

Sports and Recreation Injuries in US Children and Adolescents

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Objectives: To estimate and describe morbidity from sports and recreation injuries in children and adolescents.

Design: Survey conducted by the National Center for Health Statistics—the Child Health Supplement to the 1988 National Health Interview Survey.

Setting: The general community.

Participants: Representative sample of the noninstitutionalized civilian US population. Five percent of the eligible households did not participate. The subject of this report is 11 840 children and adolescents aged 5 to 17 years.

Main Outcome Measures: Medically attended nonfatal injuries resulting from sports and recreation, and serious sports injuries, defined as injuries resulting in hospitalization, surgical treatment, missed school, or half a day or more in bed. Sports and recreation injuries were defined as those occurring in a place of recreation or

sports, or receiving any of the following *International Classification of Diseases, Ninth Revision (ICD-9)* E-codes: struck in sports, fall in sports, bicycle-related injury, riding an animal, water sports, overexertion, fall from playground equipment or other vehicles, primarily skates and skateboards.

Results: The estimated annual number of all injuries from sports and recreation in US children and adolescents is +379 000 (95% confidence interval=3 147 000 to 5 611 000); from serious sport injuries, 1 363 000 (95% confidence interval=632 000 to 2 095 000). Sports account for 36% of injuries from all causes. Cause and nature of injury are strongly related to age. Sports do not account for a disproportionate number of serious or repeated injuries compared with other causes of injuries.

Conclusion: Sports activities account for a large number and substantial proportion of all injuries to children and youth.

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Editor's Note: This study provides valuable data on the occurrence of sports and other recreation-related injuries in children and adolescents. Too often, what seems to be re-created is pain and suffering instead of the good feeling that is supposed to be associated with sports.

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INJURIES HAVE been identified as a major cause of morbidity and mortality in children, adolescents, and young adults. Children and adolescents engage extensively in organized and informal athletic activities, and participation is increasing,

especially among girls.¹ Considering injury as the result of an adverse energy exchange,² many sports and recreational activities can damage the human body because a high level of mechanical energy is involved.

The participation of sporting associations, coaches, and parents in organized sports activities and the use of potentially modifiable equipment in organized sports and informal recreation offer the promise of countermeasures that could prevent the occurrence or decrease the severity of injuries from these activities. Changes in rules (eg, instituting a penalty for high sticking in ice hockey³), pro-

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SUBJECTS AND METHODS

The data for this study come from the CHS to the 1988 NHIS, an annual survey of the health and health care utilization of the US civilian noninstitutionalized population.⁹ Data are collected through household interviews by the US Bureau of the Census for the National Center for Health Statistics. Interviewers are trained, and their work is checked by periodic observation and reinterview. The 1988 NHIS sample consisted of 47 485 households with 122 310 individuals. Five percent of the targeted households did not participate. One child in each NHIS household with children was selected to be included in the CHS.

Data were obtained on 17 110 children younger than 18 years. Data on the injuries were provided by an adult from each household, usually the mother. This report is restricted to children aged 5 to 17 years at the time of the interview. There were 11 840 children in this age range.

The children were divided into the following three age groups for the analyses: 5 to 9 years, 10 to 13 years, and 14 to 17 years at the time of the interview. These nonstandard age groups were used so that the number of years in each category would be as similar as possible. The cutoff between ages 13 and 14 was chosen because in many regions, it corresponds to entry into high school, which has an effect on the level of sports activities.

INJURY EPISODES

The CHS respondents were asked if the sampled child had experienced an accident, injury, or poisoning that received medical attention in the 12 months before the interview. The respondents were asked to provide details about the circumstances, nature, and treatment of the injuries. The circumstances leading to the injuries were coded using the Supplementary Classification of External Causes of Injury and Poisoning (E-code) to the *International Classification of Diseases, Ninth Revision (ICD-9)*. Injury episodes were excluded if they occurred longer than 12 months before the interview or if they resulted from misadventures or complications of medical care, adverse effects of drugs for therapeutic use, or if they were the late effects of previous injuries (codes E870 to E879, E929, E930 to E949). Injury episodes were classified by activity limitations and treatment resulting from the episode, place of occurrence (ie, school, place of recreation or sports, home [including yard and driveway], street, other location), cause (eg, motor vehicle crash), and nature of injury (eg, fracture, sprain). More than one injury could be specified for each injury episode (eg, a sprain and dislocation from a fall in sports). Serious injury episodes were defined as injury-producing events that resulted in half a day or more in bed or missed from school, one or more nights in the hospital, or in surgical treatment.

