

# Epidemiology of Injuries in National Collegiate Athletic Association Men's Basketball: 2014–2015 Through 2018–2019

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**Context:** Basketball has remained a popular sport for players and spectators in the United States since before the first National Collegiate Athletic Association men's championship tournament in 1939.

**Background:** Routine examinations of men's basketball injuries are important for identifying emerging temporal patterns.

**Methods:** Exposure and injury data collected in the National Collegiate Athletic Association Injury Surveillance Program during 2014–2015 through 2018–2019 athletic seasons were analyzed. Injury counts, rates, and proportions were used to describe injury characteristics, and injury rate ratios were used to examine differences in injury rates.

**Results:** The overall injury rate was 7.28 per 1000 athlete exposures, with competition rates twice those of practices (injury rate ratio = 2.07; 95% CI = 1.93, 2.22). Injuries to the ankle (22.2%), knee (13.0%), head/face (11.3%), and hand/wrist (10.1%) accounted for most reported injuries, with sprains (30.4%), contusions (14.3%), and strains (13.9%) most commonly reported. Ankle sprain rates initially trended upward and decreased between 2017–2018 and 2018–2019; concussion rates remained relatively stable during 2014–2015 through 2018–2019.

**Conclusions:** Findings suggest that common injury rates are trending downward relative to previous study findings.

**Key Words:** collegiate, sport-related, surveillance

## Key Points

- Across the study period, the competition injury rate was consistently higher than the practice injury rate in NCAA men's basketball.
- The preseason injury rate was higher than the regular season and postseason injury rates across the study period, and was higher than previously reported preseason injury rates in NCAA men's basketball.
- The most commonly reported specific injuries were ankle sprains, and concussions; ankle sprain rates decreased over time while concussion rates remained relatively stable across the study period.

Basketball is a widely popular sport among all age groups.<sup>1,2</sup> In the United States alone, collegiate men's basketball rosters included nearly 19 000 participants across 1087 National Collegiate Athletic Association (NCAA) membership teams during the 2018–2019 athletic season, with participation remaining steady since 2014–2015.<sup>2</sup> Furthermore, the 2018–2019 NCAA men's basketball tournament garnered an average of 10.5 million television viewers and reported more than 100 million live streams online, along with more than 72 000 fans in attendance for the semifinals and national championship game.<sup>3</sup> With such interest in and attention on the sport, gameplay in NCAA men's basketball is dynamic, sophisticated, and rapidly evolving with regards to athlete preparedness. For instance, in recent years workload monitoring has gained notable traction in NCAA

sports, with workload management aimed at reducing injury risk.<sup>4,5</sup> Furthermore, NCAA basketball rules are also routinely amended with careful consideration of athlete health and safety. For instance, in 2015–2016, the restricted area arc was extended from 3 feet to 4 feet from the center of the basket.<sup>6</sup> Similarly, in 2017–2018, it was clarified that a player dunking the ball may hold onto the rim to avoid potential injury, even if it would result in another violation (eg, goaltending).<sup>7</sup> Given that such adaptations in the game may affect injury incidence, frequent examinations of men's basketball-related injuries and outcomes are warranted to assess temporal trends in injury incidence.

The NCAA Injury Surveillance Program (ISP) is a well-established prospective sports injury surveillance system for monitoring injuries that occur during participation in collegiate athletic events and time spent exposed to injury risk.<sup>8,9</sup> The NCAA ISP has served a critical role in examining NCAA men's basketball-related injuries over time,<sup>10,11</sup> and from these data, it has been previously estimated that the overall injury rate in this population is

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approximately 5 injuries per 1000 athlete exposures (AEs).<sup>10</sup> Furthermore, previous reports have also consistently identified ankle sprains, knee sprains, and concussion as frequently occurring injuries in this athlete population.<sup>10,11</sup> Importantly, the extant literature on the epidemiology of injuries in NCAA men's basketball has identified minimal change in practice injury rates over time; however, competition injury rates appeared to decrease from 9.9 per 1000 AEs during 1988–1989 through 2003–2004 to 8.9 per 1000 AEs during 2004–2005 through 2013–2014.<sup>10,11</sup> This decreasing trajectory of competition injury rates has been (at least partially) attributed to changes in competition playing rules<sup>6,12</sup> and further indicate the need for routine appraisals of injury incidence. Identifying changes in injury types and rates over time can help stakeholders implement strategies to help combat any emerging injury trends. Accordingly, the purpose of this study was to describe the epidemiology of sport-related injuries among NCAA men's basketball student-athletes during the 2014–2015 through 2018–2019 academic years.

