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The First Decade of Web-Based Sports Injury Surveillance: Descriptive Epidemiology of Injuries in US High School Boys' Basketball (2005–2006 Through 2013–2014) and National Collegiate Athletic Association Men's Basketball (2004–2005 Through 2013–2014)

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Context: The advent of Web-based sports injury surveillance via programs such as the High School Reporting Information Online system and the National Collegiate Athletic Association Injury Surveillance Program has aided the acquisition of boys' and men's basketball injury data.

Objective: To describe the epidemiology of injuries sustained in high school boys' basketball in the 2005–2006 through 2013–2014 academic years and collegiate men's basketball in the 2004–2005 through 2013–2014 academic years using Web-based sports injury surveillance.

Design: Descriptive epidemiology study.

Setting: Online injury surveillance from basketball teams of high school boys (annual average = 100) and collegiate men (annual average = 55).

Patients or Other Participants: Boys' and men's basketball players who participated in practices and competitions during the 2005–2006 through 2013–2014 academic years in high school or the 2004–2005 through 2013–2014 academic years in college.

Main Outcome Measures: Athletic trainers collected time-loss (≥24 hours) injury and exposure data. Injury rates per 1000 athlete-exposures (AEs) were calculated. Injury rate ratios (IRRs) with 95% confidence intervals (CIs) compared injury rates by school size or division, time in season, event type, and competition level.

Results: The High School Reporting Information Online system documented 3056 time-loss injuries during 1 977 480 AEs; the National Collegiate Athletic Association Injury Surveillance Program documented 4607 time-loss injuries during 868 631 AEs. The injury rate was higher for college than for high school (5.30 versus 1.55/1000 AE; IRR = 3.43; 95% CI = 3.28, 3.59). The injury rate was higher for competitions than for practices in both high school (IRR = 2.38; 95% CI = 2.22, 2.56) and college (IRR = 2.02; 95% CI = 1.90, 2.14). The most common injuries at both levels were ligament sprains, muscle/tendon strains, and concussions; most injuries affected the ankle, knee, and head/face. Injuries were most often caused by contact with another player or noncontact mechanisms.

Conclusions: Injury rates were greater among collegiate players compared with high school players and were greater during competitions than practices at both levels. Distributions of injuries by body part, diagnoses, and mechanisms of injury were similar, suggesting that athletes at both levels may benefit from similar injury-prevention strategies.

Key Words: injury surveillance, basketball, males

Key Points

- The rate of injury for collegiate men's basketball exceeded that for high school boys' basketball.
- Competition injury rates were higher than practice injury rates.
- Most reported injuries were to the upper extremity.
- Common injuries during competitions were concussions, ankle sprains, and knee sprains.

The number of high school and colleges sponsoring basketball has increased over the past 10 years.[1,2] Over this same time, the number of high school participants stayed relatively constant while the number of collegiate participants increased.[1,2] Compared with the 2004–2005 academic year, the number of high school teams in 2013–2014 increased by 3.7% (2004–2005 = 17 482; 2013–2014 = 18 126), but the number of student-athletes decreased by 1.0% (2004–2005 = 545 497; 2013–2014 = 541 054).[1] The number of collegiate men's basketball teams and student-athletes in 2013–2014 increased by 8.1% (2004–2005 = 1000; 2013–2014 = 1081) and 12.6% (2004–2005 = 16 271; 2013–2014 = 18 320), respectively, after 2004–2005.[2]

Establishing epidemiologic trends for injuries among high school and collegiate basketball players may help guide injury-prevention efforts, such as informing rule changes or identifying the most common injury diagnoses or mechanisms that clinicians should target. The National Collegiate Athletic Association (NCAA) has used injury surveillance to acquire collegiate sports injury data since the 1980s. Although this NCAA-based surveillance system has had several names, we herein denote it as the *NCAA Injury Surveillance Program* (ISP). Since the 2004–2005 academic year, the NCAA has used a Web-based platform to collect collegiate sports injury and exposure data via athletic trainers (ATs).[3] A year later, the High School Reporting Information Online (HS RIO) system, a similar Web-based high school sports injury-surveillance system, was launched.[4]

As denoted in the van Mechelen et al[5] framework, injury prevention benefits from ongoing monitoring of injury incidence, and updated descriptive epidemiology is needed. A previous NCAA-ISP report for the 1988–1989 through 2003–2004 academic years documented men's basketball competition and practice injury rates of 9.9 and 4.3/1000 athlete-exposures (AEs), respectively.[6] However, over the past decade, rule changes have been enforced to help reduce the incidence of injury[7] and awareness has been heightened of injury-prevention efforts, particularly for concussion.[8,9] Because less research has been conducted at the high school level, documenting injuries through high school sports injury surveillance is important to establish injury incidence estimates and compare findings between the high school and collegiate settings. The purpose of this article is to summarize the descriptive epidemiology of injuries sustained in high school boys' and collegiate men's basketball during the first decade of Web-based sports injury surveillance (2004–2005 through 2013–2014 academic years). We hypothesized that injury rates would be greater among collegiate than high school athletes and greater during competitions than practices, regardless of competition level. We also hypothesized that collegiate injury rates would be greater during the preseason than during the regular season or postseason.

METHODS

Data Sources and Study Period

This study used data collected by HS RIO and the NCAA-ISP, sports injury-surveillance programs for the high school and collegiate levels, respectively. Use of the HS RIO data was approved by the Nationwide Children's Hospital Subjects Review Board (Columbus, OH). Use of the NCAA-ISP data was approved by the Research Review Board of the NCAA.

An average of 100 high schools sponsoring boys' basketball provided data to the HS RIO random sample during the 2005–2006 through 2013–2014 academic years (2005–2006 was the first year HS RIO collected data). An average of 55 NCAA member institutions (Division I = 22, Division II = 11, Division III = 22) sponsoring men's basketball participated in the NCAA-ISP during the 2004–2005 through 2013–2014 academic years. The methods of HS RIO and the NCAA-ISP are summarized in the following sections. In-depth information on the methods and analyses for this special series of articles on Web-based sports injury surveillance can be found in the previously published methodologic article.[10] In addition, previous publications have described the sampling and data collection of HS RIO[4,11] and the NCAA-ISP[3] in depth.

High School RIO

High School RIO consists of a sample of high schools with 1 or more National Athletic Trainers' Association-affiliated ATs with valid e-mail addresses. The ATs from participating high schools reported injury incidence and AE information weekly throughout the academic year using a secure Web site. For each injury, the AT completed a detailed injury report on the injured athlete (age, height, weight, etc), the injury (site, diagnosis, severity, etc), and the injury event (activity, mechanism, etc). Throughout each academic year, participating ATs were able to view and update previously submitted reports as needed with new information (eg, time loss).

Data for HS RIO during the 2005–2006 through 2013–2014 academic years originated from a random sample of 100 schools that were recruited annually. Eligible schools were randomly selected from 8 strata (12 or 13 per stratum) based on school population (enrollment $\leq$1000 or $>$1000) and US Census geographic region.[12] The ATs from these schools reported data for the 9 sports of interest (boys' baseball, basketball, football, soccer, and wrestling; girls' basketball, soccer, softball, and volleyball). If a school dropped out of the system, a replacement from the same stratum was selected.

In HS RIO, national injury estimates were calculated from injury counts obtained from the sample. A weighting algorithm based on the inverse probability of participant

schools' selection into the study (based on geographic location and high school size) was applied to individual case counts in order to calculate the national injury estimates.

The NCAA-ISP

The NCAA-ISP depends on a convenience sample of teams with ATs voluntarily reporting injury and exposure data.[3] Participation in the NCAA-ISP, while voluntary, is available to all NCAA institutions. For each injury event, the AT completes a detailed event report on the injury or condition (eg, site, diagnosis) and the circumstances (eg, activity, mechanism, event type [ie, competition or practice]). The ATs are able to view and update previously submitted information as needed during the course of a season. In addition, ATs also provide the number of student-athletes participating in each practice and competition. Data collection for the 2004–2005 through 2013–2014 academic years is described in the following paragraphs.