Sports and recreational injury episodes were defined as those that occurred in a place of recreation or sports, were coded as having occurred during sports (code E917.0,

struck in sports; E886.0, fall in sports), or were coded as bicycle-related (E813.6, E826.0, E826.1, E826.9), riding an animal (E828.2, E828.9), water sports (E832.9, E838.4, E883.0), overexertion and strenuous movements (E927), fall from playground equipment (E884.0), or while using motorized or nonmotorized recreational vehicles, primarily skates and skateboards, (E821.9, E825.9, E948, E886.9). The *ICD-9* classifies E848 as accidents involving other vehicles, not elsewhere classified. Injury episodes involving skates and skateboards were assigned this code (Ms Patricia B. King, of the NCHS, oral communication, March 12, 1993).

STATISTICS

The annual rates of injuries were calculated by dividing the number of injuries by the number of children and multiplying by 100. Person weights provided by the National Center for Health Statistics were used to adjust the numbers of injuries and rates for the nonequal probability of sample selection, for nonresponse, and to allow calculation of national estimates. The estimates of the number and rate of injuries were further adjusted to account for underestimation of injury events because a 1-year recall period was used in the CHS survey instrument. These are referred to as "recall-adjusted estimates." The adjustment coefficients were derived by calculating the ratios of the annual sports and recreational injury rates (all and serious) estimated from a 1-month recall period to the annual rates estimated from a 12-month period. These coefficients were also calculated for each gender and for the three age groups separately, 5 to 9 years, 10 to 13 years and 14 to 17 years. Details of the rationale and derivation of the adjustment coefficients have been published previously.¹⁰

Rates and numbers of sports injuries resulting in hospitalization, rates of specific nature and causes of injuries, and rates categorized by gender and age simultaneously were not adjusted for recall during a 12-month period because the number of injuries that occurred 1 month before the interview in each of these categorizations was too small to provide stable adjustment coefficients.

Confidence intervals (CIs) around all the estimates were calculated using a computer package (SUDAAN, Research Triangle Institute, Research Triangle Park, NC) designed to allow for the complex sample design. For the recall-adjusted estimates, the CIs were further adjusted to account for the additional source of variability introduced by the adjustment coefficients. The SUDAAN software was also used for significance testing of the rates and proportions not adjusted for recall. The Regress Procedure was used to test differences in rates, and the Crosstabs Procedure was used to test differences in proportions. A significance criterion of .05 was used. χ^2 tests with more than 1 *df* were followed by *z* tests of specific proportions using adjusted standardized residuals,¹¹ or by Mantel-Haenszel χ^2 tests. Significant differences between more than two rates were followed by tests of linear trend or *t* tests. A probability of .01 was used for these post hoc comparisons of specific rates or proportions to adjust for the effect of multiple testing on statistical inference.

protective equipment (eg, prophylactic knee braces⁴) and conditions (eg, field resurfacing and maintenance⁵) have reduced the number and severity of some types of sports and recreational injuries. Reliable and comprehensive data are needed to focus attention on the magnitude of the

problem of sports and recreational injuries and to monitor the effect of countermeasures.

Few sources provide comprehensive data on sports injuries. Most studies have been limited to a single sport, specific anatomic sites, or have had too few subjects to

Table 1. Estimates of Injury Episodes and Serious Injury Episodes From Sports and Recreational Activities

	No. in Thousands	95% Confidence Interval	Rate/100	95% Confidence Interval	Recall- Adjusted* No. in Thousands	95% Confidence Interval	Recall- Adjusted Rate/100	95% Confidence Interval	% of All Episodes
All injuries†									
Total	2902	2641-3160	6.4	5.9-7.0	4379	3147-5611	9.7	7.0-12.4	35.8
Sex									
M	1910	1697-2122	8.3	7.4-9.2	3050	2046-4054	13.1	8.9-17.6	37.5
F	992	845-1136	4.4	3.8-5.1	1308	745-1862	5.9	3.4-8.3	32.9
Age, y									
5-9	720	602-837	4.0	3.4-4.7	1042	546-1538	5.8	3.0-8.6	27.7
10-13	956	797-1114	7.2	6.0-8.4	1469	774-2163	11.0	5.8-16.2	40.2
14-17	1226	1060-1391	8.9	7.7-10.0	1873	1177-2568	13.5	8.5-18.5	39.3
Serious Injuries‡									
Total	978	831-1120	2.2	1.8-2.5	1363	632-2095	3.0	1.4-4.6	32.3
Sex									
M	691	566-813	3.0	2.4-3.5	974	291-1658	4.2	1.3-7.2	35.4
F	287	212-360	1.3	1.0-1.6	388	146-631	1.8	0.7-2.9	26.6
Age, y									
5-9	223	158-285	1.2	0.9-1.6	296	56-537	1.7	0.3-3.0	22.8
10-13	343	260-425	2.6	2.0-3.2	424	79-769	3.2	0.6-5.8	40.6
14-17	412	312-510	3.0	2.3-3.7	648	151-1146	4.7	1.1-8.3	34.1

* Recall-adjusted estimates based on National Center for Health Statistics person weights and adjustment for loss to recall during 12 months.

