

[Primary Care Sports Medicine]

The Epidemiology of Pediatric Basketball Injuries Presenting to US Emergency Departments: 2000-2006

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Background: There is limited published research on the epidemiology of basketball injuries treated in US emergency departments (EDs).

Hypothesis: Age and sex patterns exist for the most common pediatric basketball injuries treated in EDs.

Study Design: Descriptive epidemiology study.

Methods: Data from the National Electronic Injury Surveillance System and the National Sporting Goods Association were used to calculate national injury incidence rates and 95% confidence intervals of pediatric basketball injuries.

Results: An estimated 325 465 annual visits were made to US EDs for pediatric basketball-related injuries from 2000 to 2006. The 5 most common injuries were ankle sprains (21.7%), finger sprains (8.0%), finger fractures (7.8%), knee sprains (3.9%), and facial lacerations (3.9%). Among persons aged 12 to 17 years, girls had a higher rate of knee sprains than boys ($P < 0.001$), but this association did not exist among those aged 7 to 11 years ($P = 0.27$). Boys had a higher rate of facial lacerations than girls ($P < 0.01$). Among persons aged 12 to 17 years, girls had a higher rate of finger sprains ($P < 0.01$). For both boys and girls, the rate of the 5 most common basketball injuries was higher among those aged 12 to 17 years compared with those aged 7 to 11 years ($P < 0.01$).

Conclusions: The annual number of basketball-related pediatric ED visits approaches a third of a million and demonstrates the extent of the public health problem that injuries in this sport pose. Distinct sex and age patterns were observed.

Clinical Relevance: The study findings provide important information on basketball injury rates that may be used for targeting prevention interventions by sex and age group.

Keywords: epidemiology; athletic injuries; emergency department; sprains; finger injuries

Regular team sports participation has well-documented health benefits by improving physical fitness, socialization, and other health-related behaviors.¹⁸

However, as with any sport, basketball participation carries the risk of injury. Basketball is one of the most popular sports in the United States, with approximately 1 in 13 Americans participating at least once a year.¹⁶

Sports injuries account for 4.3 million hospital emergency department (ED) visits annually in the United States.⁶ Basketball is the most common sports activity that leads to ED visits for males and the second-most common for females after bicycling.⁶

Several studies have described the epidemiology of basketball injuries in organized sports at the high school,^{5,12,17} collegiate,^{1,9} and professional levels.²³ However, studies have not described the most common ED injuries in pediatric basketball players. Such data may provide invaluable insight into injury patterns in the general pediatric population.

The initial step in van Mechelen's "sequence of sports injury prevention" is the accurate identification and description of the epidemiology of sports injuries, followed by the etiology and mechanisms responsible for sports injuries, and finally injury prevention.²⁶ The objective of the current study was to use ED

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DOI: 10.1177/1941738111409861

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data to describe sex and age patterns of the most common pediatric basketball injuries. We hypothesized that significant sex and age patterns would be observed among those injuries as they have been described in epidemiologic studies in organized sports.²¹

MATERIALS AND METHODS

Data were obtained from the National Electronic Injury Surveillance System (NEISS), which is maintained by the US Consumer Product Safety Commission. The NEISS receives data on all injuries presenting to EDs at a network of 100 hospitals. At NEISS hospitals (a stratified probability sample of all US hospitals with at least 6 beds and a 24-hour ED), trained coders review all ED records daily and enter demographic, injury, and treatment information into the NEISS database. Each case is assigned 1 or 2 commission-specific product codes, which designate what products or activities were involved with the injury. Each case is also assigned a statistical weight to account for the nonparticipating hospitals and to allow the calculation of national-level injury estimates.²⁵ Data from the NEISS has been shown to be both accurate and reliable for the description of nonfatal injuries in the United States.^{7,22,24}

Information was obtained on all basketball-related injuries sustained by persons aged 7 to 17 years presenting to EDs at NEISS hospitals from January 1, 2000, through December 31, 2006. The data encompass all basketball-related injuries presenting in EDs regardless of whether they were the result of organized or recreational basketball activities. The data set included information on sex, age, diagnosis, and disposition. The Institutional Review Board of the primary author's institution approved this project.

STATISTICAL ANALYSIS

Each recorded NEISS case has an associated statistical weight based on the inverse probability of being selected, which allows for calculation of national injury estimates.²⁵ Frequency distributions were calculated for sex, age, and disposition for the most common basketball-related injuries.