During the 2004–2005 through 2008–2009 academic years, ATs used a Web-based platform launched by the NCAA to track injury and exposure data.[3] This platform integrated some of the functional components of an electronic medical record, such as athlete demographic and preseason injury information. During the 2009–2010 through 2013–2014 academic years, the Datalys Center for Sports Injury Research and Prevention, Inc (Datalys Center, Indianapolis, IN) introduced a common data element (CDE) standard to improve process flow. The CDE standard allowed data to be gathered from different electronic medical record or injury-documentation applications, including the Athletic Trainer System (Keffer Development, Grove City, PA), Injury Surveillance Tool (Datalys Center), and the Sports Injury Monitoring System (FlanTech, Iowa City, IA). The CDE export standard allowed ATs to document injuries as they normally would during their daily clinical practice, as opposed to asking them to report injuries solely for purposes of participation in an injury-surveillance program. Data were de-identified and sent to the Datalys Center, where they were examined by data quality-control staff and a verification engine.

To calculate national estimates of the number of injuries and AEs, poststratification sample weights, based on sport, division, and academic year, were applied to each reported injury and AE. Weights for all data were further adjusted to correct for underreporting, according to the findings of Kucera et al,[13] who estimated that the ISP captured 88.3% of all time-loss medical-care injury events. Weighted counts were scaled up by a factor of (0.883^{-1}). In-depth information on the formula used to calculate national estimates can be found in the previously published methodologic article.[10]

Definitions

Injury. A reportable *injury* in both HS RIO and the NCAA-ISP was defined as an injury that (1) occurred as a result of participation in an organized practice or competition, (2) required medical attention by a certified AT or physician, and (3) resulted in restriction of the student-athlete's participation for 1 or more days beyond the day of injury. Since the 2007–2008 academic year, HS RIO has also captured all concussions, fractures, and dental injuries, regardless of time loss. In the NCAA-ISP, multiple injuries occurring from 1 injury event could be included, whereas in HS RIO, only the principal injury was captured. Beginning in the 2009–2010 academic year, the NCAA-ISP also began to monitor all non–time-loss injuries. A *non–time-loss injury* was defined as any injury that was evaluated or treated (or both) by an AT or physician but did not result in restriction from participation beyond the day of injury. However, because HS RIO captures only time-loss injuries (to reduce the burden on high school ATs), for this series of publications, only time-loss injuries (with the exception of concussions, fractures, and dental injuries as noted earlier) were included.

Athlete-Exposures. For both surveillance systems, a reportable *AE* was defined as 1 student-athlete participating in 1 school-sanctioned practice or competition in which he or she was exposed to the possibility of athletic injury, regardless of the time associated with that participation. Preseason scrimmages were considered practice exposures, not competition exposures.

Statistical Analysis

Data were analyzed using SAS-Enterprise Guide software (version 5.4; SAS Institute Inc, Cary, NC). Because the data collected from HS RIO and the NCAA-ISP were similar, we opted to recode data when necessary in order to increase the comparability between high school and collegiate student-athletes. We also opted to ensure that categorizations were consistent among all sport-specific articles within this special series. Because methodologic variations may lead to small differences in injury reporting among these surveillance systems, caution must be taken when interpreting these results.

We examined injury counts, national estimates, and distributions by event type (practice and competition), time in season (preseason, regular season, postseason), time loss (1 to 6 days; 7 to 21 days; more than 21 days, including injuries resulting in a premature end to the season), body part injured, diagnosis, mechanism of injury, activity during injury, and position. We also calculated injury rates per 1000 AEs and injury rate ratios (IRRs). The IRR focused on comparisons by level of play (high school and college), event type (practice and competition), school size in high school (>1000 and ≤ 1000 students), division in college (Divisions I, II, and III), and time in season (preseason, regular season, and postseason). All IRRs with 95% confidence intervals (CIs) not containing 1.0 were considered statistically significant.

Last, we used linear regression to analyze linear trends across time of injury rates and compute average annual changes (ie, mean differences). Because of the 2 data-collection methods for the NCAA-ISP during the 2004–2005 through 2008–2009 and 2009–2010 through 2013–2014 academic years, linear trends were examined separately for each time period. All mean differences with 95% CIs not containing 0.0 were considered statistically significant.

RESULTS

Total Injury Frequency, National Estimates, and Injury Rates

During the study period, ATs reported a total of 7663 injuries in boys' and men's basketball (high school n =

Table 1. Injury Rates by School Size or Division and Type of Athlete Exposure in High School Boys' and Collegiate Men's Basketball[a]

Surveillance System and School Size or Division	Exposure Type	Injuries in Sample, No. (%)	National Estimates, No. (%)	Athlete-Exposures	Injury Rate/1000 Athlete-Exposures (95% Confidence Interval)
HS RIO (2005–2006 through 2013–2014)					
≤1000 students	Practice	688 (48.1)	266 976 (50.0)	556 469	1.24 (1.14, 1.33)
	Competition	741 (51.9)	271 382 (50.0)	234 092	3.17 (2.94, 3.39)
	Total	1429 (100.0)	538 358 (100.0)	790 561	1.81 (1.71, 1.90)
>1000 students	Practice	837 (51.4)	130 156 (51.1)	834 513	1.00 (0.94, 1.07)
	Competition	790 (48.6)	124 699 (48.9)	352 406	2.24 (2.09, 2.40)
	Total	1627 (100.0)	254 855 (100.0)	1 186 919	1.37 (1.30, 1.44)
Total	Practice	1525 (50.0)	397 132 (50.0)	1 390 982	1.10 (1.04, 1.15)
	Competition	1531 (50.0)	396 081 (50.0)	586 498	2.61 (2.48, 2.74)
	Total	3056 (100.0)	793 213 (100.0)	1 977 480	1.55 (1.49, 1.60)
NCAA-ISP (2004–2005 through 2013–2014)					
Division I	Practice	1367 (64.6)	21 109 (65.3)	307 986	4.44 (4.20, 4.67)
	Competition	750 (35.4)	11 236 (34.7)	74 063	10.13 (9.40, 10.85)
	Total	2117 (100.0)	32 345 (100.0)	382 049	5.54 (5.31, 5.78)
Division II	Practice	546 (65.3)	14 983 (66.2)	139 622	3.91 (3.58, 4.24)
	Competition	290 (34.7)	7638 (33.8)	36 700	7.90 (6.99, 8.81)
	Total	836 (100.0)	22 621 (100.0)	176 322	4.74 (4.42, 5.06)
Division III	Practice	1117 (67.5)	23 263 (68.3)	242 772	4.60 (4.33, 4.87)
	Competition	537 (32.5)	10 774 (31.7)	67 488	7.96 (7.28, 8.63)
	Total	1654 (100.0)	34 037 (100.0)	310 260	5.33 (5.07, 5.59)
Total	Practice	3030 (65.8)	59 355 (66.7)	690 379	4.39 (4.23, 4.55)
	Competition	1577 (34.2)	29 648 (33.3)	178 251	8.85 (8.41, 9.28)
	Total	4607 (100.0)	89 003 (100.0)	868 631	5.30 (5.15, 5.46)

Abbreviations: HS RIO, High School Reporting Information Online; NCAA-ISP, National Collegiate Athletic Association Injury Surveillance Program.

[a] High school data originated from HS RIO surveillance data, 2005–2006 through 2013–2014; collegiate data originated from NCAA-ISP surveillance data, 2004–2005 through 2013–2014. Injuries included in the analysis were those that (1) occurred during a sanctioned practice or competition; (2) were evaluated or treated (or both) by an athletic trainer, physician, or other health care professional; and (3) restricted the student-athlete from participation for at least 24 hours past the day of injury. All concussions, fractures, and dental injuries were included in the analysis regardless of time loss. Data may include multiple injuries that occurred at 1 injury event. National estimates and athlete-exposures may not sum to totals due to rounding error.

