

Epidemiology of Football Injuries in the National Collegiate Athletic Association, 2004-2005 to 2008-2009

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Background: Research has found that injury rates in football are higher in competition than during practice. However, there is little research on the association between injury rates and type of football practices and how these specific rates compare with those in competitions.

Purpose: This study utilized data from the National Collegiate Athletic Association Injury Surveillance System (NCAA ISS) to describe men's collegiate football practice injuries (academic years 2004-2005 to 2008-2009) in 4 event types: competitions, scrimmages, regular practices, and walkthroughs.

Study Design: Descriptive epidemiological study.

Methods: Football data during the 2004-2005 to 2008-2009 academic years were analyzed. Annually, an average of 60 men's football programs provided data (9.7% of all universities sponsoring football). Injury rates per 1000 athlete-exposures (AEs), injury rate ratios (RRs), 95% CIs, and injury proportions were reported.

Results: The NCAA ISS captured 18,075 football injuries. Most injuries were reported in regular practices (55.9%), followed by competitions (38.8%), scrimmages (4.4%), and walkthroughs (0.8%). Most AEs were reported in regular practices (77.6%), followed by walkthroughs (11.5%), competitions (8.6%), and scrimmages (2.3%). The highest injury rate was found in competitions (36.94/1000 AEs), followed by scrimmages (15.7/1000 AEs), regular practices (5.9/1000 AEs), and walkthroughs (0.6/1000 AEs). These rates were all significantly different from one another. Distributions of injury location and diagnoses were similar across all 4 event types, with most injuries occurring at the lower extremity (56.0%) and consisting of sprains and strains (50.6%). However, injury mechanisms varied. The proportion of injuries due to player contact was greatest in scrimmages (66.8%), followed by regular practices (48.5%) and walkthroughs (34.9%); in contrast, the proportion of injuries due to noncontact/overuse was greatest in walkthroughs (41.7%), followed by regular practices (35.6%) and scrimmages (21.9%).

Conclusion: Injury rates were the highest in competitions but then varied by the type of practice event, with higher practice injury rates reported in scrimmage. In addition, greater proportions of injuries were reported in regular practices, and greater proportions of exposures were reported in regular practices and walkthroughs. Efforts to minimize injury in all types of practice events are essential to mitigating injury incidence related to both contact and noncontact.

Keywords: college football; injury rates; practice seasons; scrimmages

American football has the greatest proportion of student-athletes among all sports sponsored by member institutions in the National Collegiate Athletic Association (NCAA).²⁰ A recent study of football injuries in 1 institution over 4 years found that on average, 50% of football players sustained an injury resulting in absence of participation for at least 1 day per season.²⁴ Because of this high number, coupled with football having one of the largest overall injury rates,

examination of the specific exposure at time of injury is essential to the creation and implementation of effective injury prevention strategies in NCAA football.^{9,12}

Although practice injury rates have been found to be lower than competition injury rates in college football, the actual number of reported injuries is greater in practices than competitions, most likely because there are more practices than competitions within a football season and more players within a team participating in practices than competitions.^{4,12,22} In addition, practices are typically structured environments in which focus is placed on skill development and preparation of future competitions, which

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may contribute to the lower injury rates. Previous research has found that among football practices, concussion rates were highest in scrimmages, followed by regular practices and walkthroughs.¹¹ A specific study of sports injuries in the Big Ten Conference found that scrimmages had higher total injury rates than other practice sessions.¹ However, there is a paucity of research that has fully examined all injuries in a similar manner.

Previous research has called for a more in-depth examination of specific event types that go beyond the classic “practice versus competition” paradigm to aid the development of injury prevention interventions.⁹ At the same time, it is important to consider the rate at which injuries occur within sport as well as the reported incidence of injury and exposure.¹² The NCAA Injury Surveillance System (ISS) monitored injuries and exposures occurring in a sample of men’s collegiate football varsity teams from all divisions during the 2004-2005 to 2008-2009 academic years. Injury and exposure data were classified by type of event (ie, competition, scrimmage, regular practice, walkthrough) and time in season (ie, preseason, in-season, and postseason). Our specific aims for this study were to (1) estimate injury rates by specific type of event and (2) identify whether type of event-specific injury rates varied by time in season, body part injured, diagnosis, or injury mechanism.

METHODS

Data were obtained from the NCAA ISS, which is managed by the Datalys Center for Sports Injury Research and Prevention, an independent, nonprofit research organization.¹⁰ The ISS depended on a convenience sample of NCAA varsity sport teams, with athletic trainers (ATs) reporting injury and exposure data. During the study time frame (academic years 2004-2005 to 2008-2009), data were provided by ATs from an average of 60 men’s football programs annually (28 Division I, 10 Division II, and 22 Division III; 9.7% of all universities sponsoring football). Although data collected from subsequent academic years has been utilized in surveillance research,¹² type of event specific to competition, scrimmage, regular practice, and walkthrough has not been collected since the 2008-2009 academic year.