† Estimates based on following observed number of injuries: boys, 512; girls, 272; 5 to 9 y, 178; 10 to 13 y, 234; 14 to 17 y, 372.

‡ Estimates based on following observed number of injuries: boys, 183; girls, 76; 5 to 9 y, 57; 10 to 13 y, 85; 14 to 17 y, 117.

provide reliable and generalizable data on incidence. In a review of 25 years of literature, Kraus and Conroy⁶ estimated that 3 to 5 million injuries occur per year from sports and recreational activity in the total adult and child US population. The authors point out the difficulty of estimating the morbidity associated with sports injuries because the data sources are unrepresentative.

One source of national data is the National Electronic Injury Surveillance System, conducted by the Consumer Product Safety Commission.⁷ The National Safety Council has used these data to estimate that 1.5 million injuries occurred to participants in basketball, football, gymnastics, soccer, volleyball, and wrestling in 1991.⁸ These data reflect only emergency department visits for injuries that involve the use of products. Injuries treated in clinics and by private physicians, and injuries that do not involve product usage, are not recorded. The data also do not provide a means of estimating incidence rates, because no data are available on the population at risk.

The Child Health Supplement (CHS) to the 1988 National Health Interview Survey (NHIS) offers a unique opportunity to estimate population rates and numbers of injuries associated with sports. These data reflect the occurrence and circumstances of medically attended injuries in a large, representative sample of US children and adolescents for 1 year. This study also assesses whether sports and recreational activities result in more serious injuries than other causes of injury, and whether these activities are responsible for a disproportionate number of repeated injuries because the exposures are repetitive.

RESULTS

Injury episodes from sports and recreational activities represented 35.8% of all the injury episodes reported in the

1988 CHS (Table 1). As given in Table 1, more than 2.9 million sports and recreational injuries occur annually in 5- to 17-year-olds in the United States, estimated from a 12-month recall period. Adjustment for recall loss during a 12-month period resulted in a 51% increase in the estimated number of injuries, to more than 4.3 million. The recall-adjusted annual rate was 9.7 per 100 children and adolescents. As given in Table 1, 978 000 serious sports and recreational injuries occur annually in 5- to 17-year-olds in the United States, estimated from data with a 12-month recall period. This estimate increased to more than 1.3 million after adjustment for recall loss, a 39% increase. Sports and recreational injuries account for 32.3% of all the serious injury episodes experienced, a slightly smaller proportion than for all injuries. Sports and recreational activities resulted in an estimated 80 750 hospitalizations (95% CI=41 500 to 120 000), or 27.7% of all injury-related hospitalizations (data not shown in Table 1).

GENDER AND AGE DISTRIBUTION

The number and rates of all sports and recreational injury episodes were more frequent in boys than girls, and increased with age, as given in Table 1. The overall male-female ratio of injuries was 1.8:1 (95% CI=1.5 to 2.2). Serious sports and recreational injury episodes follow a similar pattern, with a male predominance and an increased incidence with age.

Sports and recreational activities accounted for a significantly smaller proportion of the youngest children's injury episodes than they did of the older children's injuries ($\chi^2=28.1$, $P<.001$). Sports and recreational activities accounted for significantly more of all the serious injury episodes in the 10- to 13-year-olds than in the other age groups ($\chi^2=16.9$, $P<.001$). Sports and recreational

injuries accounted for significantly more of the boys' injuries from all causes than of the girls' injuries from all causes ($\chi^2=5.62$, $P=.02$; serious injuries, $\chi^2=7.60$, $P=.006$)

When examined by individual year of age and gender simultaneously as shown in **Figure 1**, the unadjusted rates of all sports and recreational injury episodes of the boys were fairly constant until age 11 years, rose steeply to a peak at age 15 years, and then declined. The rates for girls showed a similar decline after age 15 years. The rates for boys were higher than the rates for girls at all ages except ages 10 and 11 years. The gap between the male and female rates was greatest after age 12 years. The male-female ratio of injuries in the 14- to 17-year age group was 2.4:1 (95% CI=1.8 to 3.2). A similar pattern was observed for the serious injuries (data not shown).