3056, college n = 4607; Table 1). This equated to a national estimate of 793 213 high school injuries (annual average = 88 135) and 89 003 collegiate injuries (annual average = 8900). The total injury rate for high school boys' basketball was 1.55/1000 AEs (95% CI = 1.49, 1.60) and for collegiate men's basketball was 5.30/1000 AEs (95% CI= 5.15, 5.46). The total injury rate was higher for collegiate than high school (IRR = 3.43; 95% CI = 3.28, 3.59) athletes.

School Size and Division

The total injury rate was higher for high schools with ≤1000 students than for high schools with >1000 students (IRR = 1.32; 95% CI = 1.23, 1.42; Table 1). Among colleges, Division I had a higher total injury rate than Division II (IRR = 1.17; 95% CI = 1.08, 1.27) but not Division III (IRR = 1.04; 95% CI = 0.97, 1.11). Also, Division III had a higher total injury rate than Division II (IRR = 1.12; 95% CI = 1.03, 1.22).

Event Type

Among high school players, nearly equal numbers of injuries occurred during competitions and practices, whereas the majority of injuries among collegiate players occurred during practices (65.8%; Table 1). The competition injury rate was higher than the practice injury rate at both the high school (IRR = 2.38; 95% CI = 2.22, 2.56) and collegiate (IRR = 2.02; 95% CI = 1.90, 2.14) levels.

No linear trends were seen in the annual injury rates for high school practices (annual average change of –0.03/1000 AEs; 95% CI = –0.07, 0.01) or competitions (annual average change = –0.03/1000 AEs; 95% CI = –0.08, 0.03; Figure 1). A decrease was found in the 2004–2005 through 2008–2009 academic years for practices (annual average change = –0.54/1000 AEs; 95% CI = –0.86, –0.23) but not for competitions (annual average change = –0.57/1000 AEs; 95% CI = –1.39, 0.25). However, increases were noted in the 2009–2010 through 2013–2014 academic years for practices (annual average change = 0.10/1000 AEs; 95% CI = 0.01, 0.19) and competitions (annual average change of 0.28/1000 AEs; 95% CI = 0.04, 0.52).

Time in Season

Among both high school and collegiate athletes, the majority of injuries occurred during the regular season (high school = 77.7%, college = 62.2%; Table 2). The collegiate preseason had a higher injury rate than the regular season (IRR = 1.70; 95% CI = 1.60, 1.80) and postseason (IRR = 2.82; 95% CI = 2.33, 3.42). In addition, the injury rate was higher during the regular season than during the postseason (IRR = 1.66; 95% CI = 1.38, 2.01). Injury rates by time in season could not be calculated for high schools as AEs were not stratified by time in season.

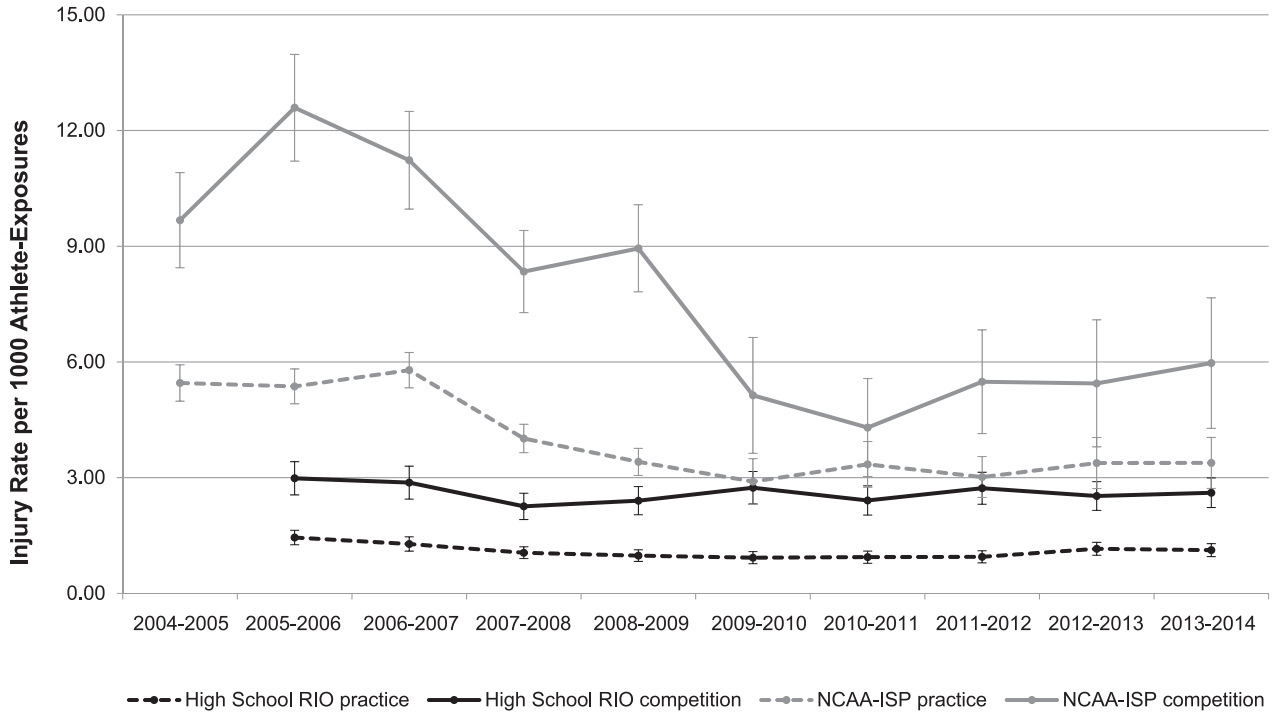

Figure. Injury rates by year and type of athlete-exposure (AE) in high school boys' and collegiate men's basketball. Note: Annual average changes for linear trend test for injury rates are as follows: High School Reporting Information Online (RIO; practices = –0.03/1000 AEs, 95% confidence interval (CI) = 0.07, 0.01; competitions = –0.03/1000 AEs, 95% CI = –0.08, 0.03); National Collegiate Athletic Association Injury Surveillance Program (NCAA-ISP) 2004–2005 through 2008–2009 (practices = –0.54/1000 AEs, 95% CI = –0.86, –0.23; competitions = –0.57/1000 AEs, 95% CI = –1.39, 0.25); NCAA-ISP 2009–2010 through 2013–2014 academic years (practices = 0.10/1000 AEs, 95% CI = 0.01, 0.19; competitions = 0.28/1000 AEs, 95% CI = 0.04, 0.52). A negative rate indicates a decrease in the annual average change between years, and a positive rate indicates an increase in the annual average change. Any 95% CIs that include 0.00 are not significant.

Time Loss From Participation

For both high school and collegiate players, the largest proportion of injuries resulted in time loss of less than 1 week, ranging from 45.3% of injuries in high school competitions to 62.2% of injuries in collegiate practices (Table 3).

