Journal of Athletic Training 2014;49(3):381–388
doi: 10.4085/1062-6050-49.3.09

www.natajournals.org

original research

Epidemiologic Comparison of Injured High School Basketball Athletes Reporting to Emergency Departments and the Athletic Training Setting

Erica N. Fletcher, MPH*; Lara B. McKenzie, PhD, MA*†‡; R. Dawn Comstock, PhD*§

*Center for Injury Research and Policy, The Research Institute at Nationwide Children's Hospital, Columbus, OH; †Department of Pediatrics, College of Medicine, and ‡Division of Epidemiology, College of Public Health, The Ohio State University, Columbus; §Colorado School of Public Health, Department of Epidemiology and Pediatric Injury Prevention, Education, and Research (PIPER) Program, Aurora

Context: Basketball is a popular US high school sport with more than 1 million participants annually.

Objective: To compare patterns of athletes with basketball-related injuries presenting to US emergency departments from 2005 through 2010 and the high school athletic training setting from the 2005–2011 seasons.

Design: Descriptive epidemiology study.

Setting: Data from the National Electronic Injury Surveillance System of the US Consumer Product Safety Commission and the High School Reporting Information Online database.

Main Outcome Measure(s): Complex sample weights were used to calculate national estimates of basketball-related injuries for comparison.

Patients or Other Participants: Adolescents from 13 to 19 years of age treated in US emergency departments for basketball-related injuries and athletes from 13 to 19 years of age from schools participating in High School Reporting Information Online who were injured while playing basketball.

Results: Nationally, an estimated 1 514 957 (95% confidence interval = 1 337 441, 1 692 474) athletes with basketball-related injuries reported to the emergency department and 1 064 551 (95% confidence interval = 1 055 482, 1 073 620) presented to the athletic training setting. Overall, the most frequent injuries seen in the emergency department were lacerations and fractures (injury proportion ratios [IPRs] = 3.45 and 1.72, respectively), whereas those seen in the athletic training setting were more commonly concussions and strains/sprains (IPRs = 2.23 and 1.19, respectively; all P values $<$ .0001). Comparisons of body site and diagnosis combinations revealed additional differences. For example, athletes with lower leg fractures more often presented to the emergency department (IPR = 6.53), whereas those with hand fractures more frequently presented to the athletic training setting (IPR = 1.18; all P values $<$ .0001).

Conclusions: Patterns of injury differed among high school basketball players presenting for treatment in the emergency department and the athletic training setting. Understanding differences specific to clinical settings is crucial to grasping the full epidemiologic and clinical picture of sport-related injuries. Certified athletic trainers play an important role in identifying, assessing, and treating athletes with sport-related injuries who might otherwise present to clinical settings with higher costs, such as the emergency department.

Key Words: injury surveillance, adolescents, assessment

Key Points

- Patterns of patients with basketball injuries presenting to US emergency departments and the high school athletic training setting varied.
- Patients with injuries that required more extensive diagnostic or treatment procedures (eg, fractures) typically presented to the emergency department. Those with injuries that could be more quickly assessed and treated (eg, strains, sprains) more often presented to the athletic training setting.
- Understanding the patterns of athletic injuries experienced by patients presenting to the emergency department or athletic training setting will enable appropriate health care to be provided in the most cost-effective environment.

In 1998, the American Medical Association recommended all high school sports programs enlist an athletic medicine unit consisting of a physician director and an athletic trainer (AT).[1] Yet as of 2009, the National Athletic Trainers' Association (NATA) estimated that only 42% of high school sport teams had access to such a unit.[2] When available at high school or youth league practices and competitions, ATs provide immediate triage, diagnosis, and care to injured athletes and, thus, can eliminate the need for athletes with minor or moderate injuries to present to treatment facilities with higher costs, such as emergency departments (EDs).[3–5] However, to date, no authors have directly compared the rates and patterns of injured athletes presenting to EDs and high school athletic training settings to fully evaluate differences.

Basketball is a popular US high school sport, with approximately 1 million participants annually.[6] The rise in participation over the last 20 years[7] has increased the number of young athletes at risk for injury, despite the documented social and health benefits of sports.[8,9] Although not all basketball-related injuries can be prevented, providing the services of an AT to a sports team can mitigate both the severity of injuries that do occur and the risk of adverse outcomes after injury by timely diagnosis, treatment, and rehabilitation and appropriate return-to-play guidance.[3–5] Patients with basketball-related injuries who present to EDs would be expected to have more severe injuries (eg, fractures) than those presenting to the high school athletic training setting. However, such potential differences have not been fully studied to date.

To our knowledge, we are the first to compare and describe epidemiologic patterns of athletes with basketball-related injuries presenting to EDs and the high school athletic training setting using surveillance data captured from large nationally representative samples. Specifically, we compared (1) estimated national incidence, (2) rates of injury, and (3) body sites injured and diagnoses. Our a priori hypothesis was that patients with more severe injuries, such as fractures, reported to EDs, whereas ATs managed more minor and moderate injuries, such as strains/sprains, in the high school athletic training setting.

