

Bicycle Safety Knowledge and Behavior in School Age Children

Sanford R. Kimmel, MD, and Rollin W. Nagel, MA
Toledo, Ohio

The purpose of this study was to examine school age children's knowledge of bicycling rules of the road and their bicycling behaviors. A one-page questionnaire was administered in the classroom to 276 of 300 children in grades 4 through 8 of an upper middle class suburban school district. The children were questioned regarding their knowledge of three basic bicycling rules of the road, prior bicycle safety instruction, use of bicycle helmets, and the occurrence and severity of previous bicycle accidents. Students who reported receiving previous bicycle safety instruction were more knowledgeable than those receiving no instruction regarding rule 2, always stop at a stop sign or red light (90% compared with 74%), and rule 3, always stop and look when approaching a street from a driveway or alley (74% compared with 60%). Students who did not know rule 3 were more likely to have had a recent bicycle accident in which their bicycle was damaged (21% compared with 8%) and to have ever gone to the hospital or a physician because of injuries sustained in a bicycle accident (19% compared with 9%). Children who lacked knowledge of basic bicycling rules were more likely to have had a significant bicycling accident. Bicycle safety instruction increases children's knowledge of these rules and should be promoted by physicians caring for children. J FAM PRACT 1990; 30:677-680.

Over 550,000 persons are treated for bicycle-related injuries in US emergency departments each year.¹⁻³ The highest incidence of bicycle injury and death occurs in children aged 10 to 14 years.^{3,4} In 1981 approximately 1000 bicyclists were killed, with two thirds of these deaths occurring in children 5 to 14 years of age.⁵ Serious injury to the head or neck occurs in over 75% of fatal injuries,^{5,6} which are usually the result of collision with a motor vehicle.^{7,8}

Various studies have suggested that wearing protective headgear is one way to reduce bicycle injuries.^{2,6,9} Weiss,¹⁰ however, observed less than 2% of elementary, junior, or senior high school students to be wearing helmets as they bicycled to school. Selbst et al⁶ reported that few children seen in a children's hospital emergency department for bicycle-related injuries had been wearing protective equipment such as helmets, gloves, kneepads

or reflective clothing. In addition, most children had not received previous instructions on bicycle safety.

Violations of traffic law by child bicyclists, such as riding on the wrong side of the street, or riding into traffic from driveways, side streets, or alleys without stopping, are frequent causes of bicycle-motor vehicle collisions.^{3,4} It is unclear whether children are ignorant of the rules of the road or are disregarding the rules.

The number and potential severity of bicycle-related injuries in children are serious concerns for parents, physicians, teachers, and law enforcement officials. The role of bicycle safety instruction in the reduction of bicycling accidents, however, is unclear. The present study surveyed school-age children about their knowledge of basic bicycle rules of the road and their use of helmets. The students were also asked about accidents or injuries that occurred while they were riding a bicycle.

METHODS

A one-page bicycle safety questionnaire was designed by the authors and confirmed as appropriate for the 4th and

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From the Department of Family Medicine, Medical College of Ohio, Toledo. Requests for reprints should be addressed to Sanford R. Kimmel, MD, Department of Family Medicine, Medical College of Ohio, PO Box 10008, Toledo, OH 43699.

TABLE 1. PERCENTAGE OF CHILDREN WITH KNOWLEDGE OF BICYCLE RULES OF THE ROAD, BY THE SOURCE OF BICYCLE SAFETY INSTRUCTION RECEIVED

Bicycling Rules	Source of Instruction			Total Receiving Instruction (n=229)	No Instruction (n=47)
	Class Only (n=35)	Parents Only (n=97)	Class and Parents (n=97)		
1. A bicyclist should ride on the right side of the street, with traffic	83	73	75	76	77
2. A bicyclist should always stop at a stop sign or red light	86	90*	92*	90†	74
3. A bicyclist should always stop before entering the street from a driveway or alley	71	70	78*	74	60

* $P < .05$ † $P < .01$

NOTE: Children receiving bicycle safety instruction from various sources were compared with those receiving no instruction for their knowledge of each bicycling rule.

5th grade reading level by the Fry Readability Graph.¹¹ All children present in grades 4 through 8 of an upper middle class suburban school district in Lucas County, Ohio, were given this questionnaire to complete during school in May 1988. The teachers for each grade distributed and collected the questionnaires. Each child could decline to complete the questionnaire, and all responses were anonymous. Differences in responses between groups were analyzed by the chi-square test of independence or Fisher's exact test.