Body Parts Injured and Diagnoses

High School. Commonly injured body parts in practices and competitions were the ankle (practices = 35.9%, competitions = 32.6%), head/face (practices = 14.8%, competitions = 21.5%), and knee (practices = 11.2%, competitions = 12.6%; Table 4). The most frequent injury

Table 2. Injury Rates by Time in Season and Type of Athlete Exposure in High School Boys' and Collegiate Men's Basketball[a]

		HS RIO (2005–2006 Through 2013–2014)		NCAA-ISP (2004–2005 Through 2013–2014)			
Time in Season	Exposure Type	Injuries in Sample, No. (%)	National Estimates, No. (%)	Injuries in Sample, No. (%)	National Estimates, No. (%)	Athlete-Exposures	Injury Rate/ 1000 Athlete-Exposures (95% Confidence Interval)
Preseason	Practice	491 (84.7)	126 320 (84.9)	1551 (95.2)	29 392 (96.0)	203 050	7.64 (7.26, 8.02)
	Competition	89 (15.3)	22 522 (15.1)	79 (4.8)	1223 (4.0)	4831	16.35 (12.75, 19.96)
	Total	580 (100.0)	148 843 (100.0)	1630 (100.0)	30 615 (100.0)	207 881	7.84 (7.46, 8.22)
Regular season	Practice	981 (41.6)	254 149 (41.7)	1429 (49.9)	28 935 (51.6)	456 986	3.13 (2.96, 3.29)
	Competition	1380 (58.4)	355 781 (58.3)	1436 (50.1)	27 179 (48.4)	163 415	8.79 (8.33, 9.24)
	Total	2361 (100.0)	609 931 (100.0)	2865 (100.0)	56 114 (100.0)	620 401	4.62 (4.45, 4.79)
Postseason	Practice	44 (44.4)	12 857 (47.0)	50 (44.6)	1028 (45.2)	30 343	1.65 (1.19, 2.10)
	Competition	55 (55.6)	14 477 (53.0)	62 (55.4)	1246 (54.8)	10 005	6.20 (4.65, 7.74)
	Total	99 (100.0)	27 334 (100.0)	112 (100.0)	2274 (100.0)	40 348	2.78 (2.26, 3.29)

Abbreviations: HS RIO, High School Reporting Information Online; NCAA-ISP, National Collegiate Athletic Association Injury Surveillance Program.

[a] Excluded 16 injuries reported in HS RIO due to missing data for time in season. Injury rates by time in season could not be calculated for high school as athlete-exposures were not stratified by time in season. National estimates and athlete-exposures may not sum up to totals due to rounding error. High school data originated from HS RIO surveillance data, 2005–2006 through 2013–2014; collegiate data originated from NCAA-ISP surveillance data, 2004–2005 through 2013–2014. Injuries included in the analysis were those that (1) occurred during a sanctioned practice or competition; (2) were evaluated or treated (or both) by an athletic trainer, physician, or other health care professional; and (3) restricted the student-athlete from participation for at least 24 hours past the day of injury. All concussions, fractures, and dental injuries were included in the analysis regardless of time loss. Data may include multiple injuries that occurred at 1 injury event.

Table 3. Number of Injuries and Injury Rates by Time Loss and Type of Athlete Exposure in High School Boys' and Collegiate Men's Basketball[a]

Surveillance System and Time Loss Category	Practice			Competition		
	Injuries in Sample, No. (%)	National Estimates, No. (%)	Injury Rate/ 1000 Athlete-Exposures (95% Confidence Interval)	Injuries in Sample, No. (%)	National Estimates, No. (%)	Injury Rate/ 1000 Athlete-Exposures (95% Confidence Interval)
HS RIO (2005–2006 through 2013–2014)						
1 d to <1 wk	743 (50.9)	194 078 (50.9)	0.53 (0.50, 0.57)	670 (45.3)	171 322 (44.7)	1.14 (1.06, 1.23)
1 to 3 wk	472 (32.4)	123 332 (32.4)	0.34 (0.31, 0.37)	495 (33.5)	128 240 (33.4)	0.84 (0.77, 0.92)
>3 wk[b]	244 (16.7)	63 746 (16.7)	0.18 (0.15, 0.20)	315 (21.3)	83 949 (21.9)	0.54 (0.48, 0.60)
NCAA-ISP (2004–05 through 2013–2014)						
1 d to <1 wk	1844 (62.2)	36 419 (63.6)	2.67 (2.55, 2.79)	954 (62.0)	17 537 (61.0)	5.35 (5.01, 5.69)
1 to 3 wk	675 (22.8)	12 754 (22.3)	0.98 (0.90, 1.05)	319 (20.7)	5997 (20.9)	1.79 (1.59, 1.99)
>3 wk[b]	447 (15.1)	8069 (14.1)	0.65 (0.59, 0.71)	267 (17.3)	5211 (18.1)	1.50 (1.32, 1.68)

Abbreviations: HS RIO, High School Reporting Information Online; NCAA-ISP, National Collegiate Athletic Association Injury Surveillance Program.

[a] Excluded were 117 injuries reported in HS RIO and 101 injuries reported in the NCAA-ISP due to missing data for time loss. Percentages may not add up to 100.0 due to rounding error. High school data originated from HS RIO surveillance data, 2005–2006 through 2013–2014; collegiate data originated from NCAA-ISP surveillance data, 2004–2005 through 2013–2014. Injuries included in the analysis were those that (1) occurred during a sanctioned practice or competition; (2) were evaluated or treated (or both) by an athletic trainer, physician, or other health care professional; and (3) restricted the student-athlete from participation for at least 24 hours past the day of injury. All concussions, fractures, and dental injuries were included in the analysis regardless of time loss. Data may include multiple injuries that occurred at 1 injury event.

[b] Includes injuries that resulted in time loss over 3 weeks, medical disqualification, the athlete's choosing not to continue, the athlete's being released from team, or the season ending before the athlete returned to activity.

Table 4. Number of Injuries, National Estimates, and Injury Rates by Body Part Injured and Type of Athlete Exposure in High School Boys' and Collegiate Men's Basketball[a]

Surveillance System and Body Part Injured	Practice			Competition		
	Injuries in Sample, No. (%)	National Estimates, No. (%)	Injury Rate/ 1000 Athlete-Exposures (95% Confidence Interval)	Injuries in Sample, No. (%)	National Estimates, No. (%)	Injury Rate/ 1000 Athlete-Exposures (95% Confidence Interval)
HS RIO (2005–2006 through 2013–2014)						
Head/face	225 (14.8)	55 322 (14.0)	0.16 (0.14, 0.18)	328 (21.5)	88 277 (22.3)	0.56 (0.50, 0.62)
Neck	5 (0.3)	950 (0.2)	<0.01 (0.00, 0.01)	7 (0.5)	2288 (0.6)	0.01 (0.00, 0.02)
Shoulder/clavicle	44 (2.9)	11 486 (2.9)	0.03 (0.02, 0.04)	55 (3.6)	13 895 (3.5)	0.09 (0.07, 0.12)
Arm/elbow	28 (1.8)	8023 (2.0)	0.02 (0.01, 0.03)	45 (3.0)	10 968 (2.8)	0.08 (0.05, 0.10)
Hand/wrist	154 (10.1)	41 981 (10.6)	0.11 (0.09, 0.13)	126 (8.3)	31 417 (8.0)	0.21 (0.18, 0.25)
Trunk	87 (5.7)	24 276 (6.1)	0.06 (0.05, 0.08)	71 (4.7)	16 557 (4.2)	0.12 (0.09, 0.15)
Hip/thigh/upper leg	104 (6.8)	26 106 (6.6)	0.07 (0.06, 0.09)	98 (6.4)	24 452 (6.2)	0.17 (0.13, 0.20)
Knee	171 (11.2)	46 466 (11.7)	0.12 (0.10, 0.14)	193 (12.6)	52 786 (13.4)	0.33 (0.28, 0.38)
Lower leg	51 (3.4)	13 114 (3.3)	0.04 (0.03, 0.05)	37 (2.4)	9364 (2.4)	0.06 (0.04, 0.08)
Ankle	547 (35.9)	137 101 (34.6)	0.39 (0.36, 0.43)	498 (32.6)	126 123 (31.9)	0.85 (0.77, 0.92)
Foot	90 (5.9)	27 530 (7.0)	0.06 (0.05, 0.08)	64 (4.2)	17 984 (4.6)	0.11 (0.08, 0.14)
Other	16 (1.1)	3891 (1.0)	0.01 (0.01, 0.02)	6 (0.4)	1260 (0.3)	0.01 (0.00, 0.02)
NCAA-ISP (2004–2005 through 2013–2014)						
Head/face	400 (13.2)	8904 (15.0)	0.58 (0.52, 0.64)	226 (14.3)	4807 (16.2)	1.27 (1.10, 1.43)
Neck	24 (0.8)	505 (0.9)	0.03 (0.02, 0.05)	10 (0.6)	128 (0.4)	0.06 (0.02, 0.09)
Shoulder/clavicle	147 (4.9)	2764 (4.7)	0.21 (0.18, 0.25)	72 (4.6)	1232 (4.2)	0.40 (0.31, 0.50)
Arm/elbow	47 (1.6)	825 (1.4)	0.07 (0.05, 0.09)	28 (1.8)	414 (1.4)	0.16 (0.10, 0.22)
Hand/wrist	200 (6.6)	3638 (6.1)	0.29 (0.25, 0.33)	133 (8.4)	2804 (9.5)	0.75 (0.62, 0.87)
Trunk	219 (7.2)	3679 (6.2)	0.32 (0.28, 0.36)	98 (6.2)	1687 (5.7)	0.55 (0.44, 0.66)
Hip/thigh/upper leg	395 (13.0)	7104 (12)	0.57 (0.52, 0.63)	156 (9.9)	2773 (9.4)	0.88 (0.74, 1.01)
Knee	375 (12.4)	7575 (12.8)	0.54 (0.49, 0.60)	293 (18.6)	5483 (18.5)	1.64 (1.46, 1.83)
Lower leg	163 (5.4)	2925 (4.9)	0.24 (0.20, 0.27)	62 (3.9)	1183 (4.0)	0.35 (0.26, 0.43)
Ankle	758 (25.0)	15 725 (26.5)	1.10 (1.02, 1.18)	383 (24.3)	6823 (23.0)	2.15 (1.93, 2.36)
Foot	206 (6.8)	3802 (6.4)	0.30 (0.26, 0.34)	90 (5.7)	1844 (6.2)	0.50 (0.40, 0.61)
Other	96 (3.2)	1910 (3.2)	0.14 (0.11, 0.17)	26 (1.7)	469 (1.6)	0.15 (0.09, 0.20)