## METHODS

### Study Data

Men's basketball exposure and injury data collected in the NCAA ISP during the 2014–2015 through 2018–2019 athletic seasons were analyzed in this study. The methods of the NCAA ISP have been reviewed and approved as an exempt study by the NCAA Research Review Board. Briefly, athletic trainers (ATs) at participating institutions contributed exposure and injury data using their clinical electronic medical record systems. A reportable injury was one that occurred due to participation in an organized intercollegiate practice or competition and required medical attention by a team certified AT or physician, regardless of time loss. Scheduled team practices and competitions were considered reportable exposures for this analysis. Data from 39 (4% of membership) participating programs in 2014–2015, 29 (3% of membership) in 2015–2016, 34 (3% of membership) in 2016–2017, 44 (4% of membership) in 2017–2018, and 130 (12% of membership) in 2018–2019 qualified for inclusion in analyses. Qualification criteria are detailed further in the methods manuscript within this special issue.<sup>13</sup>

### Statistical Analysis

Injury counts and rates per 1000 AEs were examined by event type (practice, competition), competition level (Division I, Division II, Division III), season segment (preseason, regular season, postseason), and time loss (time loss [TL], non-time loss [NTL]). An AE was defined as 1 athlete participating in 1 exposure event. Poststratification sample weights by sport and division are established within the surveillance system to compute national estimates of injury events based on the sampled teams; weighted and unweighted rates were estimated for this study, and results are presented in terms of unweighted rates unless otherwise specified (due to low frequencies of injury observations across levels of certain covariates). Temporal trends in injury rates across the study period were qualitatively described using rate profile plots stratified by levels of exposure characteristics. Similarly, temporal trends in rates

of most commonly reported injuries were also qualitatively described across the study period. Injury counts and proportions were examined by TL, body part injured, injury mechanism, injury diagnosis, player position, and activity at the time of injury. Injury rate ratios (IRRs) were used to examine differential injury rates across event types, competition levels, and season segments. IRRs with associated 95% CIs excluding 1.00 were considered statistically significant. All analyses were conducted using SAS version 9.4 (SAS Institute).

## RESULTS

A total of 3481 men's basketball injuries from 478 150 AEs were reported to the NCAA ISP during the 2014–2015 through 2018–2019 athletic seasons (rate = 7.28 per 1000 AEs). This equated to a national estimate of 75 059 injuries overall (Table 1). Across the study period, the competition injury rate was higher than the practice injury rate (IRR = 2.07; 95% CI = 1.93, 2.22). Competition injury rates were highest in 2015–2016, steadily decreasing through 2017–2018 but with an increase in 2018–2019. Practice injury rates remained relatively stable between 2014–2015 and 2017–2018, increasing thereafter during the last year of the study (Figure A). The overall Division I injury rate was the highest among all divisions (rate = 7.89 per 1000 AEs), followed by Division II (rate = 7.47 per 1000 AEs) and Division III (rate = 6.30 per 1000 AEs). Statistically significant differences were observed when comparing Division I and Division III rates (IRR = 1.25; 95% CI = 1.15, 1.36) and Division II and Division III rates (IRR = 1.19; 95% CI = 1.09, 1.30); there was no statistically significant difference between rates observed in Division I and Division II (Table 1).

### Injuries by Season Segment

A total of 988 preseason injuries (national estimate: 22,070), 2391 regular season injuries (national estimate: 51,100) and 102 postseason injuries (national estimate: 1889) were reported between 2014–2015 and 2018–2019 (Table 2). The preseason injury rate was higher than regular season (IRR = 1.34; 95% CI = 1.25, 1.44) and postseason injury rates (IRR = 1.81; 95% CI = 1.47, 2.22). Preseason and regular season injury rates followed a similar trend, with a slight increase between 2014–2015 and 2015–2016, then a steady decrease through 2017–2018, followed by a sizeable increase in 2018–2019 (Figure B). The postseason injury rate increased sharply between 2015–2016 and 2016–2017, decreasing the next season, and increasing again in 2018/19 (Figure B).

### Time Loss

Similar proportions of TL and NTL injuries were reported (TL: 41.1%; NTL: 41.3%); TL was not recorded in approximately 18% of all reported injuries. Of the 1432 reported TL injuries, a larger proportion was observed in practice (66.3%) than competitions (33.7%). Competition-related TL injury rates increased between 2014–2015 and 2016–2017, decreased sharply in 2017–2018, then increased again in 2018–2019 (Figure C). Practice-related TL injuries increased slightly between 2014–2015 and 2015–

**Table 1. Reported and National Estimates of Injuries, Athlete Exposures (AEs), and Rates per 1000 AEs by Event Type Across Divisions<sup>a</sup>**