Data Collection

ATs from participating NCAA member institutions reported injuries in real-time through a Web-based injury

surveillance platform provided by the NCAA. In addition, the web-based platform captured sports-related adverse health events such as heat-related conditions, general medical conditions, and skin infections. Only varsity-level practice and competition events were included in the ISS data sets. Data were not collected from individual weight lifting and conditioning sessions, the offseason, or spring practices and scrimmages.

For each injury occurrence, the ATs completed a detailed event report on the injury or condition (eg, body part injured, diagnosis) and the circumstances (eg, mechanism, activity). In addition, ATs provided information for each type of event (competition, scrimmage, practice, or walkthrough), including the number of participating student-athletes and time of season (eg, preseason, in-season, postseason).

ATs were able to view and update previously submitted information as needed during the course of a season. On submission, event reports were stripped of any personally identifiable information and retained only variables relevant to future study. As data arrived, full-time data quality assurance staff conducted a series of quality control measures including consistency checks, in which invalid values were flagged and reviewed. If necessary, staff would notify and assist the AT in the resolution of the issue.¹⁰ Data that passed the verification process were then added to the sport-specific aggregate datasets.

Definitions

Injury. A reportable injury in the ISS was defined as an injury that (1) occurred as a result of participation in an organized intercollegiate practice or competition, (2) required attention from an AT or physician, and (3) resulted in restriction of the student-athlete’s participation for 1 or more days beyond the day of injury (ie, time loss). Multiple injuries occurring from 1 injury event could be included. If an “off-day” followed the injury event, ATs were asked to assess whether the injured athlete would have been able to participate to determine whether the injury fit inclusion criteria. Additionally, ATs were asked to include any dental injury, concussion, or fracture occurring in an organized practice or game, regardless of time loss.

Athlete-Exposure. A reportable athlete-exposure (AE) was defined as 1 student-athlete participating in 1 NCAA-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. AE

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counts included all athletes who were suited up for participation and in competition settings, included those participating in warm-ups. The AE count data were collected at the aggregate (ie, team) level (eg, ATs reported the number of athletes participating per event without consideration of which specific athletes participated in which specific events).

Type of Event. Type of event was the specific event type in which the injury was reported to have occurred. ATs chose from competitions and practices; if the latter was chosen, ATs then reported on the specific type of practice (ie, scrimmage, regular practice, walkthrough). A scrimmage was defined as a practice session in which an informal football game was played between 2 units of the same team. A walkthrough was defined as a practice session that included thorough demonstrations of skills development and/or game-play strategy. Typically, walkthroughs are slower paced than other practice sessions and focus on mental preparation alongside physical preparation. All other practice sessions encompassed regular practices.

Injury Mechanism. Injury mechanism was defined as the manner in which the student-athlete sustained his injury. In the NCAA ISS, ATs selected from a preset list of options, including the following: contact with player, contact with surface, contact with equipment, noncontact, overuse, illness, infection, and unknown. When selecting “contact with player,” ATs could further define the specific mechanism of injury such as tackling, being tackled, blocking, being blocked, stepped on/fell on/kicked, and other. In addition, illness and infection were merged into 1 category.

Statistical Analysis

Data were analyzed to assess rates of injuries occurring during football competitions, scrimmages, regular practices, and walkthroughs. Injury rates were calculated as the ratio of injuries per 1000 AEs. Rate ratios (RRs) compared injury rates between the 4 types of events overall and then by time in season (ie, preseason, in-season, and postseason), body part injured, diagnosis, and injury mechanism. Injury rates specific to type of equipment were also compared within practices. The following is an example of an RR comparing injury rates between competitions and scrimmages:

$$RR = \frac{\left(\frac{\sum \text{Number of competition injuries}}{\sum \text{Competition AEs}} \right)}{\left(\frac{\sum \text{Number of scrimmage injuries}}{\sum \text{Scrimmage AEs}} \right)}$$

All 95% CIs not containing 1.0 were considered statistically significant. Data were analyzed using SAS-Enterprise Guide software (version 5.1; SAS Institute Inc). This study was approved by the Research Review Board of the NCAA.