Abbreviations: HS RIO, High School Reporting Information Online; NCAA-ISP, National Collegiate Athletic Association Injury Surveillance Program.

[a] Excluded were 6 injuries reported in HS RIO due to missing data for body part. Percentages may not add up to 100.0 due to rounding error. High school data originated from HS RIO surveillance data, 2005–2006 through 2013–2014; collegiate data originated from NCAA-ISP surveillance data, 2004–2005 through 2013–2014. Injuries included in the analysis were those that (1) occurred during a sanctioned practice or competition; (2) were evaluated or treated (or both) by an athletic trainer, physician, or other health care professional; and (3) restricted the student-athlete from participation for at least 24 hours past the day of injury. All concussions, fractures, and dental injuries were included in the analysis regardless of time loss. Data may include multiple injuries that occurred at 1 injury event.

Table 5. Number of Injuries, National Estimates, and Injury Rates by Diagnosis and Type of Athlete Exposure in High School Boys' and Collegiate Men's Basketball[a]

Surveillance System and Diagnosis	Practice			Competition		
	Injuries in Sample, No. (%)	National Estimates, No. (%)	Injury Rate/ 1000 Athlete-Exposures (95% Confidence Interval)	Injuries in Sample, No. (%)	National Estimates, No. (%)	Injury Rate/ 1000 Athlete-Exposures (95% Confidence Interval)
HS RIO (2005–2006 through 2013–2014)						
Concussion	110 (7.2)	25 592 (6.5)	0.08 (0.06, 0.09)	192 (12.6)	49 774 (12.6)	0.33 (0.28, 0.37)
Contusion	104 (6.8)	25 630 (6.5)	0.07 (0.06, 0.09)	174 (11.4)	43 993 (11.2)	0.3 (0.25, 0.34)
Dislocation[b]	44 (2.9)	12 105 (3.1)	0.03 (0.02, 0.04)	35 (2.3)	10 079 (2.6)	0.06 (0.04, 0.08)
Fracture/avulsion	163 (10.7)	42 144 (10.7)	0.12 (0.10, 0.14)	186 (12.2)	52 896 (13.4)	0.32 (0.27, 0.36)
Laceration	51 (3.4)	13 043 (3.3)	0.04 (0.03, 0.05)	59 (3.9)	15 038 (3.8)	0.1 (0.07, 0.13)
Ligament sprain	658 (43.3)	169 457 (42.8)	0.47 (0.44, 0.51)	627 (41.1)	157 023 (39.9)	1.07 (0.99, 1.15)
Muscle/tendon strain	181 (11.9)	49 698 (12.6)	0.13 (0.11, 0.15)	123 (8.1)	29 941 (7.6)	0.21 (0.17, 0.25)
Other	209 (13.8)	58 109 (14.7)	0.15 (0.13, 0.17)	129 (8.5)	34 994 (8.9)	0.22 (0.18, 0.26)
NCAA-ISP (2004–2005 through 2013–2014)						
Concussion	312 (10.3)	6101 (10.3)	0.45 (0.40, 0.50)	225 (14.3)	3773 (12.8)	1.26 (1.10, 1.43)
Contusion	196 (6.5)	4702 (8.0)	0.28 (0.24, 0.32)	106 (6.7)	2283 (7.7)	0.59 (0.48, 0.71)
Dislocation[b]	53 (1.8)	910 (1.5)	0.08 (0.06, 0.10)	22 (1.4)	408 (1.4)	0.12 (0.07, 0.17)
Fracture/avulsion	163 (5.4)	3135 (5.3)	0.24 (0.20, 0.27)	116 (7.4)	2686 (9.1)	0.65 (0.53, 0.77)
Laceration	91 (3.0)	1728 (2.9)	0.13 (0.10, 0.16)	40 (2.5)	689 (2.3)	0.22 (0.15, 0.29)
Ligament sprain	986 (32.7)	20 178 (34.1)	1.43 (1.34, 1.52)	593 (37.7)	10 847 (36.7)	3.33 (3.06, 3.59)
Muscle/tendon strain	483 (16.0)	8760 (14.8)	0.70 (0.64, 0.76)	155 (9.9)	3056 (10.3)	0.87 (0.73, 1.01)
Other	732 (24.3)	13 663 (23.1)	1.06 (0.98, 1.14)	316 (20.1)	5851 (19.8)	1.77 (1.58, 1.97)

Abbreviations: HS RIO, High School Reporting Information Online; NCAA-ISP, National Collegiate Athletic Association Injury Surveillance Program.

[a] Excluded were 11 injuries reported in HS RIO and 18 injuries reported in the NCAA-ISP due to missing data for diagnosis. Percentages may not add up to 100.0 due to rounding error. High school data originated from HS RIO surveillance data, 2005–2006 through 2013–2014; collegiate data originated from NCAA-ISP surveillance data, 2004–2005 through 2013–2014. Injuries included in the analysis were those that (1) occurred during a sanctioned practice or competition; (2) were evaluated or treated (or both) by an athletic trainer, physician, or other health care professional; and (3) restricted the student-athlete from participation for at least 24 hours past the day of injury. All concussions, fractures, and dental injuries were included in the analysis regardless of time loss. Data may include multiple injuries that occurred at 1 injury event.

[b] Includes separations.

diagnosis from practices and competitions was ligament sprains (practices = 43.3%, competitions = 41.1%; Table 5). Other common injury diagnoses were muscle/tendon strains (11.9%) and fractures/avulsions (10.7%) from practices and concussions (12.6%), fractures/avulsions (12.2%), and contusions (11.4%) from competitions.

College. The most often injured body part in practices and competitions was the ankle (practices = 25.0%, competitions = 24.3%; Table 4). Other frequently injured body parts were the head/face (13.2%), hip/thigh/upper leg (13.0%), and knee (12.4%) in practices and the knee (18.6%) and head/face (14.3%) in competitions. The most common injury diagnosis in practices and competitions was ligament sprains (practices = 32.7%, competitions = 37.7%; Table 5). Other often reported injury diagnoses were muscle/tendon strains (16.0%) and concussions (10.3%) in practices and concussions (14.3%) in competitions.