MULTIPLE INJURIES RESULTING FROM INJURY EPISODES

Injury episodes that resulted in more than one injury (eg, fracture and laceration from a single bicycle or vehicle crash), are given as follows:

Characteristic	Episodes Resulting in Multiple Injuries, %
Total	13.8
Sex	
M	16.0
F	9.6
Age, y	
5-9	12.5
10-13	18.4
14-17	11.0
Cause	
Riding animals	26.2
Bicycling	23.7
Skates/skateboards	16.9
Fall/struck in sports	12.8
Water sports	8.1
Overexertion	5.6
Playground equipment	2.8

Boys were more likely to have multiple injuries than girls ($\chi^2=6.6$, $P=.01$), and children aged 10 to 13 years were more likely to have multiple injuries than older and younger children ($\chi^2=7.1$, $P=.03$).

The proportion of injury episodes resulting in multiple injuries varied substantially with cause of the episode ($\chi^2=40.1$, $P<.001$). The highest proportion of multiple injuries resulted from riding animals and bicycling. Water sports, falls from playground equipment, and overexertion and strenuous movements resulted in the lowest proportion of multiple injuries.

Episodes resulting in multiple injuries were more often classified as serious (resulting in lost days from school, days spend in bed, hospitalization, or surgery) than episodes resulting in single injuries. Forty-two percent of episodes with multiple injuries were classified as serious vs 32.4% of episodes that resulted in single injuries. This association tended toward statistical significance ($\chi^2=3.5$, $P<.07$) (data not shown).

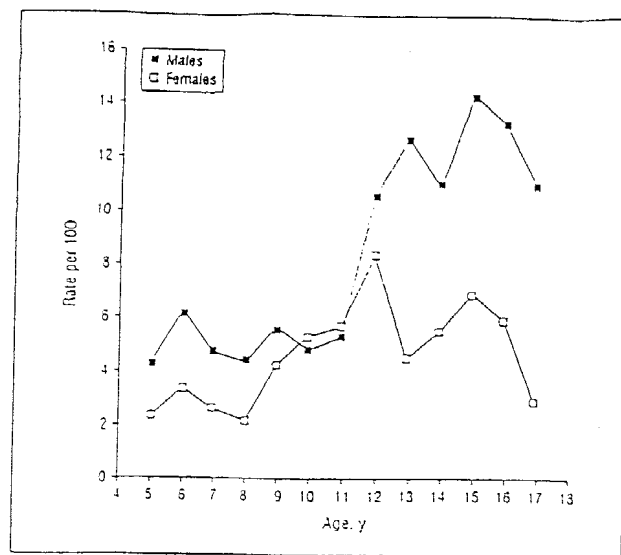


Figure 1. Rates of sports and recreational injuries by age and gender.

REPEATED INJURY EPISODES

Two or more episodes of sports and recreational injuries were reported for only 0.6% of the children in the 12-month period, and 2.4% of the sample had two or more injury episodes from all causes. Thus, one fourth (0.6/2.4) of the children with repeated episodes of injury in a 1-year period had repeated episodes associated with sports and recreational activities. Boys were not significantly more likely to have repeated injury episodes from sports and recreation than girls ($\chi^2=2.3$, $P=.13$). The percentage of children with repeated injury episodes from sports and recreation increased significantly with age (Mantel-Haenszel $\chi^2=16.5$, $P<.001$) (data not shown).

NATURE OF INJURY

The most common sports and recreational injury was sprain, followed by fracture or dislocation, and laceration as given in **Table 2**. Sports and recreational activities accounted for 59.4% of sprains from all causes, 48% of the fractures and dislocations, and 25.5% of the lacerations. There were significantly more fractures and dislocations and sprains than would be expected from the overall proportion of all injury episodes related to sports and recreation (35.8%) (fractures and dislocations, $z=5.8$, $P<.001$); (sprains, $z=10.8$, $P<.001$) and significantly fewer lacerations and other injuries (lacerations $z=-7.0$, $P<.001$; other injuries, $z=-9.0$, $P<.001$).

The distribution of nature of injury was similar in boys and girls. In contrast, the nature of injury varied with age ($\chi^2=123.1$, $P<.001$) as shown in **Figure 2**. Almost half of the injuries of the 5- to 9-year-olds were lacerations, and this proportion declined markedly with age (M-H $\chi^2=67.5$, $P<.001$). The proportion of all the sports and recreational injuries that were sprains, in contrast, increased linearly with age (Mantel-Haenszel $\chi^2=75.9$, $P<.001$) The percentage of injuries that were fractures or dislocations was similar in all three age groups.

Table 2. Distribution of Injuries* Resulting From Sports and Recreation

	Estimated No. In Thousands	Estimated Rate/100	Injuries From All Causes Related to Sports and Recreation, %†
Sprain	852	1.9	59.4
Fractures and dislocations	766	1.7	48.0
Laceration	665	1.4	25.5
Contusion	267	0.6	42.0
Other injuries	212	0.5	15.6
Head injuries	140	0.3	29.5
Total	2902	6.4	35.8

*For injury episodes resulting in multiple injuries, the episode is counted only once, using the following hierarchy: fracture, head injury, laceration, contusion, sprain, or other.