RESULTS

Overall Frequencies and Rates

A total of 18,075 injuries were reported in the participating NCAA football programs during 2,222,155 AEs in the 2004-2005 to 2008-2009 academic years. Most injuries were

TABLE 1
Injury Rates by Type of Event and Time in Season in NCAA Football^a

	Injuries, n	AEs, n	Rate per 1000 AEs (95% CI)
Competition			
Preseason	n/a	0	n/a
In-season	6861	183,995	37.29 (36.41-38.17)
Postseason	159	6032	26.36 (22.26-30.46)
Total	7020	190,027	36.94 (36.08-37.81)
Scrimmage			
Preseason	693	43,520	15.92 (14.74-17.11)
In-season	109	7526	14.48 (11.76-17.20)
Postseason	n/a	0	n/a
Total	802	51,046	15.71 (14.62-16.80)
Regular practice			
Preseason	6187	625,953	9.88 (9.64-10.13)
In-season	3690	1,023,444	3.61 (3.49-3.72)
Postseason	230	75,770	3.04 (2.64-3.43)
Total	10,107	1,725,167	5.86 (5.74-5.97)
Walkthrough			
Preseason	76	50,361	1.51 (1.17-1.85)
In-season	70	198,098	0.35 (0.27-0.44)
Postseason	0	7456	0.00
Total	146	255,915	0.57 (0.48-0.66)

^aData originate from the Datalys Center for Sports Injury Research and Prevention Injury Surveillance Program, 2004-2005 to 2008-2009. AE, athlete-exposure; n/a, not applicable; NCAA, National Collegiate Athletic Association.

TABLE 2
Rate Ratios Comparing Type of Event in NCAA Football^a

Comparison	Rate Ratios (95% CI)
Competition vs scrimmage	2.35 (2.19-2.53)
Competition vs regular practice	6.31 (6.12-6.50)
Competition vs walkthrough	64.75 (54.97-76.29)
Scrimmage vs regular practice	2.68 (2.50-2.88)
Scrimmage vs walkthrough	27.54 (23.09-32.85)
Regular practice vs walkthrough	10.27 (8.72-12.09)

^aData originate from the Datalys Center for Sports Injury Research and Prevention Injury Surveillance Program, 2004-2005 to 2008-2009. NCAA, National Collegiate Athletic Association.

reported in regular practices (55.9%), followed by competitions (38.8%), scrimmages (4.4%), and walkthroughs (0.8%; Table 1). Most AEs were reported in regular practices (77.6%), followed by walkthroughs (11.5%), competitions (8.6%), and scrimmages (2.3%). The highest injury rate was found in competition, followed by scrimmages, regular practices, and walkthroughs. These rates were all significantly different from one another (Table 2).

Time in Season

Most competition injuries occurred in-season (97.7%) (Table 1). The preseason comprised the largest proportion

TABLE 3
Injuries by Time Loss and Type of Event in NCAA Football, 2004-2005 to 2008-2009^a

	1 to 6 d	7 to 21 d	≥22 d	Missing	Total
Type of event					
Competition	3034 (43.2)	2398 (34.2)	1468 (20.9)	120 (1.7)	7020 (100.0)
Scrimmage	370 (46.1)	247 (30.8)	176 (21.9)	9 (1.1)	802 (100.0)
Regular practice	5139 (50.8)	2784 (27.5)	1974 (19.5)	210 (2.1)	10107 (100.0)
Walkthrough	79 (54.1)	46 (31.5)	21 (14.4)	0	146 (100.0)
Time in season					
Preseason	3661 (52.3)	1980 (28.3)	1251 (17.9)	114 (1.6)	7006 (100.0)
In-season	4813 (45.1)	3380 (31.6)	2273 (21.3)	214 (2.0)	10680 (100.0)
Postseason	148 (38.0)	115 (29.6)	115 (29.6)	11 (2.8)	389 (100.0)

^aSource, Datatlys Center for Sports Injury Research and Prevention Injury Surveillance Program, 2004-2005 to 2008-2009. NCAA, National Collegiate Athletic Association.

of injuries in scrimmages (86.4%), regular practices (61.2%), and walkthroughs (52.1%). However, whereas the preseason accounted for the most AEs in scrimmages (85.3%), the regular season accounted for the most AEs in regular practices (59.3%) and walkthroughs (77.4%).

For competitions, the injury rate was higher in-season than in the postseason (RR, 1.41; 95% CI, 1.21-1.66). For scrimmages, preseason and in-season injury rates did not differ (RR, 1.10; 95% CI, 0.90-1.35). For regular practices, the injury rate in the preseason was higher than those in-season (RR, 2.74; 95% CI, 2.63-2.86) and in the postseason (RR, 3.26; 95% CI, 2.85-3.71); in addition, the injury rate was higher in-season than in the postseason (RR, 1.19; 95% CI, 1.04-1.36). For walkthroughs, the injury rate was higher in the preseason than in-season (RR, 4.27; 95% CI, 3.09-5.91).

Time Loss

Regardless of type of event or time in season, the largest proportion of injuries had time loss of 1 to 6 days (Table 3). The proportion of injuries with time loss of 1 to 6 days was greatest in walkthroughs, the preseason, and when shells were worn. The proportion of injuries with time loss of 22 or more days was greatest in the postseason and the lowest in walkthroughs.