Mechanisms of Injury and Activities

High School. The most common mechanisms of injury during practices and competitions were contact with another person (practices = 44.1%, competitions = 51.5%), no contact (practices = 21.2%, competitions = 16.9%), and contact with the playing surface (practices = 19.0%, competitions = 26.6%; Table 6). The most frequent activity during which injury occurred in practices and competitions was rebounding (practices = 26.3%, competitions = 29.0%; Table 7).

College. The most often reported mechanisms of injury during practices and competitions were contact with another person (practices = 46.0%, competitions = 53.0%), no contact (practices = 29.7%, competitions = 23.1%), and contact with the playing surface (practices = 10.2%, competitions = 16.2%; Table 6). The most common activities during which injury occurred in practices and competitions were general play (practices = 35.6%, competitions = 26.4%) and rebounding (practices = 19.8%, competitions = 22.8%; Table 7).

Position-Specific Injuries During Competitions

During both high school and collegiate competitions, the most frequent injury across all positions was ankle sprain due to contact with another person (Table 8). The second most common injury was concussion for all positions in high school and among collegiate guards and knee sprain among collegiate centers and forwards; contact with another person was the most frequent mechanism for each type of injury at both levels.

DISCUSSION

This study provides the most detailed comparison of injury epidemiology in high school boys' and collegiate men's basketball players to date. National annual estimates of approximately 88 000 injuries among boys' basketball players and approximately 8900 injuries among men's

Table 6. Number of Injuries, National Estimates, and Injury Rates by Mechanism of Injury and Type of Athlete Exposure in High School Boys' and Collegiate Men's Basketball[a]

Surveillance System and Mechanism of Injury	Practice			Competition		
	Injuries in Sample, No. (%)	National Estimates, No. (%)	Injury Rate/ 1000 Athlete-Exposures (95% Confidence Interval)	Injuries in Sample, No. (%)	National Estimates, No. (%)	Injury Rate/ 1000 Athlete-Exposures (95% Confidence Interval)
HS RIO (2005–2006 through 2013–2014)						
Contact with another person	656 (44.1)	165 457 (42.8)	0.47 (0.44, 0.51)	772 (51.5)	200 676 (51.9)	1.32 (1.22, 1.41)
Contact with playing surface	283 (19.0)	75 653 (19.6)	0.20 (0.18, 0.23)	399 (26.6)	99 856 (25.8)	0.68 (0.61, 0.75)
Contact with ball	84 (5.7)	22 996 (6.0)	0.06 (0.05, 0.07)	32 (2.1)	8300 (2.1)	0.05 (0.04, 0.07)
Contact with other playing equipment	13 (0.9)	2940 (0.8)	0.01 (0.00, 0.01)	14 (0.9)	4031 (1.0)	0.02 (0.01, 0.04)
Contact with out-of-bounds object	3 (0.2)	806 (0.2)	<0.01 (0.00, <0.01)	2 (0.1)	407 (0.1)	<0.01 (0.00, <0.01)
No contact	316 (21.2)	82 266 (21.3)	0.23 (0.20, 0.25)	253 (16.9)	65 182 (16.8)	0.43 (0.38, 0.48)
Overuse/chronic	110 (7.4)	29 640 (7.7)	0.08 (0.06, 0.09)	25 (1.7)	8272 (2.1)	0.04 (0.03, 0.06)
Illness/infection	23 (1.6)	6939 (1.8)	0.02 (0.01, 0.02)	2 (0.1)	304 (0.1)	<0.01 (0.00, <0.01)
NCAA-ISP (2004–2005 through 2013–2014)						
Contact with another person	1374 (46.0)	28 208 (48.7)	1.99 (1.88, 2.10)	826 (53.0)	15 896 (54.7)	4.63 (4.32, 4.95)
Contact with playing surface	304 (10.2)	6547 (11.3)	0.44 (0.39, 0.49)	252 (16.2)	4754 (16.4)	1.41 (1.24, 1.59)
Contact with ball	57 (1.9)	1019 (1.8)	0.08 (0.06, 0.10)	19 (1.2)	394 (1.4)	0.11 (0.06, 0.15)
Contact with other playing equipment	13 (0.4)	209 (0.4)	0.02 (0.01, 0.03)	7 (0.5)	162 (0.6)	0.04 (0.01, 0.07)
Contact with out-of-bounds object	14 (0.5)	181 (0.3)	0.02 (0.01, 0.03)	14 (0.9)	350 (1.2)	0.08 (0.04, 0.12)
No contact	886 (29.7)	15 806 (27.3)	1.28 (1.20, 1.37)	360 (23.1)	5978 (20.6)	2.02 (1.81, 2.23)
Overuse/chronic	250 (8.4)	4326 (7.5)	0.36 (0.32, 0.41)	56 (3.6)	1079 (3.7)	0.31 (0.23, 0.40)
Illness/infection	90 (3.0)	1651 (2.9)	0.13 (0.10, 0.16)	26 (1.7)	441 (1.5)	0.15 (0.09, 0.20)

Abbreviations: HS RIO, High School Reporting Information Online; NCAA-ISP, National Collegiate Athletic Association Injury Surveillance Program.

[a] Mechanism of injury excluded 69 injuries reported in HS RIO and 59 injuries reported in the NCAA-ISP due to missing data or athletic trainer reporting *Other* or *Unknown*. Percentages may not add up to 100.0 due to rounding error. High school data originated from HS RIO surveillance data, 2005–2006 through 2013–2014; collegiate data originated from NCAA-ISP surveillance data, 2004–2005 through 2013–2014. Injuries included in the analysis were those that (1) occurred during a sanctioned practice or competition; (2) were evaluated or treated (or both) by an athletic trainer, physician, or other health care professional; and (3) restricted the student-athlete from participation for at least 24 hours past the day of injury. All concussions, fractures, and dental injuries were included in the analysis regardless of time loss. Data may include multiple injuries that occurred at 1 injury event.

basketball players highlight the importance of injury-prevention efforts. Additionally, establishing epidemiologic trends of injuries among high school and collegiate basketball players may help guide targeted injury-prevention efforts. Broad similarities in distributions of injuries by body part, specific diagnosis, and mechanism of injury in high school and collegiate basketball players suggest that both levels may benefit from similar injury-prevention strategies, although variations in injury rates by time in season and school size and division indicate that some interventions more targeted to playing level may also be warranted.

Comparisons With Previous Research

Our reported injury rates in high school boys' basketball for the 2005–2006 through 2013–2014 academic years were slightly lower than those reported by previous authors[14] using only data from the 2005–2006 through 2006–2007 academic years. Compared with our injury rate of 1.55/1000 AEs, Borowski et al[14] observed an overall injury rate of 1.83/1000 AEs. Our practice and competition injury rates for men's collegiate basketball were similar to those in a report[6] from the 1988–1989 through 2003–2004 academic years. Compared with our practice and competition injury rates of 4.39/1000 AEs and 8.85/1000 AEs, respectively, Dick et al[6] noted practice and competition injury rates of 4.3/1000 AEs and 9.9/1000 AEs, respectively. The decreases in injury rates compared with other studies may be due to changes in rules and points of emphasis[7] over the past decade that have resulted in less player contact. Examples include changing the definition of flagrant fouls, emphasizing the calling of flagrant fouls, and creating more space under the basket during free throws. The definition of a flagrant foul has changed, and enforcement of such fouls has been emphasized, which may have resulted in players' intentionally fouling opponents less often.[7] Emphasizing the importance of calling fouls on activities used to illegally gain rebounding position may have resulted in fewer injuries in high school basketball players. Additionally, leaving the block closest to the basket open during free throws and moving the 3-point line back have created more space for players by the basket, potentially resulting in less player-to-player contact.[7]