Division	Number AEs Rate per 1000 AEs (95% CI)					
	Overall		Practices		Competitions	
	Reported	National Estimate	Reported	National Estimate	Reported	National Estimate
I	1469	26 582	881	15 782	588	10 800
	186 238	3 826 179	146 181	3 039 758	40 057	786 420
	7.89 (7.48, 8.29)	6.95 (6.54, 7.35)	6.03 (5.63, 6.42)	5.19 (4.79, 5.59)	14.68 (13.49, 15.87)	13.73 (12.55, 14.92)
II	1105	23 027	674	13 856	431	9172
	147 876	2 752 381	111 384	2 091 330	36 492	661 051
	7.47 (7.03, 7.91)	8.37 (7.93, 8.81)	6.05 (5.59, 6.51)	6.63 (6.17, 7.08)	11.81 (10.70, 12.93)	13.87 (12.76, 14.99)
III	907	25 449	578	16 587	329	8862
	144 036	4 221 158	108 742	3 195 054	35 294	1 026 104
	6.30 (5.89, 6.71)	6.03 (5.62, 6.44)	5.32 (4.88, 5.75)	5.19 (4.76, 5.62)	9.32 (8.31, 10.33)	8.64 (7.63, 9.64)
Overall	3481	75 059	2133	46 225	1348	28 833
	478 150	10 799 718	366 307	8 326 143	111 843	2 473 575
	7.28 (7.04, 7.52)	6.95 (6.71, 7.19)	5.82 (5.58, 6.07)	5.55 (5.30, 5.80)	12.05 (11.41, 12.70)	11.66 (11.01, 12.30)

<sup>a</sup> Data presented in the order of reported number, followed by AEs, estimated injury rates, and associated 95% CIs for each cross-tabulation of division and event types. Data pooled association wide are presented overall and separately for practices and competitions. National estimates were produced using sampling weights estimated based on sport, division, and year. All CIs were constructed using variance estimates calculated on the basis of reported data. A reportable injury was one that occurred due to participation in an organized intercollegiate practice or competition and required medical attention by a team certified athletic trainer or physician (regardless of time loss). Only scheduled team practices and competitions were retained in this analysis.

2016, then steadily decreased through 2017–2018, and increased slightly in 2018–2019 (Figure C).

**Injury Characteristics**

Injuries to the ankle (22.2%), knee (13.0%), head/face (11.3%), and hand/wrist (10.1%) accounted for the largest proportions of all injuries reported during the study period. The most prevalently reported contact injury mechanisms were player contact (42.4%) and surface contact (15.0%). Player contact injuries and surface contact injuries accounted for larger proportions of competition injuries

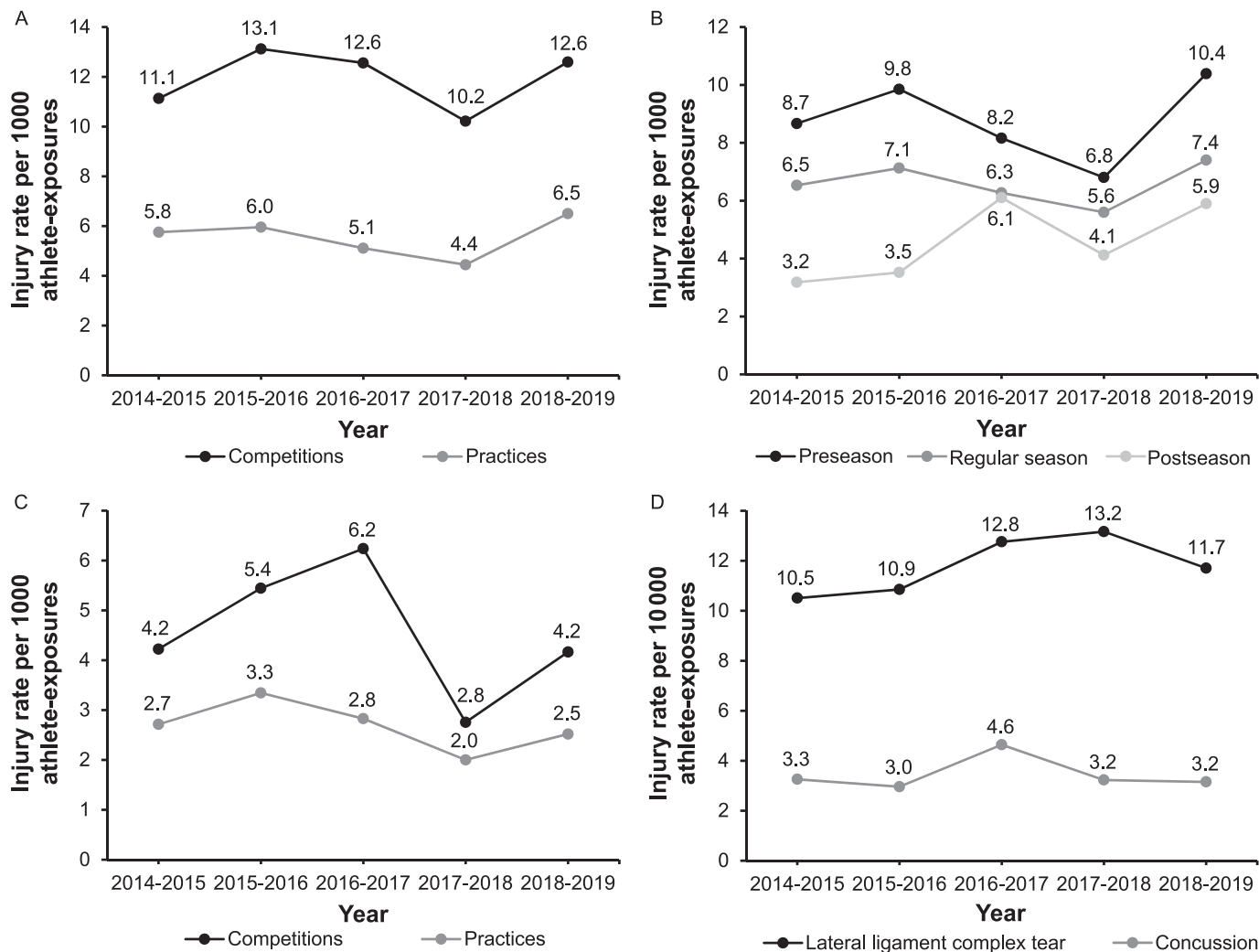
than practice injuries (Table 3). Noncontact injuries also accounted for a notable proportion (21.2%) of all reported injuries; relatively similar proportions of competition (19.1%) and practice (22.6%) injuries were attributed to this injury mechanism.