Body Part Injured

In competitions and scrimmages, the most common body parts injured were the knee, ankle, and shoulder (Table 4). In regular practices and walkthroughs, the most common body parts injured were the knee, upper leg, and shoulder. As with overall rates, most body part-specific injury rates were highest in competitions, followed by scrimmages, regular practices, and walkthroughs.

Diagnosis

Sprains, strains, and contusions comprised the majority of injuries across all event types (Table 5). When examining sprains in particular, most occurred to the ankle and knee across all event types (Figure 1). In particular, the most

common knee sprains were medial collateral ligament (MCL) sprains followed by anterior cruciate ligament (ACL) sprains; the most common ankle sprains were to the lateral ligament complex. As with overall rates, most diagnosis-specific injury rates were highest in competitions, followed by scrimmages, regular practices, and walkthroughs.

Injury Mechanism

Of all possible injury mechanisms, most injuries across all types of events had reported mechanisms of injury of either contact with another player or noncontact (Table 6). In particular, most player contact-related injuries occurred while tackling or being tackled. The most common injuries due to contact with another player were sprains (36.0%), contusions (17.9%), and concussions (12.2%). The most common injuries due to noncontact and overuse were strains (51.8%) and sprains (21.7%). As with overall rates, most mechanism-specific injury rates were highest in competitions, followed by scrimmages, regular practices, and walkthroughs.

DISCUSSION

Football has one of the highest injury rates among college sports.^{9,12} Unlike most football-related research, which examines rates within competitions and practices,^{4,5,12-16,22} our study separated practices into scrimmages, regular practices, and walkthroughs to assess rate of injury by different event types. We found that while injury rates were highest in competition and scrimmages, larger proportions of injuries were reported in regular practices and walkthroughs. In addition, although injury rates were highest in the preseason, substantial proportions of injuries were reported in the regular season. Our findings highlight the need for multiple, concurrent injury prevention interventions that target the various types of at-risk exposure time that exist within football.

Regular practices comprised 55.9% of all injuries. The large proportion is most likely due to regular practices comprising the large majority of exposures for collegiate

TABLE 4
Injury Counts, Percentages, and Rates per 1000 Athlete-Exposures (AEs) by Body Part Injured and Type of Event in NCAA Football, 2004-2005 to 2008-2009^a

Body Part	Competition		Scrimmage		Regular Practice		Walkthrough	
	Injury Count (%)	Rate per 1000 AEs (95% CI)	Injury Count (%)	Rate per 1000 AEs (95% CI)	Injury Count (%)	Rate per 1000 AEs (95% CI)	Injury Count (%)	Rate per 1000 AEs (95% CI)
Head/face	620 (8.8)	3.26 (3.01-3.52)	86 (10.7)	1.68 (1.33-2.04)	810 (8.0)	0.47 (0.44-0.50)	6 (4.1)	0.02 (0.00-0.04)
Neck	281 (4.0)	1.48 (1.31-1.65)	26 (3.2)	0.51 (0.31-0.71)	310 (3.1)	0.18 (0.16-0.20)	3 (2.1)	0.01 (0.00-0.02)
Shoulder	963 (13.7)	5.07 (4.75-5.39)	122 (15.2)	2.39 (1.97-2.81)	1226 (12.1)	0.71 (0.67-0.75)	14 (9.6)	0.05 (0.03-0.08)
Arm/elbow	229 (3.3)	1.21 (1.05-1.36)	23 (2.9)	0.45 (0.27-0.63)	211 (2.1)	0.12 (0.11-0.14)	3 (2.1)	0.01 (0.00-0.02)
Hand/wrist	429 (6.1)	2.26 (2.04-2.47)	52 (6.5)	1.02 (0.74-1.30)	588 (5.8)	0.34 (0.31-0.37)	11 (7.5)	0.04 (0.02-0.07)
Trunk	441 (6.3)	2.32 (2.10-2.54)	42 (5.2)	0.82 (0.57-1.07)	667 (6.6)	0.39 (0.36-0.42)	16 (11.0)	0.06 (0.03-0.09)
Hip/groin	229 (3.3)	1.21 (1.05-1.36)	42 (5.2)	0.82 (0.57-1.07)	772 (7.6)	0.45 (0.42-0.48)	11 (7.5)	0.04 (0.02-0.07)
Upper leg	525 (7.5)	2.76 (2.53-3.00)	50 (6.2)	0.98 (0.71-1.25)	1380 (13.7)	0.80 (0.76-0.84)	16 (11.0)	0.06 (0.03-0.09)
Knee	1395 (19.9)	7.34 (6.96-7.73)	153 (19.1)	3.00 (2.52-3.47)	1521 (15.0)	0.88 (0.84-0.93)	22 (15.1)	0.09 (0.05-0.12)
Lower leg	329 (4.7)	1.73 (1.54-1.92)	22 (2.7)	0.43 (0.25-0.61)	368 (3.6)	0.21 (0.19-0.24)	9 (6.2)	0.04 (0.01-0.06)
Ankle	1211 (17.3)	6.37 (6.01-6.73)	126 (15.7)	2.47 (2.04-2.90)	1173 (11.6)	0.68 (0.64-0.72)	13 (8.9)	0.05 (0.02-0.08)
Foot	289 (4.1)	1.52 (1.35-1.70)	35 (4.4)	0.69 (0.46-0.91)	477 (4.7)	0.28 (0.25-0.30)	2 (1.4)	0.01 (0.00-0.02)
Other	79 (1.1)	0.42 (0.32-0.51)	23 (2.9)	0.45 (0.27-0.63)	604 (6.0)	0.35 (0.32-0.38)	20 (13.7)	0.08 (0.04-0.11)
Total	7020 (100.0)	36.94 (36.08-37.81)	802 (100.0)	15.71 (14.62-16.80)	10,107 (100.0)	5.86 (5.74-5.97)	146 (100.0)	0.57 (0.48-0.66)

