a child was classified as a rider if he or she used a bicycle at least once from May to October 1992. Most of the children who rode bicycles did so daily (60%) or weekly (36%). Only 4% rode their bicycle less than once a week.

Reliable information on the proportion of children riding bicycles to school in Stavanger was unavailable. Therefore, incidence rates representing school related bicycle injuries were calculated per 1000 bicycle riders in the child population.

Differences in injury incidence were tested by the χ^2 test. Differences in the MAIS score between children injured on the way to or from school or during other travel were tested by the Mann-Whitney U test.

Results

INCIDENCE

Between 1 January 1990 and 31 December 1993, 352 children aged 10 to 15 years residing in Stavanger received medical treatment for bicycle related injuries (12·6/1000 bicycle riders, 12·1/1000 population). Of these, 151 children (10·9/1000 bicycle riders) were 10–12 years of age, and 201 children (14·4/1000 bicycle riders) were 13–15 years of age. The difference in injury incidence between these two age groups was statistically significant ($p < 0·01$). Among the injured children, 116 were girls (8·5/1000 bicycle riders) and 236 were boys (16·6/1000 bicycle riders). The difference in injury rate between girls and boys was also statistically significant ($p < 0·01$).

PURPOSE OF TRAVEL

Of the 352 bicycle injuries reported, 108 (30·6%)* occurred during travel to school (3·9/1000 bicycle riders), and 244 (69·4%) occurred during travel for other purposes (8·8/1000 bicycle riders). The number and rates of injuries are shown by age, sex, and purpose of travel in table 1. Among children injured while cycling to school, rates were highest for older children (4·7 *v* 3·1/1000 bicycle riders for children 13–15 and 10–12, respectively, $p < 0.05$) and for boys (4·8 *v* 2·9/1000 bicycle riders, respectively, $p < 0·01$). The higher rate among boys was entirely due to the higher rate among boys 13–15. The incidence of injuries during travel for other purposes was similar ($p > 0·05$) for children aged 13–15 and 10–12 years (7·8 and 9·7/1000 bicycle riders, respectively).

TRAFFIC SITUATION

The majority (77%, 277/346) of injuries occurred in non-collision accidents (table 2). (Note information on the traffic situation was missing for six cases, and hence, table 2 is based on 346, not 352, cases.) Collisions with another bicycle accounted for 9%, while collision with a motor vehicle occurred in 14%. The proportion of injuries sustained in collisions with a motor vehicle was higher (although not statistically significantly) for injuries sustained by children cycling to school than among those cycling for other purposes (19% and 12%, respectively). Injuries sustained by children cycling to school accounted for 40% of all motor vehicle collision injuries. Although not shown in table 2, technical malfunction (for example loose front wheel, brake problems) accounted for 8% of all injuries.

*A total of 120 children sustained traffic related injuries on the way to or from school. Of these, six were pedestrians, four were bicycle passengers, two were passengers in buses, and 108 were bicycle riders. This study includes only the 108 cases representing a bicycle rider.

Table 1 Number and injury rates by age, sex, and purpose of travel

	Girls		Boys		Total	
	No	*Rate/1000*	*No*	*Rate/1000*	*No*	*Rate/1000*
To/from school						
10–12 years	22	3·3	21	2·9	43	3·1
13–15 years	17	2·5	48	6·8**	65	4·7†
Total	39	2·9	69	4·8**	108	3.9
Other travel						
10–12 years	43	6·4	65	9.0	108	7·8
13–15 years	34	4·9	102	14.5**	136	9·7
Total	77	5·7	167	11.7**	244	8·8

**Statistical significance for the difference in the incidence between boys and girls within the same age cohort: $p < 0.01$. †Statistical significance for the difference in the incidence between older and younger children: $p < 0.01$.

DATE AND TIME

Seventy eight per cent of all injuries occurred from April to October. The distribution of cases by the month was bimodal for injuries that occurred during school trips, with peaks observed in spring and autumn. The low number of cases observed during the winter months coincide with cold weather, while the low number during summer months coincide with summer holidays. In contrast, for injuries sustained during travel for other purposes, cases by month was normally distributed (unimodal, symmetric), except in July, when somewhat fewer than expected cases occurred, probably because many children are away from home for holidays.

The frequency of injuries during school trips was similar during all weekdays (Monday to Friday) and no such injuries occurred on weekends when the schools are closed. The injuries that occurred during travel for other purposes were, however, equally distributed among all weekdays.

The majority (87%) of injuries sustained during travel to or from school occurred in two time intervals — 40% from 7 am to 9 am (commuting to school), and 37% from 1 pm to 3 pm (commuting home from school). Most of the injuries (75%) to children travelling for other purposes occurred during the afternoon and early evening, from 1 pm to 8 pm.

DIAGNOSES AND SEVERITY

The 352 injured pedal cyclists had 394 diagnoses, the most common of which were contusions (27%) and lacerations (23%) (see table 3). Other frequent diagnoses were fractures (20%), lacerations (19%), sprains and strains (13%), and brain concussion (12%). The diagnostic profile of injuries sustained by children on school trips versus those riding for other purposes was similar. Although not shown in table 3, 69 (20%) children sustained upper head injuries (brain, scalp, forehead). There was again no statistically significant difference in the proportion of upper head injuries sustained by children injured while cycling to school and children cycling for other purpoes.