Most men’s basketball injuries reported between 2014–2015 and 2018–2019 were sprains (30.4%), contusions (14.3%), and strains (13.9%). While the sprains and strains accounted for comparable proportions of competition (32.2% and 13.2%, respectively) and practice (29.3% and 14.4%, respectively) injuries, a larger proportion of

**Table 2. Reported and National Estimates of Injuries, Athlete Exposures (AEs), and Rates per 1000 AEs by Season Segment Across Divisions<sup>a</sup>**

Division	Number AEs Rate per 1000 AEs (95% CI)					
	Preseason		Regular Season		Post Season	
	Reported	National Estimate	Reported	National Estimate	Reported	National Estimate
I	427	7556	980	17 895	62	1131
	43,317	893 902	133 074	2 728 468	9847	203 809
	9.86 (8.92, 10.79)	8.45 (7.52, 9.39)	7.36 (6.90, 7.83)	6.56 (6.10, 7.02)	6.30 (4.73, 7.86)	5.55 (3.98, 7.12)
II	289	6108	788	16 442	28	477
	29 877	578 523	112 400	2 070 922	5599	102 936
	9.67 (8.56, 10.79)	10.56 (9.44, 11.67)	7.01 (6.52, 7.50)	7.94 (7.45, 8.43)	5.00 (3.15, 6.85)	4.63 (2.78, 6.49)
III	272	8406	623	16 763	12	280
	34 654	1 036 077	104 705	3 044 852	4677	140 230
	7.85 (6.92, 8.78)	8.11 (7.18, 9.05)	5.95 (5.48, 6.42)	5.51 (5.04, 5.97)	2.57 (1.11, 4.02)	2.00 (0.55, 3.45)
Overall	988	22 070	2391	51 100	102	1889
	107 847	2 508 501	350 179	7 844 242	20 124	446 974
	9.16 (8.59, 9.73)	8.80 (8.23, 9.37)	6.83 (6.55, 7.10)	6.51 (6.24, 6.79)	5.07 (4.08, 6.05)	4.23 (3.24, 5.21)

<sup>a</sup> Data presented in the order of reported number, followed by AEs, estimated injury rates, and associated 95% CIs for each cross-tabulation of division and season segment. Data pooled association wide are presented overall and separately for preseason, regular season, and postseason. National estimates were produced using sampling weights estimated based on sport, division, and year. All CIs were constructed using variance estimates calculated on the basis of reported data. A reportable injury was one that occurred due to participation in an organized intercollegiate practice or competition and required medical attention by a team certified athletic trainer or physician (regardless of time loss). Only scheduled team practices and competitions were retained in this analysis.



**Figure.** Temporal patterns in injury rates between 2014-15 through 2018-2019. **A,** Overall injury rates (per 1000 athlete exposures [AEs]) stratified by event type (practices, competitions). **B,** Injury rates (per 1000 AEs) stratified by season segment. **C,** Rates (per 1000 AEs) of time loss injuries stratified by event type (practices, competitions). **D,** Rates (per 1000 AEs) of most commonly reported injuries. Rates presented in all figures are unweighted and based on reported data.

competition-related injuries (17.4%) than practice-related injuries (12.3%) were contusions. The most commonly reported specific injuries during the study period were partial or complete lateral ligament complex tears (ankle sprains; 16.2%), concussions (4.6%), and quadriceps contusions (2.5%). Rates of ankle lateral ligament complex tears steadily increased between 2014–2015 and 2017–2018, then decreased in 2018–2019 (Figure D). Concussion rates remained relatively stable throughout the study period (Figure D). Temporal patterns in incidence of quadriceps contusions were not examined due to low frequencies of this injury reported during certain years of the study period.