^aData originate from the Datalys Center for Sports Injury Research and Prevention Injury Surveillance Program, 2004-2005 to 2008-2009. National Collegiate Athletic Association.

TABLE 5
Injury Counts, Percentages, and Rates by Diagnosis and Type of Event in NCAA Football, 2004-2005 to 2008-2009^a

Injury Diagnosis	Competition		Scrimmage		Regular Practice		Walkthrough	
	n (%)	Rate per 1000 AEs (95% CI)	n (%)	Rate per 1000 AEs (95% CI)	n (%)	Rate per 1000 AEs (95% CI)	n (%)	Rate per 1000 AEs (95% CI)
Cartilage injury	197 (2.8)	1.04 (0.89-1.18)	30 (3.7)	0.59 (0.38-0.80)	285 (2.8)	0.17 (0.15-0.18)	2 (1.4)	0.01 (0.00-0.02)
Concussion	572 (8.1)	3.01 (2.76-3.26)	77 (9.6)	1.51 (1.17-1.85)	713 (7.1)	0.41 (0.38-0.44)	5 (3.4)	0.02 (0.00-0.04)
Contusion	1143 (16.3)	6.01 (5.67-6.36)	100 (12.5)	1.96 (1.58-2.34)	1017 (10.1)	0.59 (0.55-0.63)	10 (6.8)	0.04 (0.01-0.06)
Dislocation	150 (2.1)	0.79 (0.66-0.92)	21 (2.6)	0.41 (0.24-0.59)	184 (1.8)	0.11 (0.09-0.12)	2 (1.4)	0.01 (0.00-0.02)
Fracture	398 (5.7)	2.09 (1.89-2.30)	34 (4.2)	0.67 (0.44-0.89)	363 (3.6)	0.21 (0.19-0.23)	6 (4.1)	0.02 (0.00-0.04)
Inflammatory condition ^b	146 (2.1)	0.77 (0.64-0.89)	18 (2.2)	0.35 (0.19-0.52)	414 (4.1)	0.24 (0.22-0.26)	10 (6.8)	0.04 (0.01-0.06)
Laceration	29 (0.4)	0.15 (0.10-0.21)	4 (0.5)	0.08 (0.00-0.16)	59 (0.6)	0.03 (0.03-0.04)	0	0.00
Nerve injury	194 (2.8)	1.02 (0.88-1.16)	16 (2.0)	0.31 (0.16-0.47)	200 (2.0)	0.12 (0.10-0.13)	1 (0.7)	<0.01 (0.00-0.01)
Spasm	69 (1.0)	0.36 (0.28-0.45)	2 (0.2)	0.04 (0.00-0.09)	177 (1.8)	0.10 (0.09-0.12)	3 (2.1)	0.01 (0.00-0.02)
Sprain	2755 (39.2)	14.50 (13.96-15.04)	289 (36.0)	5.66 (5.01-6.31)	2488 (24.6)	1.44 (1.39-1.50)	35 (24.0)	0.14 (0.09-0.18)
Strain	852 (12.1)	4.48 (4.18-4.78)	126 (15.7)	2.47 (2.04-2.90)	2624 (26.0)	1.52 (1.46-1.58)	35 (24.0)	0.14 (0.09-0.18)
Subluxation	212 (3)	1.12 (0.97-1.27)	28 (3.5)	0.55 (0.35-0.75)	409 (4.0)	0.24 (0.21-0.26)	3 (2.1)	0.01 (0.00-0.02)
Other	303 (4.3)	1.59 (1.41-1.77)	57 (7.1)	1.12 (0.83-1.41)	1174 (11.6)	0.68 (0.64-0.72)	34 (23.3)	0.13 (0.09-0.18)
Total	7020 (100.0)	36.94 (36.08-37.81)	802 (100.0)	15.71 (14.62-16.80)	10,107 (100.0)	5.86 (5.74-5.97)	146 (100.0)	0.57 (0.48-0.66)

^aData originate from the Datalys Center for Sports Injury Research and Prevention Injury Surveillance Program, 2004-2005 to 2008-2009. AE, athlete-exposure; NCAA, National Collegiate Athletic Association.