†Percentage equals the number of injuries from sports and recreational activities times 100 divided by total number of injuries.

CAUSE OF INJURY

The most frequent cause of injury was overexertion and strenuous movements, followed by bicycles and being struck by a person or object (eg, bat, ball, or other player) for boys, and by unspecified causes in recreational areas and bicycles for girls. The overall distribution of causes of injury varied significantly by sex ($\chi^2=14.1$, $P<.05$). None of the tests of specific causes, however, met the significance criterion of .01.

Cause of injury was strongly associated with age of the child (Mantel-Haenszel $\chi^2=179.1$, $P<.001$) (Figure 3). Forty percent of the injury episodes in children aged 5 to 9 years were associated with bicycles, but this proportion declined to 24% for children aged 10 to 13 years and 10% for adolescents aged 14 to 17 years (Mantel-Haenszel $\chi^2=66.4$, $P<.001$). The age distribution of injuries classified as struck or fall in sports increased with age (Mantel-Haenszel $\chi^2=43.5$, $P<.001$), as did overexertion and strenuous movements (Mantel-Haenszel $\chi^2=56.4$, $P<.001$), but playground injuries decreased with age (Mantel-Haenszel $\chi^2=34.7$, $P<.001$).

The distribution of nature of injury varied by cause of injury as given in Table 3. Many of the injuries associated with skates and skateboards and falls from playground equipment were fractures or dislocations, but less than one fifth of the injuries associated with overexertion or strenuous movements and bicycles were fractures or dislocations. The most frequent injuries resulting from episodes involving bicycles were lacerations. Almost 50% of all head injuries occurring to children and adolescents during sports and recreational activities result from bicycle riding, skates, and skateboards.

The distribution of the place the injury occurred varied with the cause of the injury as given in Table 3. Almost 30% of the sports and recreational injuries occurred at school, and most school injuries were associated with overexertion or strenuous movements and falling or being struck in sports. It is not surprising that half of the bicycle-related injuries occurred in the street; however, one fourth were reported as occurring at home,

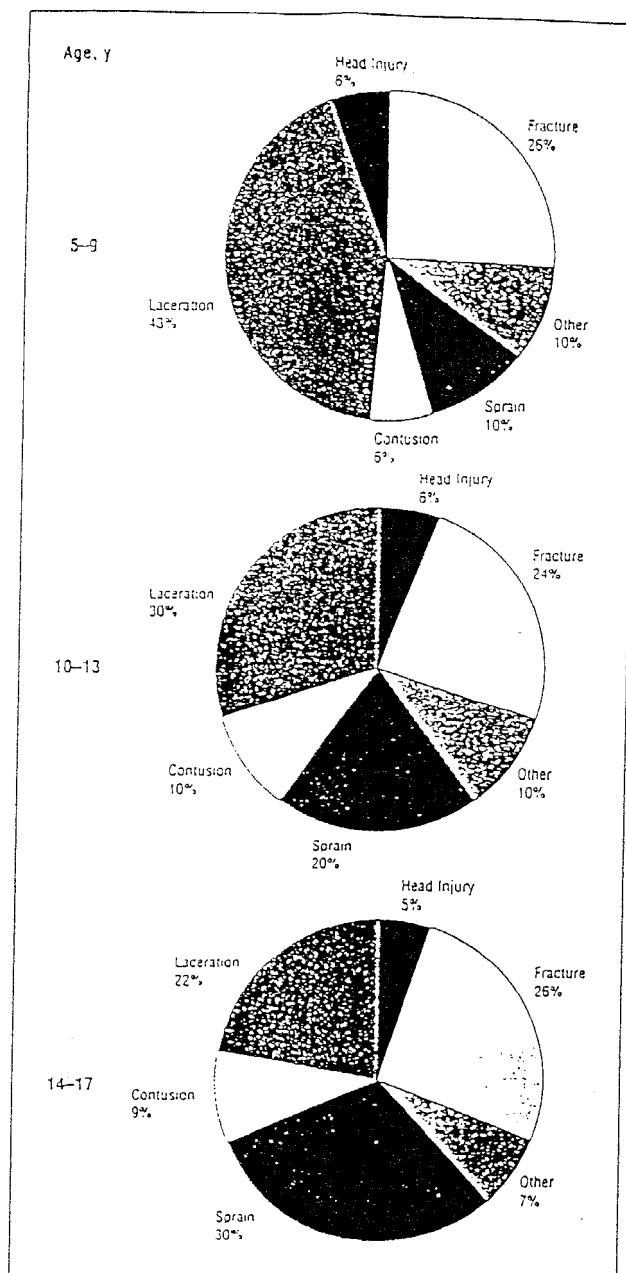


Figure 2. Distribution of nature of sports and recreational injuries by age.

which includes driveways and yards. Similarly, many injuries associated with skates and skateboards occurred at home (38.6%), and only one fifth of them occurred in the street. Three fourths of the falls from playground equipment occurred at school and places of recreation, with the remainder occurring at home.