### Injuries by Basketball-Specific Activities and Playing Positions

Most injuries in men's basketball between 2014–2015 and 2018–2019 occurred during general play (30.4%). Defending (15.6%) and rebounding (15.4%) also accounted for notable proportions of all reported injuries (Table 4). Guards accounted for the largest proportion of injured

athletes (48.9%), followed by forwards (29.6%) and centers (15.5%).

### SUMMARY

The purpose of this study was to describe the epidemiology of NCAA men's basketball injuries during the 2014–2015 through 2018–2019 athletic seasons. Similar to previous findings in this population (competition injury rates 8.9–9.9 per 1000 AEs; practice injury rates: 4.3–4.4 per 1000 AEs),<sup>10,11</sup> the competition injury rate was higher than the practice injury rate in the present study (Table 1). Notably, both the practice and competition injury rates observed between 1988–1989 through 2003–2004 and 2004–2005 through 2013–2014 were lower than the practice (5.8 per 1000 AEs) and competition (12.1 per 1000 AEs) injury rates across the present study period (although previous studies have only included TL injuries in analyses).<sup>10,11</sup> While the reasons for these increases may be understandably multifactorial, given the observed increasing trajectory of practice and competition injury rates, injury incidence across both event types should be

**Table 3. Distribution of Injuries by Body Part, Mechanism, and Injury Diagnosis Stratified by Event Type<sup>a</sup>**

	Overall		Competitions		Practices	
	Injuries Reported (%)	National Estimate (%)	Injuries Reported (%)	National Estimate (%)	Injuries Reported (%)	National Estimate (%)
<b>Body part</b>						
Head/face	394 (11.32)	9075 (12.09)	147 (10.91)	3201 (11.10)	247 (11.58)	5874 (12.71)
Neck	28 (0.80)	753 (1.00)	13 (0.96)	342 (1.19)	15 (0.70)	410 (0.89)
Shoulder	191 (5.49)	4353 (5.80)	95 (7.05)	2169 (7.52)	96 (4.50)	2183 (4.72)
Arm/elbow	81 (2.33)	1879 (2.50)	37 (2.74)	841 (2.92)	44 (2.06)	1038 (2.25)
Hand/wrist	352 (10.11)	7050 (9.39)	142 (10.53)	2884 (10.00)	210 (9.85)	4166 (9.01)
Trunk	243 (6.98)	4820 (6.42)	92 (6.82)	1704 (5.91)	151 (7.08)	3116 (6.74)
Hip/groin	234 (6.72)	4857 (6.47)	81 (6.01)	1609 (5.58)	153 (7.17)	3248 (7.03)
Thigh	211 (6.06)	4570 (6.09)	69 (5.12)	1627 (5.64)	142 (6.66)	2943 (6.37)
Knee	451 (12.96)	9404 (12.53)	167 (12.39)	3499 (12.14)	284 (13.31)	5905 (12.77)
Lower leg	202 (5.80)	4470 (5.96)	72 (5.34)	1602 (5.56)	130 (6.09)	2868 (6.20)
Ankle	772 (22.18)	17 343 (23.11)	317 (23.52)	7139 (24.76)	455 (21.33)	10 204 (22.07)
Foot	244 (7.01)	4858 (6.47)	92 (6.82)	1726 (5.99)	152 (7.13)	3132 (6.78)
Other	78 (2.24)	1629 (2.17)	24 (1.78)	492 (1.71)	54 (2.53)	1138 (2.46)
<b>Mechanism</b>						
Player contact	1476 (42.40)	32 922 (43.86)	621 (46.07)	14 239 (49.38)	855 (40.08)	18 684 (40.42)
Surface contact	521 (14.97)	10 595 (14.12)	258 (19.14)	5054 (17.53)	263 (12.33)	5541 (11.99)
Ball contact	69 (1.98)	1638 (2.18)	13 (0.96)	365 (1.27)	56 (2.63)	1272 (2.75)
Other apparatus Contact	29 (0.83)	749 (1.00)	13 (0.96)	323 (1.12)	16 (0.75)	426 (0.92)
Out of bounds Contact	16 (0.46)	314 (0.42)	8 (0.59)	132 (0.46)	8 (0.38)	182 (0.39)
Noncontact	738 (21.20)	16 216 (21.60)	257 (19.07)	5469 (18.97)	481 (22.55)	10 748 (23.25)
Overuse	333 (9.57)	7121 (9.49)	68 (5.04)	1402 (4.86)	265 (12.42)	5719 (12.37)
Other/unknown	299 (8.59)	5503 (7.33)	110 (8.16)	1850 (6.42)	189 (8.86)	3653 (7.90)
<b>Diagnosis</b>						
Abrasion/laceration	137 (3.94)	3215 (4.28)	54 (4.01)	1191 (4.13)	83 (3.89)	2024 (4.38)
Concussion	160 (4.60)	3794 (5.05)	59 (4.38)	1335 (4.63)	101 (4.74)	2459 (5.32)
Contusion	496 (14.25)	9969 (13.28)	234 (17.36)	5095 (17.67)	262 (12.28)	4874 (10.54)
Dislocation/subluxation	112 (3.22)	2585 (3.44)	48 (3.56)	1138 (3.95)	64 (3.00)	1447 (3.13)
Fracture	106 (3.05)	2139 (2.85)	41 (3.04)	824 (2.86)	65 (3.05)	1316 (2.85)
Illness/infection	14 (0.40)	355 (0.47)	3 (0.22)	52 (0.18)	11 (0.52)	303 (0.66)
Inflammatory condition	296 (8.50)	6349 (8.46)	80 (5.93)	1485 (5.15)	216 (10.13)	4863 (10.52)
Spasm	126 (3.62)	2144 (2.86)	41 (3.04)	617 (2.14)	85 (3.98)	1527 (3.30)
Sprain	1059 (30.42)	23 779 (31.68)	434 (32.20)	9621 (33.37)	625 (29.30)	14 158 (30.63)
Strain	485 (13.93)	11 055 (14.73)	178 (13.20)	4094 (14.20)	307 (14.39)	6960 (15.06)
Other	490 (14.08)	9675 (12.89)	176 (13.06)	3380 (11.72)	314 (14.72)	6295 (13.62)