^bInflammatory condition includes the following diagnoses from the NCAA Injury Surveillance Program: tendinopathy, synovitis, bursitis, arthritis/chondromalacia, exostosis, myositis ossificans, capsulitis, and inflammation (general).

football athletes (77.6% of all AEs reported). These findings parallel previous research noting the reported number of injuries in practices exceeded that of competitions.^{4,12,13,16,22} Walkthroughs may have some of the lowest rates of injury as they occur in the most structured environments, focus on game play preparation, and have minimal contact. This is further demonstrated with

walkthroughs having the largest proportion of injuries with time loss of 1 to 6 days and the smallest proportion of injuries with time loss of ≥22 days. In contrast, competitions and scrimmages are more intense; nevertheless, because scrimmages still occur within a more supervised environment, this may mitigate injury risk. In 2007, Hootman et al⁹ called for more in-depth examinations of the

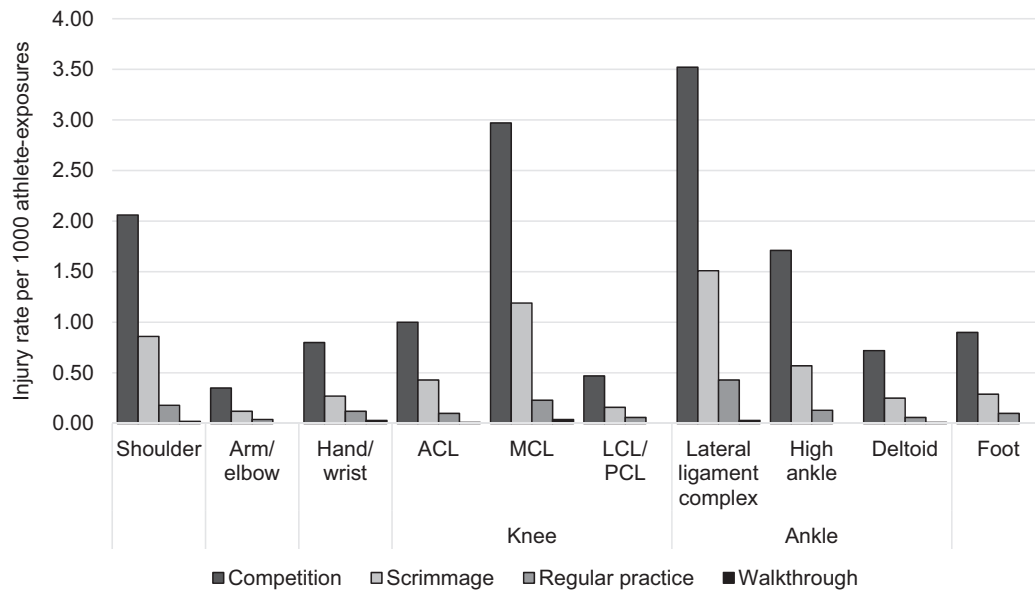


Figure 1. Sprain injury rates per 1000 athlete-exposures by body part injured and type of event in National Collegiate Athletic Association football, 2004-2005 to 2008-2009. Data originate from the Datalys Center for Sports Injury Research and Prevention Injury Surveillance Program, 2004-2005 to 2008-2009. ACL, anterior cruciate ligament; LCL, lateral collateral ligament; MCL, medial collateral ligament; PCL, posterior cruciate ligament.

TABLE 6

Injury Counts, Percentages, and Rates by Injury Mechanism and Type of Event in NCAA Football, 2004-2005 to 2008-2009^a