Comparisons with previous findings should be made cautiously, however, as there may have been variations in data-collection procedures and injury definitions. Across our study period, no linear trends were seen for high school injury rates, but increases were observed in more recent years for collegiate injury rates. Thus, our results reinforce the need for the continued development of injury-prevention interventions that help to decrease the incidence and severity of basketball injuries. It is important to acknowledge that given small basketball roster sizes, the injury rates presented in this study did not result in a higher number of injuries for each basketball team. An average basketball team with 15 players would expect small numbers of time-loss injuries per season. Therefore, despite

Table 7. Number of Injuries, National Estimates, and Injury Rates by Activity During Injury and Type of Athlete Exposure (AE) in High School Boys' and Collegiate Men's Basketball[a]

	Practice			Competition		
Surveillance System and Activity During Injury	Injuries in Sample, No. (%)	National Estimates, No. (%)	Injury Rate/ 1000 Athlete-Exposures (95% Confidence Interval)	Injuries in Sample, No. (%)	National Estimates, No. (%)	Injury Rate/ 1000 Athlete-Exposures (95% Confidence Interval)
HS RIO (2005–2006 through 2013–2014)						
Ball handling	71 (5.0)	19 778 (5.3)	0.05 (0.04, 0.06)	104 (7.2)	25 456 (6.8)	0.18 (0.14, 0.21)
Conditioning	110 (7.7)	27 263 (7.3)	0.08 (0.06, 0.09)	192 (13.3)	51 410 (13.8)	0.33 (0.28, 0.37)
Defending	92 (6.5)	20 919 (5.6)	0.07 (0.05, 0.08)	4 (0.3)	1471 (0.4)	0.01 (0.00, 0.01)
General play	202 (14.2)	52 501 (14.1)	0.15 (0.13, 0.17)	267 (18.5)	66 225 (17.8)	0.46 (0.40, 0.51)
Loose ball	338 (23.7)	90 347 (24.3)	0.24 (0.22, 0.27)	199 (13.8)	52 599 (14.1)	0.34 (0.29, 0.39)
Passing	17 (1.2)	3603 (1.0)	0.01 (0.01, 0.02)	8 (0.6)	1815 (0.5)	0.01 (0.00, 0.02)
Rebounding	375 (26.3)	97 031 (26.1)	0.27 (0.24, 0.30)	419 (29.0)	108 728 (29.2)	0.71 (0.65, 0.78)
Receiving pass	70 (4.9)	20 065 (5.4)	0.05 (0.04, 0.06)	42 (2.9)	10 379 (2.8)	0.07 (0.05, 0.09)
Screening	18 (1.3)	4582 (1.2)	0.01 (0.01, 0.02)	9 (0.6)	2592 (0.7)	0.02 (0.01, 0.03)
Shooting	131 (9.2)	35 658 (9.6)	0.09 (0.08, 0.11)	200 (13.9)	51 793 (13.9)	0.34 (0.29, 0.39)
NCAA-ISP (2004–2005 through 2013–2014)						
Ball handling	128 (4.4)	1931 (3.4)	0.19 (0.15, 0.22)	105 (6.8)	1592 (5.6)	0.59 (0.48, 0.70)
Conditioning	136 (4.6)	2211 (3.9)	0.20 (0.16, 0.23)	3 (0.2)	44 (0.2)	0.02 (0.00, 0.04)
Defending	508 (17.3)	9936 (17.5)	0.74 (0.67, 0.80)	261 (16.9)	4665 (16.3)	1.46 (1.29, 1.64)
General play	1047 (35.6)	20 393 (36.0)	1.52 (1.42, 1.61)	408 (26.4)	8275 (29.0)	2.29 (2.07, 2.51)
Loose ball	214 (7.3)	4328 (7.6)	0.31 (0.27, 0.35)	177 (11.5)	3017 (10.6)	0.99 (0.85, 1.14)
Passing	38 (1.3)	694 (1.2)	0.06 (0.04, 0.07)	16 (1.0)	240 (0.8)	0.09 (0.05, 0.13)
Rebounding	582 (19.8)	11 662 (20.6)	0.84 (0.77, 0.91)	351 (22.8)	6713 (23.5)	1.97 (1.76, 2.18)
Receiving pass	45 (1.5)	831 (1.5)	0.07 (0.05, 0.08)	27 (1.8)	392 (1.4)	0.15 (0.09, 0.21)
Screening	43 (1.5)	716 (1.3)	0.06 (0.04, 0.08)	10 (0.7)	195 (0.7)	0.06 (0.02, 0.09)
Shooting	201 (6.8)	3955 (7.0)	0.29 (0.25, 0.33)	185 (12.0)	3414 (12.0)	1.04 (0.89, 1.19)

Abbreviations: HS RIO, High School Reporting Information Online; NCAA-ISP, National Collegiate Athletic Association Injury Surveillance Program.

[a] Activity excluded 188 injuries reported in HS RIO and 122 injuries reported in the NCAA-ISP due to missing data or athletic trainer reporting *Other* or *Unknown*. Percentages may not add up to 100.0 due to rounding error. High school data originated from HS RIO surveillance data, 2005–2006 through 2013–2014; collegiate data originated from NCAA-ISP surveillance data, 2004–2005 through 2013–2014. Injuries included in the analysis were those that (1) occurred during a sanctioned practice or competition; (2) were evaluated or treated (or both) by an athletic trainer, physician, or other health care professional; and (3) restricted the student-athlete from participation for at least 24 hours past the day of injury. All concussions, fractures, and dental injuries were included in the analysis regardless of time loss. Data may include multiple injuries that occurred at 1 injury event.

Table 8. Most Common Injuries Associated With Position in Competitions in High School Boys' and Collegiate Men's Basketball[a]

	HS RIO (2005–2006 Through 2013–2014)			NCAA-ISP (2004–2005 Through 2013–2014)		
Position	Most Common Injuries	Injuries Within Position, %	Most Frequent Mechanism of Injury for This Injury Within Position	Most Common Injuries	Injuries Within Position, %	Most Frequent Mechanism of Injury for This Injury Within Position
Center	Ankle sprain	34.9	Contact with another person	Ankle sprain	27.7	Contact with another person
	Concussion	9.6	Contact with another person	Knee sprain	8.0	Contact with another person
				Concussion	8.0	Contact with another person
Forward	Ankle sprain	29.9	Contact with another person	Ankle sprain	24.3	Contact with another person
	Concussion	12.8	Contact with another person	Knee sprain	7.3	Contact with another person
				Concussion	4.5	Contact with another person
Guard	Ankle sprain	29.8	Contact with another person	Ankle sprain	20.9	Contact with another person
	Concussion	12.8	Contact with another person	Concussion	7.7	Contact with another person
				Knee sprain	7.6	Contact with another person

Abbreviations: HS RIO, High School Reporting Information Online; NCAA-ISP, National Collegiate Athletic Association Injury Surveillance Program.

[a] Excluded were 55 competition injuries reported in HS RIO and 53 competition injuries reported in the NCAA-ISP due to position not being indicated. The table reads as follows: for the center position in high school, ankle sprains comprised 34.9% of all competition injuries to that position. The most common mechanism of injury for this specific injury for this specific position was contact with another person. High school data originated from HS RIO surveillance data, 2005–2006 through 2013–2014; collegiate data originated from NCAA-ISP surveillance data, 2004–2005 through 2013–2014. Injuries included in the analysis were those that (1) occurred during a sanctioned practice or competition; (2) were evaluated or treated (or both) by an athletic trainer, physician, or other health care professional; and (3) restricted the student-athlete from participation for at least 24 hours past the day of injury. All concussions, fractures, and dental injuries were included in the analysis regardless of time loss. Data may include multiple injuries that occurred at 1 injury event.

the inherent risk of injury during athletic participation, the risk may not outweigh the benefits of physical activity.