<sup>a</sup> Data presented in the order of reported number, followed by the proportions of all injuries attributable to a given category. Data pooled across event types are presented overall and separately for practices and competitions. National estimates were produced using sampling weights estimated based on sport, division, and year. A reportable injury was one that occurred due to participation in an organized intercollegiate practice or competition and required medical attention by a team certified athletic trainer or physician (regardless of time loss). Only scheduled team practices and competitions were retained in this analysis.

closely monitored after 2018–2019 to determine whether this pattern is maintained.

Preseason injury rates were higher than rates during regular and postseason play. While previous researchers have also noted similarly increasing patterns in preseason injury rates,<sup>10,11</sup> there was a marked increase in the preseason injury rate observed here (9.2 per 1000 AEs) compared with the most recently reported preseason injury rate (7.8 per 1000 AEs) observed between 2004–2005 through 2013–2014.<sup>10</sup> This cumulative evidence suggests a potential need to direct specific attention toward player health and safety in preseason. This may be particularly salient considering that notable rule changes expanding organized practice periods during the summer months and in September/October were introduced in 2012–2013.<sup>14</sup> Implementing preseason conditioning programs focused on injury prevention and monitoring training loads during this time may be important protective factors as emerging evidence suggests that such approaches can help reduce injury incidence.<sup>5</sup>

The most common injury diagnoses reported in NCAA men's basketball were sprains, contusions, and strains. Lateral ligament complex tears (partial or complete, ankle sprain) have been reported as the most common injury in this athlete population for nearly 3 decades, although the overall injury rate appears to be decreasing over time.<sup>10,11</sup> Specific to the time period of this study, the incidence of ankle sprains increased over the first 4 years, then decreased in the final year. Reasons for the observed decrease in 2018–2019 are unclear, but a potential contributing factor may have been the increase in participation during this athletic season reflecting a more precise and stable estimate than in years prior. An increasing trend in incidence of head/face injuries has been observed in previous studies, and concussion has been identified as one of the most frequently occurring injuries.<sup>10,11</sup> Across the study period, 75% of concussions were TL injuries (note that TL information was not captured in 21.9% of concussions). Similar to previous findings, concussion rates in competitions were higher than

**Table 4. Distribution of Injuries by Injury Activity and Playing Position Stratified by Event Type<sup>a</sup>**

	Overall		Competitions		Practices	
	Injuries Reported (%)	National Estimate (%)	Injuries Reported (%)	National Estimate (%)	Injuries Reported (%)	National Estimate (%)
<b>Activity</b>						
Ball handling	62 (1.78)	1251 (1.67)	28 (2.08)	624 (2.16)	34 (1.59)	628 (1.36)
Blocking shot	49 (1.41)	1005 (1.34)	27 (2.00)	588 (2.04)	22 (1.03)	417 (0.90)
Conditioning	41 (1.18)	1377 (1.83)	0 (0.0)	0 (0.0)	41 (1.92)	1377 (2.98)
Defending	543 (15.60)	12 347 (16.45)	211 (15.65)	4836 (16.77)	332 (15.56)	7511 (16.25)
General play	1058 (30.39)	22 809 (30.39)	377 (27.97)	7903 (27.41)	681 (31.93)	14906 (32.25)
Loose ball	174 (5.00)	3899 (5.19)	99 (7.34)	2336 (8.10)	75 (3.52)	1563 (3.38)
Passing	42 (1.21)	1002 (1.33)	9 (0.67)	229 (0.79)	33 (1.55)	773 (1.67)
Rebounding	537 (15.43)	11476 (15.29)	212 (15.73)	4507 (15.63)	325 (15.24)	6969 (15.08)
Receiving	51 (1.47)	1111 (1.48)	12 (0.89)	358 (1.24)	39 (1.83)	752 (1.63)
Running	237 (6.81)	5086 (6.78)	86 (6.38)	1813 (6.29)	151 (7.08)	3272 (7.08)
Screening	32 (0.92)	770 (1.03)	9 (0.67)	209 (0.72)	23 (1.08)	561 (1.21)
Shooting	270 (7.76)	5884 (7.84)	138 (10.24)	3017 (10.46)	132 (6.19)	2867 (6.20)
Other/Unknown	385 (11.06)	7043 (9.38)	140 (10.39)	2415 (8.38)	245 (11.49)	4629 (10.01)
<b>Position</b>						
Center	540 (15.51)	10 857 (14.46)	209 (15.50)	4025 (13.96)	331 (15.52)	6832 (14.78)
Forward	1030 (29.59)	23 555 (31.38)	407 (30.19)	9489 (32.91)	623 (29.21)	14 066 (30.43)
Guard	1703 (48.92)	36 676 (48.86)	673 (49.93)	14 244 (49.40)	1030 (48.29)	22 432 (48.53)
Other/Unknown	208 (5.98)	3971 (5.29)	59 (4.38)	1075 (3.73)	149 (6.99)	2895 (6.26)