METHODS

Data Sources

National Electronic Injury Surveillance System. Data for patients treated in US EDs for basketball-related injuries from January 1, 2005, through December 31, 2010, were requested through the National Electronic Injury Surveillance System (NEISS), which has been described previously.[10] Maintained by the US Consumer Product Safety Commission, NEISS provides data on injuries that are related to consumer products and sports and treated in US EDs. The NEISS receives data from a network of approximately 100 hospitals, representing a stratified probability sample of 6100 hospitals, including urban, suburban, rural, and children's hospitals, with 6 or more beds and 24-hour EDs. At all sampled hospitals, ED charts are reviewed by trained NEISS coders to extract data regarding the patient's age, sex, injury diagnosis, body part injured, locale where the injury occurred, product or products involved, and disposition from the ED, as well as a brief narrative describing the incident. Data collected by NEISS are weighted by the Consumer Product Safety Commission to produce national estimates.[10]

High School Reporting Information Online. High School Reporting Information Online (HS RIO), an Internet-based sport-related injury-surveillance system that captured injuries from 100 nationally representative high schools from the 2005–2006 through the 2010–2011 academic years has been described previously.[11–15] Eligible schools (ie, US high schools with an NATA-affiliated AT willing to serve as reporter) were categorized by geographic region[16] and school size (enrollment $\leq$ 1000 students or $>$1000 students), and participants were randomly selected from each substratum to obtain a sample of 100 schools. Participating ATs reported basketball-related injuries and athlete-exposure (AE) data weekly. Only the primary injury sustained during each event was reported. *Injury* was defined as an event that (1) occurred as a result of participation in an organized high school basketball practice or competition, (2) required medical attention by an AT or a physician, and (3) resulted in restriction of the student-athlete's participation for 1 or more days after the date of injury. All concussions, dental injuries, and fractures were recorded beginning with the 2007–2008 academic year.[11] An *AE* consisted of 1 athlete participating in 1 practice or competition.

Case Selection Criteria

All NEISS cases identified by the product code for basketball (1509) for patients from 13 to 19 years old from 2005 through 2010 were reviewed (n = 47 554). A case was excluded if the narrative revealed the patient was not actively playing basketball at the time of injury (eg, "patient was jumping on a trampoline and hit shoulder on a basketball goal"; n = 947) or the case was duplicated (n = 12). Four fatalities due to cardiac arrest while playing basketball were also excluded. All basketball-related HS RIO injuries captured from the 2005–2006 through the 2010–2011 academic years were included (n = 4045).

Variables

The NEISS. Body parts injured were categorized as head/face (including head, face, ear, eye, and mouth), shoulder, elbow, wrist, hand (including hand and finger), lower trunk, knee, lower leg, ankle, or foot (including foot and toe). Injury diagnoses were categorized as strain/sprain, contusion/abrasion, laceration/avulsion, fracture, dislocation, or concussion (including concussions and fractures or internal organ injuries to the head).[17]

The HS RIO. Body parts injured were categorized as head/face (including head/face, nose, ear, mouth, and teeth), shoulder, elbow, wrist, hand, lower trunk, knee, lower leg, ankle, and foot. Injury diagnoses were categorized as strain/sprain, contusion/abrasion, laceration/avulsion, fracture, dislocation, or concussion.

Statistical Analyses

We analyzed the data using SAS (version 9.2; SAS Institute, Cary, NC). Sample weights assigned to each case were based on the inverse probability of selection for each dataset. All statistical analyses accounted for the complex sampling frame of NEISS[10] and HS RIO. All other data reported in this manuscript are national estimates unless specified as actual unweighted cases. Intercensal population estimates, which are estimates of the US population between official census dates, used to calculate rates of injury in NEISS from 2005 through 2010 were derived from the US Census Bureau.[18] We calculated rates of injury for HS RIO with unweighted injury incidence and AEs. Trend significance regarding rates of basketball-related injuries over time was analyzed using linear regression. Injury proportion ratios (IPRs) with 95% confidence intervals (CIs) were calculated to assess associations between categorical variables. An example of an IPR calculation comparing the proportion of basketball-related knee injuries presenting to EDs and high school athletic training settings is as follows:

$$IPR = \frac{(\text{No. NEISS knee injuries/total NEISS injuries})}{(\text{No. HS RIO knee injuries/total HS RIO injuries})}.$$

All *P* values < .05 and 95% CIs not including 1.00 were considered statistically significant. The institutional review board of Nationwide Children's Hospital approved this study.

RESULTS

Demographics

Athletes treated in the ED (according to NEISS) had a mean age of 15.7 ± 0.04 years (Table 1); most were boys (76.2%) and were treated and released from the ED (98.5%). Athletes presenting to the athletic training setting (according to HS RIO) had a mean age of 15.9 ± 0.03 years. Half were boys (50.6%), and most injuries did not require surgery (92.4%). More than half (56.6%) of injured patients presenting to the athletic training setting were reported to have been assessed by an AT and another health care provider (eg, general physician, neurologist, dentist or oral surgeon, nurse practitioner, physician assistant, orthopaedic physician, chiropractor, or other). Only 1.8% of patients presenting to the high school athletic training setting were documented to have been treated by an ED physician after being assessed by an AT.

Incidence and Injury Rates

Nationally, 1 514 957 (95% CI = 1 337 441, 1 692 474) patients with basketball-related injuries were treated in EDs from 2005 through 2010 (1 154 050 boys and 360 524 girls) estimated from 46 591 actual injuries (36 026 boys, 10 557 girls; Table 1). The overall injury rate per 1000 population in boys was more than 3 times that of girls (relative rate = 3.05, *P* < .0001). The rate of injuries per 1000 athletes reporting to EDs from 2005 through 2010 did not vary over time (boys: *P* = .786, girls: *P* = .186; Figure 1A). Nationally, 1 064 551 (95% CI = 1 055 482, 1 073 620) basketball-related injuries were treated in the athletic training setting during the 2005–2006 through 2010–2011 school years (538 932 boys, 525 619 girls; Table 1) estimated from 4045 actual injuries (2075 boys, 1970 girls) that occurred during 2 405 354 AEs (1 320 603 boys' AEs and 1 084 751 girls' AEs), for an overall injury rate of 1.68 injuries per 1000 AEs (boys = 1.57, girls = 1.82). The injury rate per 1000 AEs was higher for girls than for boys (relative rate = 1.16, *P* < .0001). Over the study period, the rate of injury per 1000 AEs decreased slightly for boys (*P* = .041) but remained stable for girls (*P* = .170; Figure 1B). Patients with basketball-related injuries presenting to the ED exhibited seasonal peaks, which coincided with the school-sanctioned basketball season for which basketball-related injuries presenting to the high school athletic training setting were reported, although the incidence of those presenting to the athletic training setting was higher for months in which data were available from both settings (Figure 2).