Sex (boy vs girl) and age group patterns (7 to 11 years old vs 12 to 17 years old) were evaluated with the use of Pearson chi-square tests and 95% confidence intervals (CIs). Injury rates were reported as annual number of injuries per 100 000 exposures (athlete days) calculated through the use of statistical weights. The age categories were chosen to coincide with the available exposure data. Exposure (denominator) data from the National Sporting Goods Association 2005 Sports Participation Study¹⁶ were used. The program has a panel of 300 000 households balanced on a number of characteristics, including household size, composition, income, age of household head, and location. A stratified sample of 10 000 households across the United States was chosen to measure sports participation in 2005 in all members of the household who were at least 7 years old. In an effort to return a sample representative of the US population, households selected are

balanced with oversampling of lower "return rate" segments. The survey measures the total number of participants in each sport and the frequency of participation (number of days) for each sex and age group category, thus allowing the calculation of the total number of athlete days within each category, as in recent studies.^{4,14,27} The statistical weights for each NEISS case were then divided by participation data and annualized by dividing by the numbers of years ($n = 7$). This method accounts for sampling error in the NEISS data but not the participation data. The National Sporting Goods Association reports that the sampling error for sports participation in its 2005 series was less than 1%¹⁶; however, raw data were not available to the investigators for statistical use of error estimates. All statistical calculations were performed using SPSS Complex Samples 13.0. Statistical significance for all tests was defined a priori as $P < 0.05$.

RESULTS

The average annual number of 7- to 17-year-old patients who presented in US EDs from 2000 to 2006 for basketball-related injuries was 9790 (actual number of injuries presenting in the sample of 100 NEISS hospitals). This corresponds to an annual national estimate of 325 465 visits. The 7- to 11-year-old category accounted for 18.9% of injuries (61 400 injuries per year) and the 12- to 17-year-old category, for 81.1% (263 984 injuries per year). Boys accounted for 67.7% of all injuries (41 587 injuries per year) in the 7- to 11-year-old category and for 72.3% of all injuries (190 954 injuries per year) in the 12- to 17-year-old category; girls accounted for the remaining 33.3% (19 813 injuries per year) and 27.7% (73 030 injuries per year), respectively. The majority of patients (98.8%, or 321 559 injuries per year) were treated and released, while only 0.8% (2604 injuries per year) were admitted, transferred to another facility, or held for observation. The remaining patients (0.4%) left without being treated, or their disposition was not reported. Overall, boys had a higher injury rate than girls (boys: 151 injuries per 100 000 athlete days, 95% CI = 131-171; girls: 124 injuries per 100 000 athlete days, 95% CI = 108-139; $P < 0.01$).

The 5 most common diagnoses were ankle sprains, which accounted for 70 511 injuries per year (21.7%); finger sprains, 26 164 injuries per year (8.0%); finger fractures, 25 287 injuries per year (7.8%); knee sprains, 12 660 injuries per year (3.9%); and facial lacerations, 12 580 injuries per year (3.9%). These 5 diagnoses accounted for 147 202 injuries per year (45.2%) of the total visits, while none of the remaining 262 diagnoses accounted for more than 3%. Therefore, the remainder of the analysis on sex and age patterns focused on these 5 most common diagnoses. The rate of each 1 of the 5 most common injuries increased in the 12- to 17-year-old category compared with the 7- to 11-year-old category ($P < 0.01$) for both boys and girls. Girls had a higher rate of knee and finger sprains, and boys had a higher rate of ankle sprains among basketball players aged 12 to 17 years, while the rate of facial lacerations was higher among boys in both age groups (Table 1).

Table 1. Rate of basketball injuries treated in emergency departments in the United States, 2000 to 2006.^a

Injury	7- to 11-Year-Olds		12- to 17-Year-Olds	
	Boys	Girls	Boys	Girls
Ankle sprains	3.4 (2.9-3.9)	3.8 (3.2-4.3)	26.5 (23.2-29.7)	23.2 (20.3-26.0) ^b
Finger sprains	5.2 (4.2-6.2)	5.4 (4.4-6.3)	6.5 (5.5-7.5)	7.9 (6.6-9.2) ^c
Finger fractures	4.2 (3.4-5.0)	4.2 (3.3-5.1)	7.3 (6.0-8.6)	7.3 (5.9-8.7)
Knee sprains	0.9 (0.7-1.1)	0.7 (0.6-0.9)	3.9 (3.3-4.5)	5.6 (4.7-6.4) ^c
Facial lacerations	1.5 (1.2-1.8)	0.4 (0.2-0.5) ^d	5.5 (4.7-6.3)	1.6 (1.2-1.9) ^d

^aNo. of injuries per 100 000 athlete days (95% confidence interval).

^bHigher in boys ($P < 0.01$).

^cHigher in girls ($P < 0.01$).

^dHigher in boys ($P < 0.01$).

In addition, the NEISS database has 2 codes that can be used to describe concussions, *head concussion* and *head internal injury*, which accounted for 5962 injuries per year (1.8%) and 3798 injuries per year (1.2%), respectively. Eye injuries accounted for 2613 injuries per year, or 0.8% of total injuries. The low number of these injuries precludes further investigation of sex and age patterns.