COMMENT

To our knowledge, these data provide the most comprehensive picture of the morbidity associated with sports and recreational activities in US children and adolescents. The best estimate of the annual incidence of sports and recreational injuries, considering the memory loss that can be expected during a 1-year period of recall, is

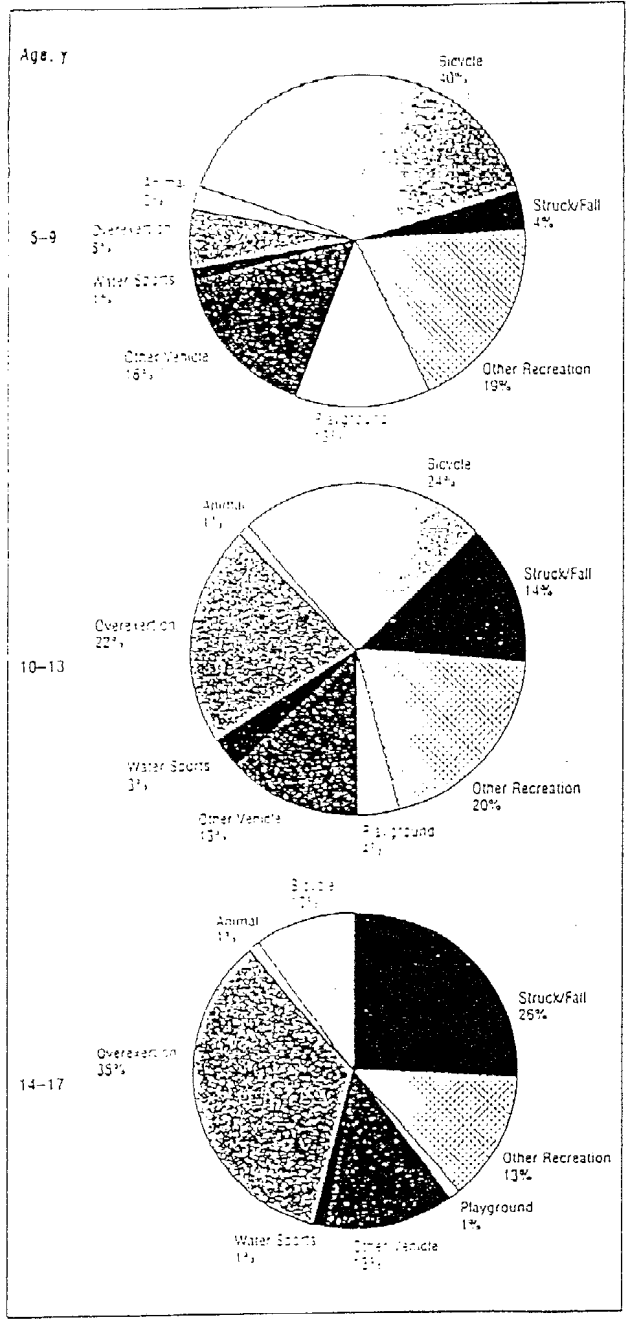


Figure 3. Distribution of cause of sports and recreational injuries by age.

approximately 4.4 million injuries to children aged 5 to 17 years, with a 95% CI of 3.1 to 5.6 million. This number represents an annual injury rate from sports and recreational activities of close to 10 injury episodes per 100 children and youth.

Several features of these data contribute to the imprecision of the morbidity estimates. First, we addressed the well-recognized underestimate of acute events that results from memory decay during a 1-year period by applying an adjustment factor, so we can only approximate the rates that would have been derived from using a shorter interval. Adjustment to a 1-month recall period may have resulted in a small overestimate of the numbers of injuries, because respondents sometimes say

events occurred more recently than they actually did. Some of the estimates were not adjusted because insufficient numbers of specific types of injuries (eg, fractures) were available to calculate reliable adjustment coefficients. The most likely consequence of this is underestimation of the rates and numbers of these injuries and disproportionate inclusion of more serious injuries.