Body Site Injured and Diagnosis

Commonly injured body sites in both treatment settings were ankle (NEISS = 29.3%, HS RIO = 32.6%) and head/

Table 1. Injury Rates per 1000 Athlete-Exposures (High School Reporting Information Online [HS RIO]) or per 1000 US Census Intercensal Population Estimate (National Electronic Injury Surveillance System [NEISS]) and Mean Age by Sex

Variable	HS RIO			NEISS		
	Boys	Girls	Total	Boys	Girls	Total[a]
National estimate	538 932	525 619	1 064 551	1 154 050	360 524	1 514 957
(95% confidence interval)	(520 172, 557 692)	(504 246, 546 992)	(1 055 482, 1 073 620)	(1 009 034, 1 299 067)	(317 509, 403 538)	(1 337 441, 1 692 474)
Actual incidence	2075	1970	4045	36 026	10 557	46 591
Exposure[b]	1 320 603	1 084 751	2 405 354	91 429 909	86 980 404	178 410 313
Rate per 1000[c]	1.57	1.82	1.68	12.62	4.14	8.49
Age, y (mean ± SD)[d]	16.2 ± 0.03	15.7 ± 0.04	15.9 ± 0.03	15.9 ± 0.04	15.1 ± 0.04	15.7 ± 0.04

[a] Boys' and girls' incidence does not sum to total due to NEISS missing n = 8 for sex.
[b] Athlete-exposures for HS RIO and US Census intercensal population estimate for NEISS.
[c] The rate per 1000 athlete-exposures for HS RIO uses the actual sample incidence in the numerator and actual sample-specific exposure (number of athlete-exposures) in the denominator, whereas the rate per 1000 US Census intercensal population estimate for NEISS uses a national estimate of incidence in the numerator and national age group and sex population estimates in the denominator. This is necessary because NEISS does not capture any sample-specific exposure data.
[d] HS RIO: missing n = 542 for age.