Injury Mechanism	Competition		Scrimmage		Regular Practice		Walkthrough	
	Injury Count (%)	Rate and 95% CI (per 1000 AEs)	Injury Count (%)	Rate and 95% CI (per 1000 AEs)	Injury Count (%)	Rate and 95% CI (per 1000 AEs)	Injury Count (%)	Rate and 95% CI (per 1000 AEs)
Contact with player	5231 (74.5)	27.53 (26.78-28.27)	536 (66.8)	10.50 (9.61-11.39)	4904 (48.5)	2.84 (2.76-2.92)	51 (34.9)	0.20 (0.14-0.25)
Tackling	1435 (20.4)	7.55 (7.16-7.94)	159 (19.8)	3.11 (2.63-3.60)	1164 (11.5)	0.67 (0.64-0.71)	13 (8.9)	0.05 (0.02-0.08)
Being tackled	1447 (20.6)	7.61 (7.22-8.01)	151 (18.8)	2.96 (2.49-3.43)	932 (9.2)	0.54 (0.51-0.57)	12 (8.2)	0.05 (0.02-0.07)
Blocking	948 (13.5)	4.99 (4.67-5.31)	87 (10.8)	1.70 (1.35-2.06)	1376 (13.6)	0.80 (0.76-0.84)	10 (6.8)	0.04 (0.01-0.06)
Being blocked	827 (11.8)	4.35 (4.06-4.65)	80 (10.0)	1.57 (1.22-1.91)	766 (7.6)	0.44 (0.41-0.48)	6 (4.1)	0.02 (0.00-0.04)
Stepped on/fell on/kicked	544 (7.7)	2.86 (2.62-3.10)	57 (7.1)	1.12 (0.83-1.41)	610 (6.0)	0.35 (0.33-0.38)	7 (4.8)	0.03 (0.01-0.05)
Other	30 (0.4)	0.16 (0.10-0.21)	2 (0.2)	0.04 (0.00-0.09)	56 (0.6)	0.03 (0.02-0.04)	3 (2.1)	0.01 (0.00-0.02)
Contact with surface	569 (8.1)	2.99 (2.75-3.24)	58 (7.2)	1.14 (0.84-1.43)	699 (6.9)	0.41 (0.38-0.44)	8 (5.5)	0.03 (0.01-0.05)
Contact with equipment	42 (0.6)	0.22 (0.15-0.29)	7 (0.9)	0.14 (0.04-0.24)	218 (2.2)	0.13 (0.11-0.14)	4 (2.7)	0.02 (0.00-0.03)
Noncontact	1005 (14.3)	5.29 (4.96-5.62)	151 (18.8)	2.96 (2.49-3.43)	3074 (30.4)	1.78 (1.72-1.84)	51 (34.9)	0.20 (0.14-0.25)
Overuse	74 (1.1)	0.39 (0.30-0.48)	25 (3.1)	0.49 (0.30-0.68)	525 (5.2)	0.30 (0.28-0.33)	10 (6.8)	0.04 (0.01-0.06)
Illness/infection	75 (1.1)	0.39 (0.31-0.48)	23 (2.9)	0.45 (0.27-0.63)	641 (6.3)	0.37 (0.34-0.40)	20 (13.7)	0.08 (0.04-0.11)
Unknown	24 (0.3)	0.13 (0.08-0.18)	2 (0.2)	0.04 (0.00-0.09)	46 (0.5)	0.03 (0.02-0.03)	2 (1.4)	0.01 (0.00-0.02)
Total	7020 (100.0)	36.94 (36.08-37.81)	802 (100.0)	15.71 (14.62-16.80)	10,107 (100.0)	5.86 (5.74-5.97)	146 (100.0)	0.57 (0.48-0.66)

^aData originate from the Datalys Center for Sports Injury Research and Prevention Injury Surveillance Program, 2004-2005 to 2008-2009. AE, athlete-exposure; NCAA, National Collegiate Athletic Association.

“intensity” of exposure in practices to aid the development of future injury prevention research and strategies. Given the nature and purview of injury surveillance, examination of the practice event types may serve as the best proxy to “intensity.” However, future research should aim to provide more in-depth examinations of the actual activities within competition and practice events to identify specific

activities and risk factors that place college football players at increased injury risk.

Consistent with previous football research across multiple levels of play,^{4,12,13,16,22} the competition injury rate was higher than the practice injury rate. The varying intensities of participation that have been previously discussed^{9,12} and resulting injury incidence may also be explained by the

relative arousal of the athletes during a competition versus practice. The stress-performance relationship is defined as increasing stress and/or arousal to improve performance to an ideal threshold; however, performance will degrade with further increases in stress or arousal.²¹ This is likely modified by type of event, with games increasing stress or arousal toward the optimal level in high-level collegiate athletes.²¹ This added arousal has the capability to improve motor performance¹⁷ and possibility to decrease coordination-related errors that contribute to noncontact injury.²⁵ Although the NCAA ISS does not distinguish between intentional and unintentional contact, it may be worthwhile for future prospective studies to further define contact-related mechanisms.

Similar to data from the Big Ten Conference from 1992 to 2000, we found that among practices, scrimmages had the highest injury rate.¹ Our study further defined practice event types, finding walkthroughs to have the lowest injury rate, which concurred with a previous study of concussions only.^{1,11} This pattern was mostly maintained when examining specific body parts injured, diagnoses, and injury mechanisms. Nevertheless, the higher injury rate in scrimmages identifies it as a high-risk activity during practices.

Given our findings, we support recommendations limiting the number of scrimmages within the season. NCAA guidelines released in 2014 limited contact practices in football, with a limit on the number of scrimmages allowed in the preseason.¹⁹ Such guidelines were practical, given that previous research found most head impacts were occurring in full-contact practices and competitions/scrimmages,¹⁸ and these guidelines aimed to reduce cumulative head impact exposure and resulting concussion incidence. However, at the same time, to more efficiently reduce the incidence of all injuries in football, additional prevention efforts should focus on injuries occurring in other settings within football. For example, more injuries were reported in regular practices because of the greater number of exposures. In addition, competitions and scrimmages had the highest noncontact injury rates whereas competitions had higher injury rates than all practice settings.