Injury Rates Between and Within High School and Collegiate Basketball

Although the number of injuries was higher in boy's high school basketball, the total injury rate was higher for men's collegiate players (IRR = 3.43; 95% CI = 3.28, 3.59). The increased injury rate may be due to a greater intensity of play in collegiate basketball. Taller and stronger players at the collegiate level may also create greater forces during play, potentially increasing the risk of injury. Previous research[15–17] supports this hypothesis, as injury rates appeared to be greater among more skilled athletes in various sports. The true relationship between skill level and injury, however, is unclear. Chomiak et al[18] identified the risk of injury in football as possibly twice as large for low-skill–level groups compared with high-skill–level groups within a single competition level. However, Harmon and Dick[19] did not observe a relationship between the risk of anterior cruciate ligament injury and NCAA men's basketball division level. In this study, we did not examine variations in injury rates by skill levels within each competition level. Thus, the role of skill level at each competition level warrants further examination. In addition, the athletes' developmental stages were not assessed and, therefore, we were not able to ascertain the specific relationship between development and injury.

When examining injury rates within competition levels, we found that rates were higher among small high schools compared with large high schools, which could be due to smaller schools having fewer resources, such as full-time AT coverage or more experienced coaches, and potentially being less likely to implement injury-prevention strategies. Smaller schools may also have fewer highly skilled athletes, resulting in less-skilled athletes on sports teams and potentially placing them at greater risk for injury. However, as previously discussed, the true relationship between skill level and injury risk is unclear. Additionally, injury rates were higher in Division I collegiate basketball compared with Divisions II and III. Division III had a higher injury rate than Division II. The increased injury rate among Division I men's basketball players may also reflect the higher intensity of play associated with this competition level.[15–17]

Event Type

Injury rates, overall as well as by body part and specific diagnosis, were greater during competitions than practices for both high school (overall IRR = 2.38; 95% CI = 2.22, 2.56) and collegiate basketball (overall IRR = 2.02; 95% CI = 1.90, 2.14). This finding is similar to the results of previous authors[6,11,20–28] who identified increased injury rates during competitions compared with practices across various competition levels and sports. Earlier HS RIO surveillance data[11] showed that the competition injury rate in high school boys' basketball was twice as large as the practice injury rate (IRR = 2.05; 95% CI = 1.69, 2.49). Hootman et al[20] noted that the competition injury rate in collegiate athletics was approximately 3.5 times larger than the practice injury rate. These findings indicate that game-play intensity appears greater during competitions compared with practices. One explanation for this increased intensity may be that athletes are willing to place themselves at risk of injury during games. Researchers[29] have suggested that individuals may be more willing to take risks if they feel the potential gain is meaningful enough. The perceived gain of winning a game may be sufficiently meaningful for athletes to take greater risks compared with practices. These findings may also be influenced by changes in practices over the course of a season. Teams may reduce practice time or the amount of drills involving contact late in a season, potentially reducing the likelihood of injury during these sessions and creating a discrepancy in injury rates between event types.

Common Injuries and Mechanisms

The most frequently injured body parts in high school boys' basketball and collegiate men's basketball were the ankle, knee (including both the tibiofemoral joint and the patellofemoral articulation), and head/face. These findings are similar to those of previous researchers[6,11,14,20,21] who indicated that the ankle and knee were commonly injured in basketball. Borowski et al[14] identified 43.2%, 10.6%, and 12.8% of all high school boys' basketball injuries from 2005 to 2007 as affecting the ankle/foot, knee, and head/face, respectively. Similarly, Hootman et al[20] cited the lower extremity as the most frequently injured body part across 15 collegiate sports. Dick et al[6] described the most often injured body parts among collegiate basketball players from 1988–1989 through 2003–2004 as the ankle (practice IRR = 1.06/1000 AEs, competition IRR = 2.33/1000 AEs) and knee (practice IRR = 0.25/1000 AEs, competition IRR = 0.66/1000 AEs).

The most frequent injury diagnoses in high school boys' basketball and collegiate men's basketball were ligament sprains, muscle/tendon strains, and concussions. These findings are consistent with previous research[6,11,14] and highlight the importance of injury-prevention programs designed to reduce ankle and knee injuries. Additionally, the concussion injury rate identified in this study highlights the continued importance of appropriate concussion recognition and management in basketball players.

The most common injury mechanisms were similar between high school and collegiate basketball players. Despite rules and points of emphasis intended to minimize the amount of contact in the sport,[7] contact with another person was the most frequent mechanism of injury at both levels. This finding supports previous research.[6,21] Tolbert et al[21] identified 58% of competition injuries and 41.6% of practice injuries in collegiate athletics as resulting from contact with another player. Noncontact and contact with the playing surface were the second and third most reported injury mechanisms, respectively. These findings are similar to those of Dick et al,[6] who showed that 20.9% and 20.8% of collegiate men's basketball injuries occurring during competition were due to contact with the playing surface and noncontact mechanisms, respectively. The distribution of injuries by mechanism highlights the need for injury-prevention strategies that target a wide range of injury mechanisms.[30–35] For example, basketball players may benefit from injury-prevention programs that simulate player contact in a safe manner, as in the Fédération Internationale de Football Association 11+ program[30,32]

developed for soccer players. Programs such as the Fédération Internationale de Football Association 11+ may be especially beneficial because of their focus on neuromuscular control to prevent lower extremity injuries, particularly those affecting the knee, which, according to our findings, account for a large percentage of all basketball injuries. These results also emphasize the need to enforce rules to improve player safety. Given the large proportion of injuries affecting the head/face, enforcing player-contact rules may be especially important for reducing these types of injuries during games. At the high school level, enforcement of such rules during rebounding could be particularly effective. At both levels, stressing rule enforcement of players scrambling for loose balls may help to reduce the number of injuries occurring from contact with the playing surface. Modifying practices may also reduce the number of head/face injuries that occur in practice, mainly by decreasing the number of drills performed that involve player contact, such as rebounding drills.

Limitations

Our findings may not be generalizable to other playing levels, such as youth, middle school, and professional programs, or collegiate programs at non-NCAA institutions, or high schools without ATs. Furthermore, we were unable to account for factors potentially associated with injury occurrence, such as AT coverage, injury-prevention programs, and athlete-specific characteristics (eg, previous injury, functional capabilities, developmental stage). Also, although HS RIO and the NCAA-ISP are similar injury-surveillance systems, it is important to consider the differences between these systems; most evident is the fact that HS RIO used a random sample, whereas the NCAA-ISP used a convenience sample. In addition, differences may exist between high school and collegiate levels with regard to the length of the season, as well as the preseason, regular season, and postseason; the potentially longer collegiate season may increase the injury risk. We calculated injury rates using AEs, which may not be as precise an at-risk exposure measure as minutes, hours, or total number of game plays across a season. However, collection of such exposure data is more laborious than for AE data and may be too burdensome for ATs collecting data for HS RIO and the NCAA-ISP.

Although our study is one of the few to examine injury incidence across multiple levels of play (eg, high school versus college and competition versus practice), we were unable to examine differences between starters and nonstarters during competitions. Differences may also exist among freshman, junior varsity, and varsity teams due to differences in maturation status. Playing positions may vary in physical demands and the resulting injury risk. Also, AEs were not collected by position, preventing calculation of position-specific injury rates.

CONCLUSIONS

Injury-surveillance data were used to describe injury rates and patterns among high school boys' and collegiate men's basketball players from 2004–2005 through 2013–2014. We identified differences in injury rates by competition level and event type. Injury rates were greater in collegiate basketball and during competitions than practices at both levels. Similarities in distributions of injuries by body part, specific diagnosis, and mechanism of injury suggest that athletes at the 2 levels may benefit from similar injury-prevention strategies. However, variations in injury rates by school size and division indicate that some interventions targeted more at the playing level may also be warranted. Although the risk of injury in basketball is low during participation, our findings should nonetheless aid in the development of future injury-prevention strategies to further protect the health, safety, and well-being of basketball athletes.

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