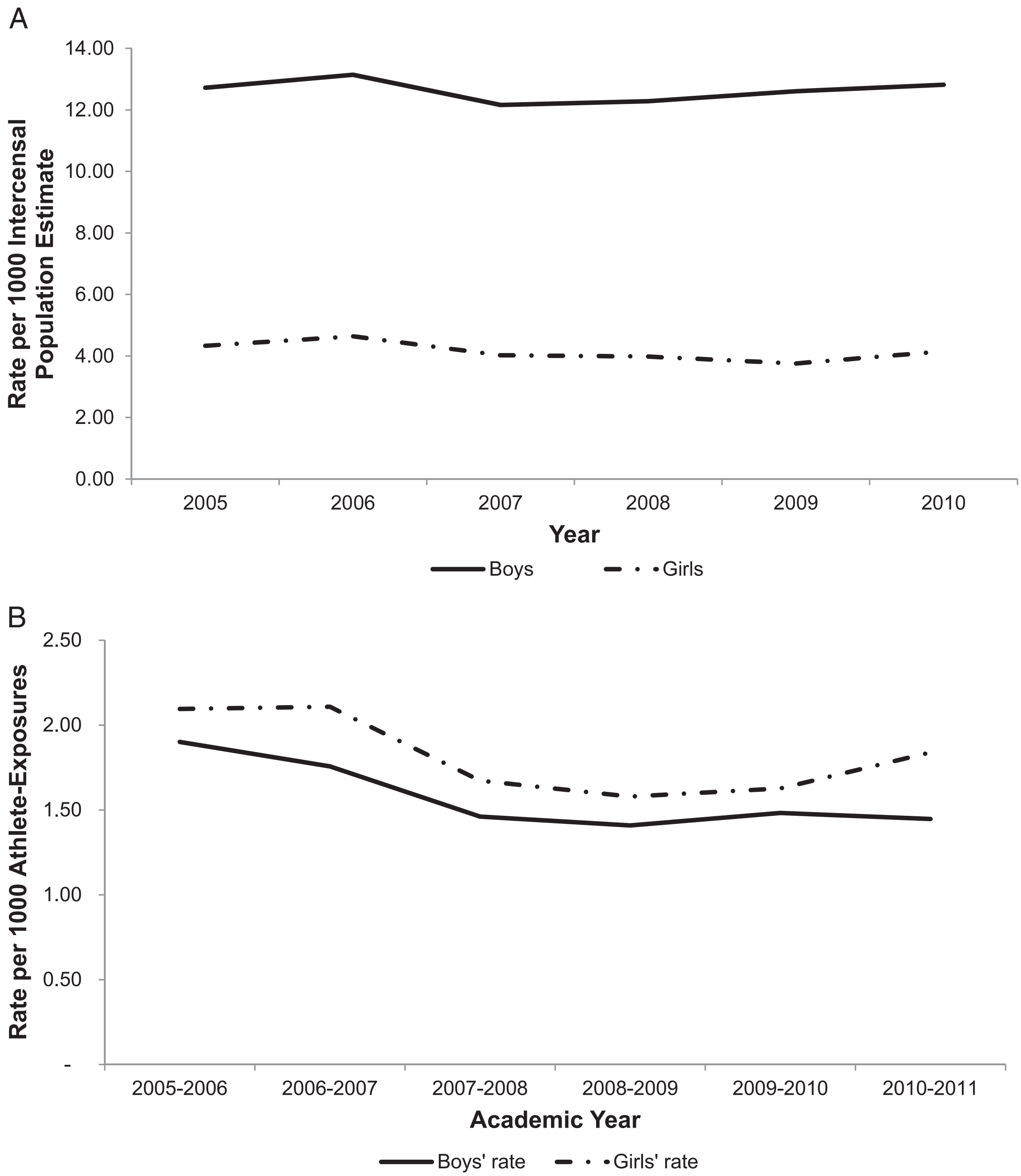

Figure 1. Injury rates. A, National Electronic Injury Surveillance System per 1000 intercensal population estimate by sex, 2005–2010. Boys: $P = .786$, girls: $P = .186$. B, High School Reporting Information Online injury rate per 1000 athlete-exposures by sex, 2005–2006 through 2010–2011.

face (NEISS: 18.9%; HS RIO: 16.5%; Table 2). A large proportion of injuries were reported to the hand in NEISS (17.5%) and the knee (15.0%) in HS RIO. Overall, knee (IPR = 1.74), lower leg (IPR = 1.71), lower trunk (IPR = 1.19), ankle (IPR = 1.14), and foot (IPR = 1.14) injuries were more commonly reported in HS RIO, whereas hand (IPR = 2.63), wrist (IPR = 2.00), and head/face (IPR = 1.15) injuries were more commonly reported in NEISS (all P values $< .0001$). Shoulder injuries were equally likely to present to either setting (IPR = 1.00, $P = .950$). The most common diagnoses reported in NEISS were strains/sprains (45.0%), fractures (15.8%), and contusions/abrasions (12.5%), whereas strains/sprains (54.0%), concussions (10.1%), and fractures (9.2%) were most often reported in HS RIO. Lacerations (IPR = 3.45), fractures (IPR = 1.72), contusion/abrasions (IPR = 1.52), and dislocations (IPR = 1.35) were more frequently reported in NEISS, whereas concussions (IPR = 2.23) and strains/sprains (IPR = 1.19) were more often reported in HS RIO (all P values $< .0001$).

More specifically, head/face lacerations (IPR = 3.26) and contusions/abrasions (IPR = 2.38) were more commonly reported in NEISS, whereas head/face fractures (IPR = 1.52) were more likely to be reported in HS RIO (all P values $< .0001$; Table 3). Ankle fractures (IPR = 4.17), knee dislocations (IPR = 2.15) and strains/sprains (IPR = 1.35); hand contusions/abrasions (IPR = 3.44); shoulder fractures (IPR = 5.90) and dislocations (IPR = 1.37); lower leg fractures (IPR = 6.35) and contusions/abrasions (IPR =

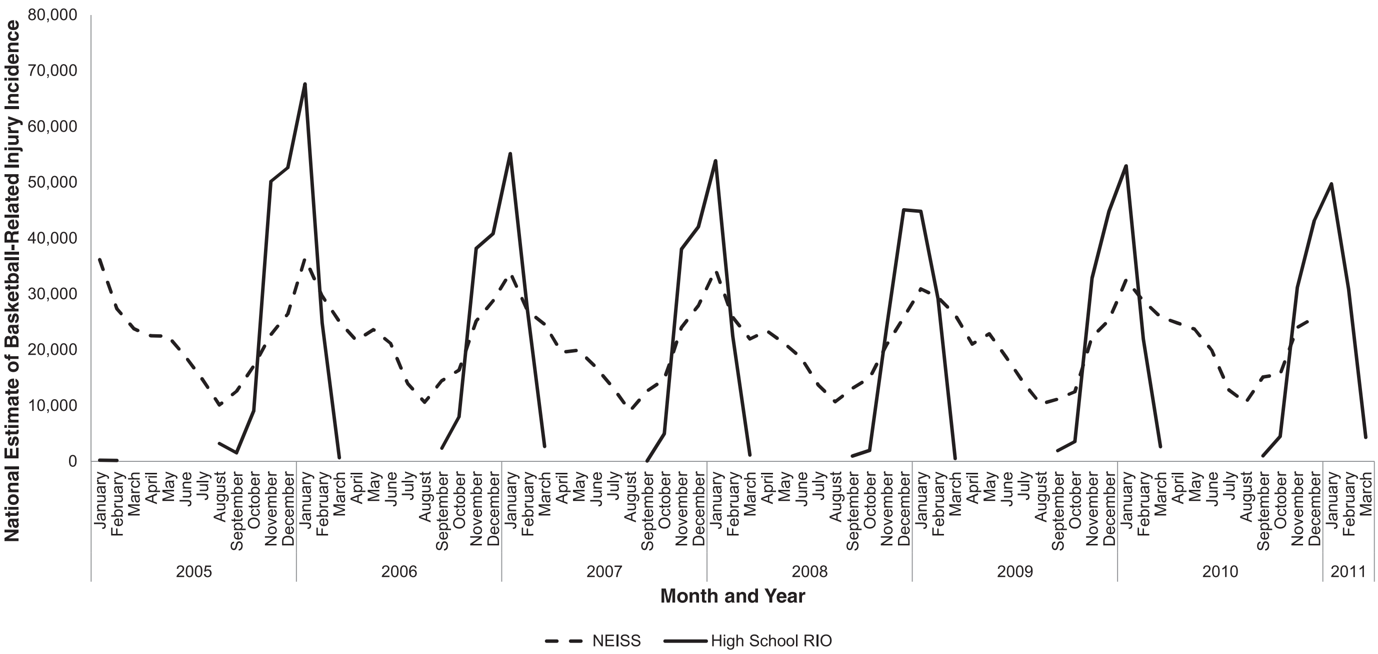

Figure 2. National estimate of basketball-related injury incidence for National Electronic Injury Surveillance System (NEISS) and High School Reporting Information Online (RIO) by month, 2005–2011. Note: Data collection for High School RIO occurred only during the school-sanctioned basketball season, so the line is not continuous.