RESULTS

The questionnaire was completed and returned by 276 of the 300 students (92%) in grades 4 through 8. Students were 9 to 15 years of age with 96% of the respondents being 10 to 14 years old. There were 146 boys (53%) completing the questionnaire. Distribution by grade level was also relatively equal.

Only 15 of 267 respondents (6%) indicated ownership of a bicycle helmet. (Nine students did not answer this question.) At least one half (8 of 15) of those owning a helmet either did not wear it or wore it less than one half the time. Thus, only 7 of 267 students (2.6%) reported frequent use of a bicycle helmet.

Almost one quarter (24%) of the students did not know that they should always ride on the right side of the street, with traffic (rule 1). One eighth (13%) did not know that a bicyclist should always stop at a stop sign or red light (rule 2). Twenty-nine percent of students did not know that a bicyclist should always stop to watch for cars and trucks when approaching a street from a driveway or alley (rule 3). There were no sex or age differences in knowledge of these rules.

Over one sixth (17%) of the students surveyed indicated

that they had not received any instruction about bicycling safety and rules of the road (BSRR) from either their parents or a class. Students who had received any instruction (class or parental) in BSRR were no more likely to know rule 1 than students lacking such instruction (Table 1). Ninety percent of students receiving instruction in BSRR, however, knew rule 2 compared with 74% of those receiving no instruction ($P = .008$). Seventy-four percent of students receiving instruction knew rule 3 compared with 60% who did not receive instruction ($P = .074$). Children who had received instruction from both a formal class and their parents indicated a better knowledge of rule 2 ($P < .02$) and rule 3 ($P < .05$) than students receiving no instruction. Children receiving instruction from only their parents also indicated a better knowledge of rule 2 ($P = .033$) than students having no instruction. Bicycle safety instruction appears to have improved children's knowledge of two basic bicycling rules essential for safe travel with motor vehicles.

Over one third (36%) of the students indicated that they had had a bicycling accident during the preceding year. Fifty-two of these 99 students also reported that they had been hurt in the accident, while 31 indicated that their bicycle had been damaged. One eighth (32/273) of the students indicated that during their lifetime they had seen a physician or gone to a hospital as the result of a bicycling accident. Students who knew rule 1, rule 2, or rule 3 and those who responded incorrectly to questions concerning these rules did not differ in the incidence of recent bicycling accidents or whether they had been hurt in the accident. As shown in Table 2, however, students who were knowledgeable about rule 3 were less likely to have had a recent significant accident in which their bicycle was damaged than were students lacking this knowledge (8% compared with 21%, $P = .005$). Those students who knew rule 3 were also less likely to have ever gone to a hospital

TABLE 2. CHILDREN WHO HAD BICYCLE DAMAGE IN A RECENT ACCIDENT, WITH REFERENCE TO THEIR KNOWLEDGE OF BICYCLE RULES OF THE ROAD

Student's Knowledge of Rules	No. of Students with Accident	Total No. with Indicated Response	Percent of Total
Rule 1			
Correct	25	206	12
Incorrect	6	65	9
Rule 2			
Correct	24	238	10
Incorrect	7	33	21
Rule 3			
Correct	15	194	8*
Incorrect	16	77	21

*P < .01.
 NOTE: Rule 1—A bicyclist should ride on the right side of the street, with traffic.
 Rule 2—A bicyclist should always stop at a stop sign or red light.
 Rule 3—A bicyclist should always stop before entering the street from a driveway or alley.

or to have seen a physician because of an injury sustained in a bicycling accident than students who did not know this rule (9% compared with 19%, $P = .028$) (Table 3). In a similar manner, children who did not know rule 2 were approximately twice as likely as correct responders to have their bicycle damaged in an accident (21% compared with 10%, $P = .112$) and to have ever gone to a physician or hospital as the result of a bicycling injury (21% compared with 11%, $P = .073$). Therefore, children who knew rule 2 and especially rule 3 were less likely to have had a significant bicycling accident than children who did not know these rules.