Table 2 Number and injury rates by traffic situation and purpose of travel

	Non-collision		Collision			
			With other bike		With motor vehicle	
	No	*Rate/1000*	*No*	*Rate/1000*	*No*	*Rate/1000*
To/from school						
10–12 years	27	1·9	4	0·3	11	0·8
13–15 years	46	3·3	10	0·7	9	0·6
Total	73	2·6	14	0·5	20	0·7
Other travel						
10–12 years	91	6·5	7	0·5	10	0·7
13–15 years	103	7·4	9	0·6	19	1·4
Total	194	7·0	16	0·6	29	1·0

Table 3 Injury diagnoses by purpose of travel; values are number (%)

	To/from school	Other travel	Total
Fracture	18 (15)	59 (22)	77 (20)
Dislocation	5 (4)	2 (1)	7 (2)
Sprain, strain	17 (14)	34 (13)	51 (13)
Brain concussion	19 (16)	28 (10)	47 (12)
Open wound	19 (16)	57 (21)	76 (19)
Abrasion	8 (7)	16 (6)	24 (6)
Bruise	36 (30)	72 (26)	108 (27)
Other	0	4 (1)	4 (1)

The average MAIS score also did not differ significantly between the two groups. Approximately three quarters (76%) of the cases had minor injuries (MAIS score = 1); one quarter (23%) were of moderate severity (MAIS score = 2); three were classified as severe (MAIS score = 3) and one as very severe (MAIS score = 4).

Most children (87%) received only outpatient treatment, although 46 (13%, 46/352) required hospitalization (1·7/1000 bicycle riders). Of these, 17 sustained injuries cycling to school (16% of all such cases), and 29 sustained injuries cycling for other purposes (12% of all such cases). There was no significant difference in the hospitalization rate for children in the two groups.

Discussion

Bicycle related injuries sustained by children cycling to school are a significant contributor to the total incidence of bicycle related traffic injuries among school age children (10–15 years) in Stavanger. These injuries account for almost a third (30·6%) of all bicycle injuries and for 40% of injuries resulting from motor vehicle collisions. Approximately 16% of the 108 children injured while cycling to school required hospitalization. Thus it appears that using a bicycle as the method of transport to school for many children involves a substantial risk of injury.

We were unable to calculate exposure adjusted injury incidence figures. The bicycle survey from 1992 found that approximately 35% of the children aged 7–14 in Norway use bicycles for school travel.[1] Information from selected schools in Stavanger suggests that the proportion of children riding to school may be considerably lower, however, perhaps on the order of 10–15%. Thus, on the national level in Norway, the problem of children injured while cycling to school may be *even greater* than suggested by this study.

There is therefore a clear need to develop specific targeted preventive measures to reduce the incidence of bicycle related injuries. What measures might be most effective? One measure, implemented in Stavanger to reduce the risk of injuries among younger children,

was to prohibit those under 10 from cycling to school. While extending this restriction beyond age 10 is an obvious way to reduce injury, it is impractical and probably unrealistic.

Another preventive measure is wearing bicycle helmets. Research indicates that use of bicycle safety helmets significantly reduces the risk of upper head injuries.[9-12] Recent unpublished data, however, show that only a small proportion of children in Norway wear helmets when bicycling. In our sample, every fifth child sustained an upper head injury. Thus, there is a clear need to promote wearing of bicycle helmets among schoolchildren. Schools may play an important part in this regard through developing targeted health education activities. In some areas of Norway, school authorities require that children wear safety helmets if they cycle to school. Extension of this measure to all schools seems certain to prove beneficial. However, the literature indicates that multifaceted community-wide campaigns are more effective in reducing injury risk than limited efforts by schools or physicians.[13] Another source of preventable injuries is bicycle malfunction. Such cases accounted for nearly every tenth injury. Measures are needed to promote impoved bicycle maintenance.

Wearing bicycle helmets and improved bicycle maintenance should reduce the risk of non-collision upper head injuries and those due to bicycle malfunction. These cases accounted for approximately one quarter of the total in our study population. To reduce risk of other injuries, children should be taught traffic codes and bicycle riding skills.[14] Schools are appropriate places to organize such instruction. Some observers have even suggested that formal training in bicycle riding should become part of the school curriculum.[15] But the effectiveness of bicycle safety courses has never been documented and requires systematic evaluation. Other interventions may also reduce the risk of bicycle injury (for example mandatory school bussing, environmental measures to create safety cycling conditions). These and other interventions should be considered as part of a comprehensive bicycle injury prevention program.

The limitations of our study should be noted. The validity of the study's findings depends upon the accuracy of the registration system. Our dataset contains information on all individuals treated (as inpatients or outpatients) for bicycle related traffic injuries at the only emergency clinic and hospital in Stavanger. The completeness of the registration is continuously monitored and (unpublished) surveys show that only a small number of (minor) injuries in Stavanger are treated in other medial facilities (for example general practitioners' offices). The incidence of bicycle related injuries reported in our study is higher than that reported by Barancik *et al*,[2] Thompson *et al*[16] and Schelp and Ekman,[17] but lower than the rate reported by Lindqvist.[5] Rates reported by Friede *et al*[18] are similar to the rates reported here.

A second limitation, dicussed earlier, is the lack of exposure data; this precludes estimating *exposure adjusted* incidence of bicycle injuries. But the lack of exposure data does not affect our main conclusions regarding the public health significance of the problem.

Conclusion

Bicycle riding is a common form of school transport for many children in Norway, and for children in other industrialized countries as well. This study shows that significant numbers of bicycle related injuries can be expected to result from this activity and these injuries constitute a large part of traffic related trauma. Increased attention among paediatricians, public health officials, and school authorities to the issue of safety for children using bicycles to travel to and from school is warranted.

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