1.33); and foot fractures (IPR = 5.54), contusions/abrasions (IPR = 2.02), and strains/sprains (IPR = 1.67) were more frequently reported in NEISS than in HS RIO (all P values $< .0001$). Hand fractures (IPR = 1.18) and strains/sprains (IPR = 1.16); wrist strains/sprains (IPR = 1.09) and fractures (IPR = 1.03); lower leg strains/sprains (IPR = 2.81); and lower trunk contusions/abrasions (IPR = 1.72) and strains/sprains (IPR =1.31) were more often reported in HS RIO than in NEISS (all P values $< .0001$).

DISCUSSION

In this study, we demonstrated that patterns of injury presenting to US EDs (according to NEISS) and the high school athletic training setting (according to HS RIO) vary. In general, patients with injuries that can be relatively quickly assessed and more easily diagnosed and treated, such as strains/sprains, presented more commonly to the athletic training setting, whereas those with injuries requiring more extensive diagnostic or treatment proce-

Table 2. Incidence and Proportion of Common Body Sites Injured and Diagnoses With Injury Proportion Ratios for Likelihood of Patients Presenting to the 2 Clinical Settings

	Injury Proportion Ratio[a]			HS RIO		NEISS	
	HS RIO	NEISS	95% CI	n (%)	95% CI	n (%)	95% CI
Body site[b]							
Knee	1.74	1.00	(1.72, 1.75)	158 935 (15.0)	13.6, 16.3	130 230 (8.6)	8.1, 9.1
Lower leg	1.71	1.00	(1.69, 1.74)	37 974 (3.6)	2.9, 4.3	31 557 (2.1)	1.7, 2.5
Lower trunk	1.19	1.00	(1.17, 1.20)	37 207 (3.5)	2.8, 4.2	44 608 (2.9)	2.7, 3.2
Ankle	1.14	1.00	(1.13, 1.14)	354 192 (32.6)	30.8, 34.2	443 703 (29.3)	28.5, 30.1
Foot	1.14	1.00	(1.13, 1.15)	57 236 (5.4)	4.6, 6.2	71 399 (4.7)	4.4, 5.1
Hand	1.00	2.63	(2.63, 2.70)	70 516 (6.7)	5.7, 7.6	265 577 (17.5)	16.3, 18.7
Wrist	1.00	2.00	(1.96, 2.04)	27 400 (2.6)	2.0, 3.2	77 946 (5.1)	4.8, 5.5
Head/face	1.00	1.15	(1.15, 1.16)	174 816 (16.5)	15.1, 17.9	286 432 (18.9)	17.9, 20.0
Shoulder	1.00	1.00	(0.99, 1.01)	34 530 (3.3)	2.6, 3.9	49 148 (3.2)	3.0, 3.5
Diagnosis							
Concussion	2.23	1.00	(2.21, 2.25)	106 942 (10.1)	9.0, 11.2	68 359 (4.5)	3.9, 5.1
Strain/sprain	1.19	1.00	(1.19, 1.20)	570 740 (54.0)	52.2, 55.6	681 402 (45.0)	42.7, 47.2
Laceration	1.00	3.45	(3.45, 3.57)	30 020 (2.8)	2.2, 3.5	148 279 (9.8)	9.2, 10.4
Fracture	1.00	1.72	(1.72, 1.75)	97 049 (9.2)	8.1, 10.2	239 200 (15.8)	14.6, 17.0
Contusion/abrasion	1.00	1.52	(1.49, 1.52)	88 172 (8.3)	7.3, 9.4	189 128 (12.5)	11.4, 13.6
Dislocation	1.00	1.35	(1.32, 1.35)	26 664 (2.5)	1.9, 3.1	50 688 (3.3)	3.0, 3.7

Abbreviations: CI, confidence interval; HS RIO, High School Reporting Information Online; NEISS, National Electronic Injury Surveillance System.

[a] All P values for injury proportion ratio $< .0001$ except for shoulder ($P = .95$).

[b] NEISS missing n = 32 for body site.

Table 3. Common Body Site and Diagnosis Combinations With Injury Proportion Ratios for Likelihood of Patients Presenting to the 2 Clinical Settings