TABLE 3. STUDENTS WHO EVER WENT TO A HOSPITAL OR A PHYSICIAN BECAUSE OF A BICYCLING INJURY, WITH REFERENCE TO THEIR KNOWLEDGE OF BICYCLE RULES

Student's Knowledge of Rules	No. of Students with Accident	Total No. with Indicated Response	Percent of Total
Rule 1			
Correct	28	207	14
Incorrect	4	64	6
Rule 2			
Correct	25	238	11
Incorrect	7	33	21
Rule 3			
Correct	17	193	9*
Incorrect	15	78	19

*P < .05.
 NOTE: Rule 1—A bicyclist should ride on the right side of the street, with traffic.
 Rule 2—A bicyclist should always stop at a stop sign or red light.
 Rule 3—A bicyclist should always stop before entering the street from a driveway or alley.

DISCUSSION

Findings from this study support the premise that educating children about bicycle safety increases their knowledge of the basic bicycling rules of the road and may decrease their risk for having a significant accident. Children who did not know rule 2 or rule 3 were almost twice as likely to have had a significant bicycling accident as students who knew these basic rules. Children who had received safety instruction knew these two rules better than students lacking such instruction.

Violation of rule 3 in particular may account for the finding by Nixon et al.⁷ that one half of severe childhood bicycle accidents occur on straight roads at mid-block during daylight hours. Williams¹² found that bicyclists aged 10 to 14 years were probably responsible for 87% of daylight motor vehicle collisions in which they were involved. Thirty-two percent of these accidents were caused by a "rideout" from a driveway, alley, sidewalk, or lawn into the path of an oncoming vehicle. Williams also found that over 50% of accidents involving bicyclists aged 4 to 9 years were caused by rideouts. In addition, Fife et al.¹³ found that fatally injured bicyclists under the age of 12 years were more likely to have been struck by a motor vehicle on their left side in contrast to older riders, whose bicycles were struck from the rear. Knowledge of rule 3 may therefore not only prevent bicycle-motor vehicle collisions, but also be potentially lifesaving.

Children instructed in bicycle safety and rules of the road by parents or by a bicycle safety class clearly had better knowledge of rule 2 when compared with children who reported that they had not received such instruction. In his analysis of 861 bicycle-motor vehicle collisions, Williams¹² found that 20% of children aged 4 to 9 years and 25% of children aged 10 to 14 years ran through a stop or yield sign. Since this rule is also extremely important to motorists and pedestrians, parents would be expected to impart this information to their children.

It is not immediately evident why rule 1 was not a factor in either the safety education of children or the reduction of significant accidents. Williams¹² determined that only 13% of the accidents in 4- to 14-year-old children were the result of riding the wrong way in traffic. Perhaps the relatively low number of these types of accidents precluded a relationship between the knowledge of this rule and the number of accidents. It is alarming, however, that approximately one fourth of all students in this study sample did not realize that bicyclists should always ride on the right side of the road, with automobile traffic. Many children (and adults) may erroneously transfer the pedestrian rule for traveling on a roadway (left side, facing traffic) to bicycling. This confusion may negate any bicycling instruction to the contrary.

The findings that only a small number of students owned bicycle helmets and an even smaller number used them are consistent with the observations of Weiss and others.^{6,9,10} O'Rourke et al⁹ found that 5 of 30 children who sustained head injuries in bicycle accidents owned helmets but were not wearing them at the time of the accident. Helmets were thought to be too big, unattractive, and "uncool." Younger children were more receptive to the idea of wearing helmets; therefore, this habit should begin at an early age, preferably from the first bicycle ride.

A simplified questionnaire enabled researchers to obtain a high response rate while minimizing interference with classroom time. It was not possible, however, to define the content of the bicycle safety instruction given by either the parents or the bicycle safety classes. Prospective studies should be undertaken to measure the effectiveness of various types of bicycle education programs both in terms of safety knowledge learned and in the reduction of the frequency and severity of bicycle injuries. These studies should include children of different demographic and socioeconomic groups, such as those in urban, rural, and inner-city areas.

Weiss and Duncan¹⁴ found that family physicians and pediatricians are often aware of the importance of bicycle accidents as a cause of childhood mortality and that head trauma causes most bicycle-related deaths. Many physicians also realized that few children use bicycle helmets, which they attributed to parental unawareness of a helmet's importance. Less than 10% of physicians routinely discussed bicycle safety with their patients and parents, however, and 70% seldom discussed it. Currently the American Academy of Pediatrics is working through the Headsmart Coalition to increase the use of bicycle helmets by 20% over the next 3 years.¹⁵ Primary care phy-

sicians should promote the use of bicycle helmets, work with educators or law enforcement officials to encourage the development of bicycle safety programs in their communities, and include information about bicycle safety as part of their routine preventive care.

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