A second limitation is that the estimates are based on parental report of injuries for which medical care was sought, rather than on records of care received. Thus the data probably underestimate injuries treated solely at school and reflect biases associated with differential access to and utilization of medical care.¹² Parents with several children might erroneously report injuries occurring to siblings of the index child, thus inflating the estimates. To quantify the effect of these biases, a methodologic study needs to be conducted to compare parental report with a review of medical records. However, in an earlier study, we conducted such a comparison for parental reports of head injuries resulting in hospitalization, and we found that the medical records could not be used as the "gold standard," because about one fourth of all the records could not be found or were illegible.¹³

A third limitation is that because the coding of the data did not allow definite identification of the activity the child or adolescent was engaged in when the injury occurred, some of the injuries may not have been caused by sports and recreation. For example, it was assumed that most injuries in this age group caused by overexertion and strenuous movements were caused by sports or recreational activities. Another explanation is that some of these injuries, especially for adolescents, were related to employment. Similarly, bicycle riding is a multipurpose activity. Some children and adolescents ride bicycles for recreation, and others ride bicycles for transportation. Therefore, some of the bicycle injuries might be more accurately classified as related to transportation. The imprecision of the data collected and coding also may have resulted in undercounting injuries that occurred during sports or recreational activities.

Although it would be interesting to separate injuries that occur in organized sports from other types of recreational athletic activities, the level of data elicited and the coding did not allow for this important distinction. This is a problem, not only for this study, but also for studies that use ICD-9 E-codes. These codes do not contain a standard definition of sports activities or a means of coding injuries as sports-related, other than falls and struck in sports. The injury prevention community has advocated the use of E-codes, but in its present form, this coding scheme cannot provide consistent data about sports or recreational injuries.

Despite these limitations, these data estimate the magnitude of injury morbidity associated with sports and recreational activities in US children and adolescents. The only other comprehensive, population-based study in the United States to which these estimates can be compared is the surveillance of a sample of injuries treated in emergency departments, resulting in admission to hospital or death in Massachusetts during a 1-year period.¹⁴ If their

Table 3. Distribution of Cause of Injury by Nature* and Place of Injury

Variable	Cause of Injury						Total†
	Fall/Struck in Sports	Bicycle	Overexertion	Skates/Skateboards	Playground Equipment	Other	
Nature of Injury, Row (Column) %							
Fracture/dislocation	34.0 (21.3)	17.8 (14.7)	18.3 (16.2)	44.4 (23.3)	42.3 (8.0)	22.5 (16.4)	26.4
Head injury	5.3 (18.1)	8.5 (38.6)	1.2 (5.8)	3.4 (9.8)	6.9 (7.1)	5.2 (20.5)	4.8
Laceration	4.2 (3.0)	54.2 (51.9)	0.8 (0.9)	23.1 (14.0)	13.1 (2.9)	32.5 (27.3)	22.9
Contusion	15.6 (28.1)	7.4 (17.7)	7.0 (17.7)	10.4 (15.7)	13.3 (7.3)	6.5 (13.5)	9.2
Sprain	33.1 (18.6)	5.5 (4.1)	67.6 (53.9)	13.9 (6.6)	18.0 (3.1)	21.0 (13.8)	29.4
Other injury	7.8 (17.8)	6.5 (19.6)	5.2 (16.5)	4.8 (9.2)	6.4 (4.4)	12.3 (32.5)	7.3
Total	100.0 (17.3)	100.0 (20.9)	100.0 (24.4)	100.0 (13.8)	100.0 (4.7)	100.0 (18.9)	100.0
Place of Injury, Row (Column) %							
Home	6.8 (6.7)	25.3 (32.7)	12.9 (17.8)	38.6 (31.6)	25.3 (7.5)	3.4 (3.8)	17.0
School	52.7 (31.6)	2.7 (2.2)	64.9 (55.1)	7.4 (3.7)	38.7 (7.0)	0.6 (0.4)	27.6
Street	0.2 (0.2)	51.3 (77.4)	0.0 (0.0)	20.5 (19.5)	0.0 (0.0)	2.2 (2.9)	14.5
Recreation	35.0 (17.3)	4.7 (3.1)	16.1 (11.3)	22.6 (9.3)	36.1 (5.4)	93.6 (53.6)	33.6
Other location	5.3 (11.8)	15.9 (47.4)	6.1 (19.4)	10.9 (20.6)	0.0 (0.0)	0.4 (0.9)	7.4
Total	100.0 (17.3)	100.0 (20.9)	100.0 (24.4)	100.0 (13.8)	100.0 (4.7)	100.0 (18.9)	100.0

*For injury episodes with multiple outcomes, the episode is counted only once, using the following hierarchy of nature of injury: fracture, head injury, laceration, contusion, sprain, or other.