Body Site Diagnosis	Injury Proportion Ratio[a]			HS RIO[b]			NEISS[c]		
	HS RIO	NEISS	95% CI	n	Body Site (%)	95% CI	n	Body Site (%)	95% CI
Ankle				354 192	100.0		443 703	100.0	
Strain/sprain	1.08	1.00	1.08, 1.08	329 636	95.7	94.4, 97.1	382 566	86.2	82.5, 90.0
Fracture	1.00	4.17	4.17, 4.35	7286	2.1	1.2, 3.0	38 271	8.6	7.3, 9.9
Head/face				174 816	100.0		286 432	100.0	
Concussion	2.23	1.00	2.21, 2.25	106 942	61.2	56.5, 65.5	68 359	23.9	21.7, 26.1
Fracture	1.52	1.00	1.50, 1.55	22 780	13.1	10.1, 16.7	24 524	8.6	7.6, 9.5
Laceration	1.00	3.26	3.22, 3.30	23 741	13.6	10.5, 16.7	11 096	44.3	42.0, 46.5
Contusion/abrasion	1.00	2.38	2.38, 2.44	12 780	7.3	4.8, 9.9	50 217	17.5	15.9, 19.2
Knee				158 935	100.0		130 230	100.0	
Dislocation	1.00	2.15	2.09, 2.22	6579	7.4	4.8, 10.0	11 599	8.9	7.0, 10.8
Strain/sprain	1.00	1.35	1.35, 1.37	72 207	46.0	41.1, 50.8	80 175	61.6	56.9, 66.2
Contusion/abrasion	1.01	1.00	0.99, 0.03	21 485	13.7	10.3, 17.1	17 473	13.4	11.4, 15.4
Hand				70 516	100.0		265 577	100.0	
Fracture	1.18	1.00	1.17, 1.19	30 332	43.0	36.0, 50.0	96 832	36.5	33.8, 39.1
Strain/sprain	1.16	1.00	1.14, 1.17	25 376	36.0	29.3, 42.7	82 669	31.1	28.8, 33.4
Contusion/abrasion	1.00	3.44	3.32, 3.56	3047	4.3	1.3, 7.4	39 431	14.8	12.4, 17.3
Wrist				27 400	100.00		77 946	100.00	
Strain/sprain	1.09	1.00	1.08, 1.11	15 354	56.0	44.6, 67.5	39 872	51.2	46.9, 55.5
Fracture	1.03	1.00	1.01, 1.05	9838	35.9	25.1, 46.7	27 270	35.0	31.3, 38.7
Shoulder				34 287	100.00		49 148	100.00	
Fracture	1.00	5.90	5.45, 6.39	656	1.9	0.0, 4.7	5546	11.3	9.3, 13.3
Dislocation	1.00	1.37	1.34, 1.40	7798	22.7	4.3, 31.2	15 296	31.1	27.5, 34.7
Strain/sprain	1.00	1.03	1.01, 1.05	11 145	32.5	23.7, 41.3	16 428	33.4	30.0, 36.9
Lower leg				37 974	100.00		31 557	100.00	
Strain/sprain	2.81	1.00	2.72, 2.90	14 402	37.9	28.7, 47.1	4261	13.5	10.8, 16.3
Fracture	1.00	6.53	6.31, 6.75	3259	8.6	3.6, 13.6	17 678	56.0	51.0, 61.1
Contusion/abrasion	1.00	1.33	1.28, 1.39	4273	11.3	5.5, 17.0	4736	15.0	11.3, 18.7
Lower trunk				36 649	100.00		44 608	100.00	
Contusion/abrasion	1.72	1.00	1.67, 1.76	6675	18.2	11.1, 25.4	13 958	31.3	27.4, 35.2
Strain/sprain	1.31	1.00	1.30, 1.33	22 168	60.5	51.0, 70.0	20 538	46.0	41.4, 50.6
Foot				57 106	100.00		71 399	100.00	
Fracture	1.00	5.54	5.34, 5.73	3259	18.6	12.2, 25.0	22 552	31.6	28.5, 34.7
Contusion/abrasion	1.00	2.02	1.96, 2.09	4273	7.1	3.0, 11.2	10 814	15.1	11.6, 18.7
Strain/sprain	1.00	1.67	1.65, 1.70	14 402	36.4	28.7, 44.1	30 134	42.2	37.5, 46.9

Abbreviations: CI, confidence interval; HS RIO, High School Reporting Information Online; NEISS, National Electronic Injury Surveillance System.

[a] All P values $< .0001$ except knee, contusion/abrasion ($P = .428$).

[b] HS RIO missing n = 29.

[c] NEISS missing n = 32.

dures, such as fractures, were treated more typically in the ED. Although the more severe injuries assessed in our study were more frequently treated in an ED, the majority of patients presenting to each setting had strains/sprains. It has been estimated that approximately 12% of ED visits are nonurgent,[19] and overuse of the ED may strain the capacity of an entire hospital.[20] Furthermore, ED visits for nonurgent conditions may result in avoidable adverse outcomes, including nosocomial infection, overtreatment, and lack of continuity of care.[21] Preliminary data from expanded health care coverage in Massachusetts suggest that ED use for nonurgent care will increase with health care reform.[22] More than half of injured patients assessed in the high school athletic training setting were treated by a health care provider in conjunction with an AT, but only a small percentage were also treated by physicians in the ED, demonstrating the ability of ATs to triage injuries to appropriate levels of clinical care. This is an important service that alleviates strain on EDs and hospital systems. Because only 42% of US high schools have access to an AT, most high school athletes are left to seek care in clinical settings other than the high school athletic training setting, including the ED.

Overall and sex-specific injury rates differed between the ED and the high school athletic training setting. Although girls had a slightly higher injury rate presenting to the high school athletic training setting, boys had more than a threefold higher injury rate presenting to the ED. The injury rate per 1000 population reporting to EDs was almost 8 times that of the injury rate per 1000 AEs presenting to the athletic training setting. We calculated rates of patients with basketball-related injuries reporting to the ED using national estimates of injury incidence and intercensal population estimates; the latter is a proxy for participation that has been used previously when analyzing patterns of sport-related injuries captured in NEISS and the only such data available because NEISS does not capture exposure data.[23–25] We calculated rates of injured patients reporting to the athletic training setting using the actual incidence of injury and actual participation of athletes, both injured and uninjured, captured in HS RIO. This disparity limits comparison across the surveillance systems; however, these methods of estimating rates of injury are useful when comparing trends over time for each system.

Seasonal peaks in the nationally estimated incidence of patients with basketball-related injuries reporting to the ED coincided with the school-sanctioned high school basketball season, during which injured patients presenting to the high school athletic training setting were reported. This suggests that school-sponsored basketball is driving much of the seasonal variation in the basketball-related injury incidence identified in NEISS. The incidence of patients with basketball-related injuries presenting to the athletic training setting during the school-sanctioned basketball season was higher than to the ED, likely because athletic trainers saw a wider spectrum of injury severities. Many patients with these less severe injuries may have presented to other clinical care settings, such as a primary care physician, urgent care center, or ED, if their schools lacked AT coverage.