<sup>a</sup> Data presented in the order of reported number, followed by the proportions of all injuries attributable to a given category. Data pooled across event types are presented overall and separately for practices and competitions. National estimates were produced using sampling weights estimated based on sport, division, and year. A reportable injury was one that occurred due to participation in an organized intercollegiate practice or competition and required medical attention by a team certified athletic trainer or physician (regardless of time loss). Only scheduled team practices and competitions were retained in this analysis.

those in practices. Between 1988–1989 and 2003–2004, the competition and practice concussion rates were estimated to be 3.2 per 10 000 AEs and 1.2 per 10 000 AEs, respectively, increasing nearly fourfold to 12.6 per 10 000 AEs and 4.5 per 10 000 AEs, respectively, between 2004–2005 and 2013–2014. This dramatic uptick in incidence could have been due to an increased national focus on sports-related concussions leading to more informed care, including more accurate diagnosis and management protocols.<sup>15</sup> Between 2014–2015 and 2018–2019, the observed concussion rate was 5.3 per 10 000 AEs for competitions and 2.8 per 10 000 AEs for practices. While this may suggest that implemented protocols and rules changes have helped decrease concussion incidence, this trend should continue to be tracked beyond 2018–2019 to identify whether this trajectory is maintained. The observed prevalence of quadriceps contusions throughout the study period has not been previously reported in men’s basketball.<sup>10,11</sup> Quadriceps contusions have been found to result in myositis ossificans within several weeks after injury and could potentially be related to knee positioning at time of injury, aggressive rehabilitation measures, or hurried return to play.<sup>16,17</sup> Subsequent study of the prevalence of myositis ossificans in this population may be needed to identify whether quadriceps contusions sustained by collegiate men’s basketball athletes are resulting in more significant injury.

While the NCAA ISP is a valuable resource in assessing epidemiologic trends and patterns associated with men’s basketball participation, when interpreting findings from this and other studies based on data from the NCAA ISP, it is important to consider challenges associated with detailed measurement of time spent at risk for injury. This vital detail has previously been discussed with regards to sports injury surveillance and can affect calculation and interpretation of estimated injury rates.<sup>18,19</sup> Future studies should

consider more precise strategies for documenting at-risk exposure time as this is dynamic for each student-athlete at different times throughout the course of a season. Better precision in capturing AEs could lead to improved estimates of injury risk, thereby enhancing strategic plans geared toward student-athlete safety and health. In addition, it should be acknowledged that these findings are not representative of all NCAA men’s basketball student-athletes. Participation in the NCAA ISP among men’s basketball programs was notably low during the early years of the study period and varied across divisions (most commonly lowest among Division III programs). Given differences in academic institutions, athletic departments, sports medicine resources, and competitive season structure across divisions, variability in participation is a particularly important consideration when interpreting findings from this study. With that said, note that participation increased during this study period, particularly in the final year. NCAA ISP recruitment strategies have evolved over time, and the improvements in participation reflect the success of recent strategies (eg, support and communication from the NCAA Sport Science Institute). Given the observed increase in participation across the study period, estimates associated with 2018–2019 in particular may be more representative of association-wide patterns than those from previous years. Furthermore, though overall participation may appear low, the participation fraction is reasonable for a national surveillance system, and the volume of data provided by participating ATs allows for stable estimation of injury rates.

Continued surveillance of NCAA men’s basketball injuries is essential to provide a comprehensive examination of injury burden in the ever-changing collegiate basketball landscape. In addition to evaluating cross-sectional snapshots of injury incidence, trends and injury

rate trajectories should also continue to be evaluated over time. Using these surveillance-based studies as a foundation, targeted studies could provide a critical component in understanding the etiology of observed epidemiologic trends and patterns.