†Column percentages are all 100.0.

categories of sports, pedal cycle, overexertion, and drownings are combined to produce comparable definitions of sports and recreational injuries, the rates are 5.3 per 100 for ages 6 to 12 years and 9.2 per 100 for ages 13 to 19 years. The authors estimated that their rates were about half the true population rates because they exclude injuries treated outside the hospital (eg, private physicians' offices, free-standing clinics, and schools). In comparison, the recall-adjusted rates estimated from the nationally representative CHS sample were: 5.8 per 100 for ages 5 to 9, 11 per 100 for ages 10 to 13 and 13.5 per 100 for ages 14 to 17 years. These rates are higher than the estimates from Massachusetts, but not as high as predicted considering the greater coverage of sources of treatment in the CHS sample. Differences in definition, methods of gathering data, and secular change during a 9-year period make it difficult to compare these rates with precision. The CHS-derived incidence rates are consistent with the Massachusetts rates, and both suggest that much of childhood and adolescent morbidity is associated with sports and recreational activities.

The higher incidence of sports and recreational injuries in boys than girls is consistent with the male-female distribution of injuries from all causes.¹⁵ Sports and recreational activities account for approximately 5% more of the total injuries for boys than injuries for girls. This difference is statistically significant, but it is not large enough for sports and recreational activities to be important contributors to the overall excess of male injuries.

The clinical sports injury literature emphasizes severe and catastrophic injuries.^{16,17} This raises the question of whether these activities confer a greater risk of severe injury than other activities of children and adolescents. In our sample, injuries associated with sports and recreational activities accounted for 35% of injuries from all causes, 32% of serious injuries, and 28% of hospitalizations for injuries from all causes. Thus, no evi-

dence exists that injuries from sports and recreational activities are any more severe than injuries from all other causes. Even a sample size of almost 12 000 is, however, too small to estimate truly catastrophic injuries. Therefore, it is possible that sports and recreation account for a disproportionate number of severe injuries.

Sports and recreational activities account for varying proportions of specific types of injuries. They account for almost half of the fractures and dislocations, which are likely to be severe. They account for almost 60% of the sprains, which are less likely to be severe. Sports and recreational activities account for only 29% of the head injuries in the CHS sample.

The issue of repeated injuries has received attention in the sports injury literature, with one research effort on recurrence of the same or similar injuries (eg, repeated subluxations and dislocations¹⁸), and a second focus on the "injury-prone" athlete.¹⁹ In this sample, 0.6% of the children experienced more than one injury that required medical attention in the preceding year from sports and recreation activity, and only 2.4% of the sample had more than one injury episode in the year from all causes. Thus, 25% of the children with more than one injury episode in the year had repeated sports or recreational injuries. If sports and recreational activities accounted for a disproportionate number of repeated injury episodes, a larger proportion than 25% would be expected, because 36% of all injuries were related to sports and recreational activities. Many sports injuries are recurrent, notably injuries associated with joint instability, such as repeated shoulder dislocations, and ankle sprains. Because no instructions were given to respondents about how to report reinjury of the same or related body sites, the number and rate of repeated injuries may be underestimated.

Almost 30% of the sports and recreational injury episodes in this study occurred at school, which suggests

that schools may be good places for intervention. This is because a higher degree of control and adult involvement exists in school athletics than in other environments in which injuries occur. The large proportion of home injuries that were associated with bicycles, skates, and skateboards, and the finding that almost half of the head injuries were caused by this equipment underscore the importance of helmet use even in the absence of traffic.

This study describes the magnitude and the distribution of a major source of morbidity for US children and adolescents, injuries from sports and recreational activities. A prerequisite for the development of a prevention strategy is the description of the magnitude and features of a public health problem. The linear increase in the number and rate of sports and recreational injuries with age in the Massachusetts and US studies, and the finding that almost 40% of all injuries experienced by US children and adolescents aged 10 to 17 years are associated with sports and recreation, underscores the importance of sports and recreational activities as a cause of morbidity, especially for older children. Much of the focus of injury prevention has been on children younger than 5 years. This emphasis may have grown from a belief that injuries to young children are more preventable than those to older children because adults supervise young children and because many of the injuries are product-related (eg, toys with small parts, packaging of medicine and toxic substances, flammable sleepwear). The recognition that a major cause of injury morbidity in older children, sports and recreational activities, combine these same two factors— involvement of adults (eg, coaches, teachers) and products (eg, bicycles, bats, balls, protective equipment)— should add weight to the growing attention to injury prevention in older children and adolescents.^{20,21} Specific injury prevention strategies require studies of injuries that occur in the context of specific activities, which a study of this breadth cannot provide. However, our study provides a context in which more focused studies can be interpreted, and a motivation to reduce the number and severity of sports and recreational injuries.

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