Concussions are estimated to make up 15% of all sport-related injuries, and most high school sport-related concussions (94.4%) are assessed and managed by an AT, either alone (47.3%) or in conjunction with a primary care physician or other medical professional (62.7%).[26] Basketball-related concussions in school-age children presenting to the ED increased 70% from 1997 to 2007.[25] Our results indicate that concussions were treated in the athletic training setting more than twice as often as in an ED. Consequently, the increase in incidence reporting to the ED[25] is likely a severe underestimation of the total burden of basketball-related concussions because patients presented to other clinical settings, including the athletic training setting, urgent care clinics, sports medicine clinics, and physicians' offices. As state-level legislation regarding concussion-management protocols continues to be developed and implemented across the US,[27] future researchers should examine presentation patterns for concussion and associated outcomes across different clinical settings. Such information will help to fully describe the epidemiology of sport-related concussion, determine efficacy of treatment, identify potential areas of improvement, and drive more efficient allocation of health care resources.

Sport-related fractures are relatively severe injuries that may require patients to undergo expensive diagnostic tests and surgeries and lose time from school and physical activity.[28–31] In this study, fractures accounted for almost 16% of patients with basketball-related injuries presenting to EDs, a value greater than recent estimates that fractures made up about 10% of all sport-related injuries[31] and far more than previous estimates for boys' (8.6%) and girls' (6.8%) basketball.[32] Sport-related fractures commonly occur from contact with other players, and illegal activity is often involved.[33] Targeted, evidence-based interventions to prevent sport-related fractures, such as policies to require appropriate protective gear or increased penalties for illegal play, are needed to mitigate the adverse effects these severe injuries have on finances and life quality.

Limitations

Like all studies, this investigation has limitations. Accurate national participation data for basketball are difficult to ascertain, particularly when unorganized play is included. Thus, rates of patients with basketball-related injuries presenting to the ED are undoubtedly underestimated because we used intercensal population estimates as a proxy for participation. Our inclusion of NEISS cases relied on case narratives, which are sometimes incomplete. Fatalities were excluded from our study; NEISS is generally not regarded as useful for identifying fatal injuries, given that only those occurring in the ED are captured. Greater detail in the initial coding of medical charts would allow additional and more direct comparison of injuries in NEISS with those reported in more detail, such as in HS RIO. For example, it was not possible to determine from NEISS if an athlete was treated by an AT before presenting in the ED, but HS RIO captures information regarding subsequent treatment of injuries initially assessed by an AT. Because only high schools with NATA-affiliated ATs were included in HS RIO, the generalizability of our findings could be limited. Also, HS RIO is limited to in-season, high school-sanctioned basketball events and does not include off-season or club events, whereas NEISS captures all injuries, including "pick-up" games and other noncompetitive basketball activities. Basketball played outside the school setting may be different from that observed in HS RIO in terms of rules of play, supervision, intensity, medical resources, and playing conditions, which makes direct comparisons challenging. However, this comparison was our objective, and the information presented here raises important issues regarding the need to better understand specific differences of clinical importance in injury-presentation patterns.

CONCLUSIONS

Athletic trainers play an important role in preventing, identifying, assessing, and treating patients with sport-related injuries who might otherwise present to clinical settings with higher costs, such as the ED.[3–5] High school and youth sports leagues should work with the community to provide athletes with access to an AT. The American Medical Association recommends that every school with a sports program include an athletic medicine unit consisting of a physician and an AT,[1] and the NATA, along with 16 other health care organizations, issued a 2004 consensus statement[34] that lists ATs as appropriate health care professionals to provide not only emergency medical services but also continuing athletic care. As the occupational demand for ATs increases over the next decade,[35] their influence on prevention, triage, and treatment of sport-related injuries is likely to become more profound. Future authors should compare patterns of injury presentation across multiple clinical settings as well as patterns of injury in high schools with and without an AT for basketball and other sports.

ACKNOWLEDGMENTS

The content of this report was funded in part by the Centers for Disease Control and Prevention grants R49/CE000674-01 and R49/CE001172-01 and by award number KL2 RR025754 from the National Center for Research Resources. Funding was also provided by the National Federation of State High School Associations, National Operating Committee on Standards for Athletic Equipment, DonJoy Orthotics, and EyeBlack.