Preseason comprised the largest proportion of practice-related injuries (86.4%, 61.2%, and 52.1% of scrimmage, regular practice, and walkthrough injuries, respectively). In addition, preseason injury rates were typically higher than in-season and postseason injury rates, although not in scrimmages (where relatively few in-season and no postseason exposures occurred). It is hypothesized that some student-athletes may enter the preseason less conditioned and therefore unprepared for the intensity of preseason practice sessions, thus increasing injury risk.⁹ Preseason practices may also be more geared to the development of fundamental football skills and techniques such as tackling and blocking.¹¹ This may lead to more physically intense and contact-heavy preseason practices and the increased level of contact work that may further contribute to player attrition and injury.⁴ However, the proportion of injuries with time loss of 1 to 6 days was greater in the preseason than postseason (52.3% vs 38.0%), and the proportion of injuries with time loss of ≥ 22 days was lower in the preseason than in the postseason (17.9% vs 29.6%). It is possible

that coaches may be more willing to accept a greater risk of minor injuries in the preseason; however, injuries that occur in regular-season practices may affect players' preparedness for a game. In addition, the intensity may be greater in the preseason as players are competing for starting positions on their teams. Athletes who experience preseason injuries that limit performance may also be removed from the team (either due to the severity of the injury or self-removal). This may decrease the regular-season injury rate as those who would otherwise get injured are already out of the exposure pool due to a preseason injury. While limited research has examined the attrition rates of collegiate football athletes over the course of a season, in high school athletes, those sustaining an injury are more likely to drop out of sport participation.⁶ Additional research regarding the rates and patterns of injury by time in season are warranted to generate prevention strategies that consider the varying conditioning of athletes at each time point.

Safety-related rule changes specific to competition are essential in reducing the incidence and severity of injury. However, practice-related policy has the potential to reduce a larger number of injuries due to the greater volume of exposures. Although these data originate from a time period prior to the implementation of policy that recommended¹⁹ or mandated^{7,8} limiting player contact in preseason practices, they still support the potential public health impact of reducing the incidence and severity of injury. These policies from the NCAA and specific conferences, coupled with ongoing rule changes during competitions, have the potential to reduce cumulative head impact and concussion incidence. Additional supplemental methods of prevention for all injuries to continue reducing injury incidence in football should also be considered. To reduce injury rates in the preseason, strategies such as applying a phased-in approach to increasing intensity of practice-related activities may help mitigate injury risk. Ensuring appropriate recovery time and preparticipation medical examinations are also recommended.⁹ Additionally, attention must be focused on practice injuries that occur in-season as well as those that occur in preseason and non-contact injuries as much as contact. Interventions for these events, time in season, and injury types should all be examined. Components from existing successful prevention interventions in other sports should be considered, such as soccer and the FIFA 11+.^{3,23} Finally, longitudinal studies are needed to evaluate the compliance with and effectiveness of such injury prevention interventions.

Limitations

Our sample was limited to a convenience sample of NCAA football programs. Thus, our findings may not be generalizable to nonparticipating programs or playing levels, such as youth, high school, and professional football. Data originated from the 2004-2005 to 2008-2009 academic years and may not be representative of the injuries and exposures in present-day collegiate football. Unfortunately, variables pertinent to this study were not collected in subsequent years of the NCAA ISS. Our exposure measure, the AE,

was unit based as opposed to time based. Thus, we were unable to report injury rates by hours of practice. In addition, AEs were not specific to position. Thus, although research has suggested that the level of contact within each type of event may vary by position,² the NCAA ISS is unable to ascertain injury rate differences by position. However, this limitation was necessary to reduce burden on the data collectors. Although our study examined 3 types of practices, more nuanced analyses specific to particular components of practice sessions were not captured. For example, variations in how much time is spent on tackling drills or how they are conducted may be associated with injury risk. Additional variables not collected in the NCAA ISS were not considered in these analyses, including but not limited to team-specific attributes (eg, whether teams implemented injury prevention programs), athlete-specific risk factors (eg, injury history), and injury-specific characteristics (eg, grade of severity of injury). Finally, the onset of injury for overuse or chronic issues is difficult to determine, and further analysis on risk of injury from strength and conditioning sessions needs to be researched.

CONCLUSION

Our findings suggest that injury rates vary by the type of event. Injury rates were the highest in competitions and scrimmages. However, greater proportions of injuries were reported in regular practices because of the greater number of exposures. The time in season was associated with injury rates. Efforts to minimize injury in all types of practice events are essential to mitigating injury incidence related to both contact and noncontact.

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