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## REFERENCES

1. High school participation survey archive. National Federation of State High School Associations. Accessed March 6, 2021. <https://www.nfhs.org/sports-resource-content/high-school-participation-survey-archive>
2. NCAA Sports sponsorship and participation rates report 1981-82–2018-19. National Collegiate Athletic Association. Published 2019. Accessed July 3, 2020. [https://ncaaorg.s3.amazonaws.com/research/sportpart/2018-19RES\\_SportsSponsorshipParticipationRatesReport.pdf](https://ncaaorg.s3.amazonaws.com/research/sportpart/2018-19RES_SportsSponsorshipParticipationRatesReport.pdf)
3. Men's Final Four viewership, attendance by the numbers. National Collegiate Athletic Association. Accessed March 6, 2021. <https://www.ncaa.com/news/basketball-men/article/2019-04-23/mens-final-four-viewership-attendance-numbers>
4. Edwards T, Spiteri T, Piggott B, Bonhotal J, Haff GG, Joyce C. Monitoring and managing fatigue in basketball. *Sports (Basel)*. 2018;6(1):19. doi:10.3390/sports6010019
5. Drew MK, Finch CF. The relationship between training load and injury, illness and soreness: a systematic and literature review. *Sport Med*. 2016;46(6):861–883. doi:10.1007/s40279-015-0459-8
6. Men's basketball rules changes 2015–16 and 2016–17. National Collegiate Athletic Association. Accessed March 6, 2021. [https://www.ncaa.org/sites/default/files/2016D1MBB\\_2015-17MensBasketballRulesChanges\\_20160224.pdf](https://www.ncaa.org/sites/default/files/2016D1MBB_2015-17MensBasketballRulesChanges_20160224.pdf)
7. Men's basketball rules of the game. National Collegiate Athletic Association. Accessed March 6, 2021. <https://www.ncaa.org/playing-rules/mens-basketball-rules-game>
8. Dick R, Agel J, Marshall SW. National Collegiate Athletic Association Injury Surveillance System commentaries: introduction and methods. *J Athl Train*. 2007;42(2):173–182.
9. Kerr ZY, Dompier TP, Snook EM, et al. National Collegiate Athletic Association Injury Surveillance System: review of methods for 2004–2005 through 2013–2014 data collection. *J Athl Train*. 2014;49(4):552–560. doi:10.4085/1062-6050-49.3.58
10. Clifton DR, Onate JA, Hertel J, et al. 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). *J Athl Train*. 2018;53(11):1025–1036. doi:10.4085/1062-6050-148-17
11. Dick R, Hertel J, Agel J, Grossman J, Marshall SW. Descriptive epidemiology of collegiate men's basketball injuries: National Collegiate Athletic Association Injury Surveillance System, 1988–1989 through 2003–2004. *J Athl Train*. 2007;42(2):194–201.
12. 2017–18 and 2018–19 Men's basketball rules changes. National Collegiate Athletic Association. Accessed March 6, 2021. [http://assets.ngin.com/attachments/document/0136/8138/Men\\_s\\_Basketball\\_-\\_2017\\_Rules\\_Change\\_Chart\\_06132017.pdf](http://assets.ngin.com/attachments/document/0136/8138/Men_s_Basketball_-_2017_Rules_Change_Chart_06132017.pdf)
13. Chandran A, Morris SN, Wasserman EB, Boltz A, Collins CL. Methods of the National Collegiate Athletic Association Injury Surveillance Program, 2014–2015 Through 2018–2019. *J Athl Train*. 2021;56(7):616–621.
14. 2011–12 and 2012–13 Men's basketball rules changes. Accessed December 5, 2020. National Collegiate Athletic Association. <http://fs.ncaa.org/Docs/rules/mbb/2011/2011MBBfinalrules.pdf>
15. Lempke LB, Schmidt JD, Lynall RC. Athletic trainers' concussion-assessment and concussion-management practices: an update. *J Athl Train*. 2020;51(1):17–26. doi:10.4085/1062-6050-322-18
16. Ryan JB, Wheeler JH, Hopkinson W, Arciero RA, Kolakowski KR. Quadriceps contusions: West Point update. *Am J Sports Med*. 1991;19(3):299–304.
17. Simon T, Guillodo Y, Madouas G, Saraux A. Myositis ossificans traumatica (circumscripta) and return to sport: a retrospective series of 19 cases. *Joint Bone Spine*. 2016;83(4):416–420. doi:10.1016/j.jbspin.2015.07.013
18. Finch C. An overview of some definitional issues for sports injury surveillance. *Sports Med*. 1997;24(3):157–163. doi:10.2165/00007256-199724030-00002
19. Bahr R, Clarsen B, Derman W, et al. International Olympic Committee consensus statement: methods for recording and reporting of epidemiological data on injury and illness in sport 2020 (including STROBE Extension for Sport Injury and Illness Surveillance (STROBE-SIIS)). *Br J Sports Med*. 2020;54(7):372–389. doi:10.1136/bjsports-2019-101969

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