REFERENCES

1. American Medical Association. Policy H-470.995: certified athletic trainers in secondary schools. http://www.ama-assn.org/resources/doc/PolicyFinder/policyfiles/HnE/H-470.995.HTM. Accessed December 18, 2013.
2. National Athletic Trainers' Association. NATA study finds head impacts among high school football players greater than collegiate level. http://www.nata.org/NR071509. Accessed May 28, 2012.
3. Lyznicki JM, Riggs JA, Champion HC. Certified athletic trainers in secondary schools: report of the council on scientific affairs, american medical association. *J Athl Train*. 1999;34(3):272–276.
4. Wham G, Sealy D, Saunders R, Montgomery S, Goforth G. Do certified athletic trainers make a difference in high school athletic healthcare? *J S C Med Assoc*. 2008;104(4):91–95.
5. Wham GS Jr, Saunders R, Mensch J. Key factors for providing appropriate medical care in secondary school athletics: athletic training services and budget. *J Athl Train*. 2010;45(1):75–86.
6. National Federation of State High School Associations. Participation data. http://www.nfhs.org/content.aspx?id=3282. Accessed May 28, 2012.
7. National Federation of State High School Associations. Participation statistics: basketball. http://www.nfhs.org/Participation/SportSearch.aspx. Accessed June 4, 2012.
8. Pate RR, Trost SG, Levin S, Dowda M. Sports participation and health-related behaviors among US youth. *Arch Pediatr Adolesc Med*. 2000;154(9):904–911.
9. Harrison PA, Narayan G. Differences in behavior, psychological factors, and environmental factors associated with participation in school sports and other activities in adolescence. *J Sch Health*. 2003;73(3):113–120.
10. US Consumer Product Safety Commission. *NEISS: National Electronic Injury Surveillance System, A Tool for Researchers*. Washington, DC: US Consumer Product Safety Commission; 2000.
11. Borowski LA, Yard EE, Fields SK, Comstock RD. The epidemiology of US high school basketball injuries, 2005–2007. *Am J Sports Med*. 2008;36(12):2328–2335.
12. Gessel LM, Fields SK, Collins CL, Dick RW, Comstock RD. Concussions among United States high school and collegiate athletes. *J Athl Train*. 2007;42(4):495–503.
13. Nelson AJ, Collins CL, Yard EE, Fields SK, Comstock RD. Ankle injuries among United States high school sports athletes, 2005–2006. *J Athl Train*. 2007;42(3):381–387.
14. Shankar PR, Fields SK, Collins CL, Dick RW, Comstock RD. Epidemiology of high school and collegiate football injuries in the United States, 2005–2006. *Am J Sports Med*. 2007;35(8):1295–1303.
15. Yard EE, Collins CL, Dick RW, Comstock RD. An epidemiologic comparison of high school and college wrestling injuries. *Am J Sports Med*. 2008;36(1):57–64.
16. United States Census Bureau. Census regions and divisions of the United States. www.census.gov/geo/www/us_regdiv.pdf. Accessed July 10, 2012.
17. Xiang H, Sinclair SA, Yu S, Smith GA, Kelleher K. Case ascertainment in pediatric traumatic brain injury: challenges in using the NEISS. *Brain Inj*. 2007;21(3):293–299.
18. US Bureau of the Census. United States resident population by age and sex. http://www.census.gov. Accessed September 22, 2011.
19. Pitts SR, Niska RW, Xu J, Burt CW. National Hospital Ambulatory Medical Care Survey: 2006 emergency department summary. *Natl Health Stat Report*. 2008;7:1–38.
20. McCabe JB. Emergency department overcrowding: a national crisis. *Acad Med*. 2001;76(7):672–674.
21. Moskop JC. Nonurgent care in the emergency department: bane or boon? *Virtual Mentor*. 2010;12:476–482.
22. Kowalczyk L. ER visits, costs in Mass. climb: questions raised about healthcare law's impact on overuse. Boston Globe. http://www.boston.com/news/local/massachusetts/articles/2009/04/24/er_visits_costs_in_mass_climb/. Accessed December 18, 2013.
23. Lawson BR, Comstock RD, Smith GA. Baseball-related injuries to children treated in hospital emergency departments in the United States, 1994–2006. *Pediatrics*. 2009;123(6):e1028–e1034.
24. Nation AD, Nelson NG, Yard EE, Comstock RD, McKenzie LB. Football-related injuries among 6- to 17-year-olds treated in US emergency departments, 1990–2007. *Clin Pediatr (Phila)*. 2011;50(3):200–207.
25. Randazzo C, Nelson NG, McKenzie LB. Basketball-related injuries in school-aged children and adolescents in 1997–2007. *Pediatrics*. 2010;126(4):727–733.
26. Meehan WP 3rd, d'Hemecourt P, Collins CL, Comstock RD. Assessment and management of sport-related concussions in United States high schools. *Am J Sports Med*. 2011;39(11):2304–2310.
27. Rickerson J. Concussion laws: 2011. http://sportsconcussions.org/laws.html. Published 2011. Accessed July 10, 2012.
28. Darrow CJ, Collins CL, Yard EE, Comstock RD. Epidemiology of severe injuries among United States high school athletes: 2005–2007. *Am J Sports Med*. 2009;37(9):1798–1805.
29. Hyman JE, Gaffney JT, Epps HR, Matsumoto H. Impact of fractures on school attendance. *J Pediatr Orthop*. 2011;31(2):113–116.
30. Knowles SB, Marshall SW, Miller T, et al. Cost of injuries from a prospective cohort study of North Carolina high school athletes. *Inj Prev*. 2007;13(6):416–421.
31. Swenson DM, Henke NM, Collins CL, Fields SK, Comstock RD. Epidemiology of United States high school sports-related fractures, 2008–09 to 2010–11. *Am J Sports Med*. 2012;40(9):2078–2084.
32. Powell JW, Barber-Foss KD. Injury patterns in selected high school sports: a review of the 1995–1997 seasons. *J Athl Train*. 1999;34(3):277–284.
33. Swenson DM, Yard EE, Collins CL, Fields SK, Comstock RD. Epidemiology of US high school sports-related fractures, 2005–2009. *Clin J Sport Med*. 2010;20(4):293–299.
34. National Athletic Trainers' Association. Appropriate medical care for secondary school-age athletes: consensus statement. http://www.nata.org/sites/default/files/AppropriateMedicalCare4SecondarySchoolAgeAthletes.pdf. 2004. Accessed July 10, 2012.
35. Bureau of Labor Statistics, US Department of Labor. Occupational outlook handbook, 2012–13 edition: athletic trainers. http://www.bls.gov/ooh/healthcare/athletic-trainers.htm. Accessed May 28, 2012.

Address correspondence to Lara B. McKenzie, PhD, MA, Center for Injury Research and Policy, Research Institute at Nationwide Children's Hospital, 700 Children's Drive, Columbus, OH 43205. Address e-mail to Lara.McKenzie@NationwideChildrens.org.