DISCUSSION

The average annual number of ED visits in 7 to 17 year old basketball players approaches a third of a million, with nearly half of them categorized as 1 of the 5 most common diagnoses: ankle sprains, finger sprains, finger fractures, knee sprains, and facial lacerations. These findings identify pediatric basketball injuries as a significant public health problem and emphasize that great efforts need to be directed toward their prevention. Ankle sprain was the most common injury treated in EDs, which is consistent with the findings of other injury epidemiology studies, where ankle sprain represented 14% to 27% of all injuries.^{1,8,9} As expected, the National Collegiate Athletic Association studies^{1,9} report much higher injury rates due to the higher level of competition and to inclusion of all injuries rather than only those treated in EDs. The association's data show that the ankle sprain injury rate for practices is 4 times higher than the injury rate in the current study for the 12- to 17-year-old group.^{1,9}

Furthermore, distinct sex and age epidemiologic patterns were identified. The study findings show that teenage female basketball players have a higher rate of knee sprains than male players, as has been reported in organized reports.^{1,5,9,12,17} However, this sex difference is not observed in young, prepubertal athletes. Additional sex patterns were identified, with male players having a higher rate of facial lacerations. The higher rate of ankle sprain among boys and the higher rate of finger sprains among girls in the 12- to 17-year-old category

need to be interpreted cautiously; that is, although statistical significance was achieved for each rate, it was accompanied by largely overlapping 95% CIs.

The present findings indicate that the previously reported higher rate of knee sprains among girls in organized high school basketball^{3,13,19} is also observed in the general population of basketball players. However, the sex difference is not present among athletes aged 7 to 11 years; it appears in the 12- to 17-year-old category. The absence of a sex disparity in the 7- to 11-year-old age group has been postulated but not demonstrated previously.¹¹ The literature provides 2 possible explanations for the emergence of the sex difference in the high school age group observed in this study. A longitudinal biomechanical study provided evidence that although both boys and girls undergo a growth spurt during puberty, boys undergo a neuromuscular spurt (increased vertical jump height and better ability to attenuate forces) that may be protective against knee sprains, while female athletes do not exhibit similar neuromuscular adaptations.²⁰ Another study² reported that girls after menarche exhibit a higher quadriceps:hamstrings strength ratio (2.06), which may result in increases in the anterior shear forces on the tibia and place higher stress on the anterior cruciate ligament; in contrast, prepubertal boys (1.58), postpubertal boys (1.48), and prepubertal girls (1.74) have lower ratios. The present study provides indirect epidemiologic support for these theories because the sex disparity coincides with the approximate ages when puberty begins.

Although sex patterns for basketball-related knee sprains have been extensively described in the literature, there is a lack of data on other types of basketball injuries. Our data demonstrated that across both age categories, boys had a 4-times-higher rate of facial lacerations than girls. Previous data from organized basketball showed that male players have a higher rate of facial injuries than female players.^{15,19} The etiology of this difference is unclear. Facial lacerations

are commonly the result of an elbow or hand hitting the opponent's face during rebounding or defending. The higher proportion of these injuries among male players may be due to higher physicality and more contact.

Increasing age had a similar effect on male and female basketball players; the rate of all injuries increased with age, with a more pronounced increase for ankle sprains, knee sprains, and facial lacerations, which had a 4- to 6-fold-higher rate in the 12- to 17-year-old category. Increased physicality and speed that come with puberty and years of training may account for the higher rate of basketball injuries.

Eye injuries in basketball have received recent attention; however, the present study found that they represent only 0.8% of total injuries—a finding consistent with the low proportion reported in professional basketball.⁸ Although eye injuries are rare, the use of protective eyewear has been recommended at high-level competition.²⁸ Concussions have also received recent attention in respect to their potentially devastating effects and to sex disparity. Although sex effects were not evaluated in this study because of the low number of injuries, concussions represent about 3% of total injuries, which is consistent with the proportion of concussions in college-level male and female basketball practices and male basketball games but only half the rate of female basketball games.^{1,9}

Ellison¹⁰ reported on basketball injuries in Canadian EDs. Despite a larger range of ages (5 to 19 years), the most common diagnoses were consistent with the present study, with ankle, finger, knee, and face injuries being the most frequent ED visits. Ankle and knee sprains had similar proportions in both studies; however, finger injuries had a higher proportion in the Canadian study (15% to 22% for finger sprains and 10% to 18% for finger fractures).

LIMITATIONS

A limitation inherent to sports epidemiologic studies is the inconsistent nomenclature for injuries that makes direct comparisons among the findings of different studies difficult. For example, the present study reported knee sprains; therefore, direct comparisons with the findings of other epidemiologic studies that focused solely on anterior cruciate ligament injuries could not be made. The diagnosis of knee sprain may include a number of pathologies, such as ligamentous or meniscal injuries. Because many athletic injuries are not treated in EDs, the present data do not represent the total number of the most common basketball-related injuries, but they may represent those that are more severe and therefore more likely to be treated in the ED. Finally, injury and exposure data both came from weighted samples and therefore have an inherent sampling error. Although this error was taken into account for the NEISS data, it was not possible to take it into account for the exposure data, which raises the possibility of type I error. Therefore, significant differences with largely overlapping 95% CIs, such as those observed for sex in ankle sprains, should be interpreted with caution.

CONCLUSIONS

The annual number of pediatric ED visits in basketball players approaches a third of a million and demonstrates the extent of the public health problem that these injuries pose. Girls had a higher rate of knee sprains in athletes aged 12 to 17 years but not among the younger, mainly prepubertal athletes. Boys had a higher rate of facial lacerations. For both boys and girls, the rate of the 5 most common basketball injuries increased with age.

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