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Ten-Year Epidemiology of Ankle Injuries in Men's and Women's Collegiate Soccer Players

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Context: Data from the National Collegiate Athletic Association (NCAA) Injury Surveillance Program (ISP) have indicated that ankle injuries are the most common injuries among NCAA soccer players.

Objective: To review 10 years of NCAA-ISP data for soccer players' ankle injuries to understand how the time period (2004–2005 through 2008–2009 versus 2009–2010 through 2013–2014), anatomical structure injured, and sex of the athlete affected the injury rate, mechanism, and prognosis.

Design: Descriptive epidemiology study.

Setting: Online injury surveillance.

Main Outcome Measure(s): The NCAA-ISP was queried for men's and women's soccer ankle data from 2004 to 2014. Ankle-injury rates were calculated on the basis of injuries per 1000 athlete-exposures. Rate ratios (RRs) were used to compare injury rates. Injury proportion ratios (IPRs) were used to compare injury characteristics.

Results: When compared with the 2004–2005 through 2008–2009 seasons, the 2009–2010 through 2013–2014 seasons showed a similar rate of injuries (RR = 0.94, 95% confidence interval [CI] = 0.85, 1.04) but fewer days missed ($P < .001$) and fewer recurrent injuries (IPR = 0.55, 95% CI = 0.41, 0.74). The 4 most common ankle injuries, which accounted for 95% of ankle injuries, were lateral ligament complex tears (65.67%), tibiofibular ligament (high ankle) sprains (10.3%), contusions (10.1%), and medial (deltoid) ligament tears (9.77%). Of these injuries, high ankle sprains were most likely to cause athletes to miss ≥30 days (IPR = 1.9, 95% CI = 1.24, 2.90). Men and women had similar injury rates (RR = 1.02, 95% CI = 0.94, 1.11). Men had more contact injuries (IPR = 1.28, 95% CI = 1.16, 1.41) and contusion injuries (IPR = 1.34, CI = 1.03, 1.73) but fewer noncontact injuries (IPR = 0.86, 95% CI = 0.78, 0.95) and lateral ligamentous complex injuries (IPR = 0.92, 95% CI = 0.86, 0.98).

Conclusions: Although the rate of ankle injuries did not change between the 2004–2005 through 2008–2009 seasons and the 2009–2010 through 2013–2014 seasons, the prognoses improved. Among the 4 most common ankle injuries, high ankle sprains resulted in the worst prognosis. Overall, male and female NCAA soccer players injured their ankles at similar rates; however, men were more likely to sustain contact injuries.

Key Words: national estimates, injury characterization, soccer

Key Points

- High ankle sprains had the worst prognosis.
- Time lost to play decreased as the seasons progressed.
- Male and female players had similar ankle-injury rates.

During 2014–2015, 24 803 men and 27 358 women played National Collegiate Athletic Association (NCAA) soccer.[1] Data from the 2004–2005 through 2009–2010 seasons suggested that NCAA soccer players were injured at a rate of 7.5 per 1000 athlete-exposures (AEs).[2] An *AE* is defined as 1 athletic event for each athlete. For example, if 1 practice consists of 20 participating players, 20 AEs are counted. Among injuries to NCAA soccer players, the ankle is the most common site of injury, accounting for 17% of all injuries among this population.[3–6] Among NCAA sports, only basketball resulted in higher rates of ankle injury than soccer.[7] The high rate of ankle injuries among soccer players is due to the frequent changes of directions and jumping while wearing cleated shoes with little ankle support.[7] These injuries often result in pain, instability, diminished performance, absence from competition, and psychological stress,[3,4,6–8] which make accurate diagnosis, treatment, and injury prevention paramount.

Due to the large number of injuries, the NCAA and athletic trainers (ATs) constantly work to identify methods of making collegiate sports safer. The NCAA modifies rules to restrict the number of preseason practices, games, and hours per week a team can practice. It also implements rules regarding the types of contact allowed during games and the equipment that players must use during games. One prominent example of this in NCAA soccer is the mandate for shin guards to be worn during all games. Since being implemented, this rule has been changed to include specific requirements regarding the size and location of the shin guards.[3] Also, ATs have worked to improve braces, taping techniques, and modes of rehabilitation, including the increased use of proprioceptive training, to protect athletes.[2,9–11] Because of these changes, it is important to compare types, mechanisms, and trends of ankle injuries

between time periods to determine whether the interventions have been effective.

One important job of ATs and team physicians is recognizing and differentiating the common types of injuries among athletes. Although it is widely reported that most NCAA soccer injuries affect the ankle, fewer data differentiating the specific types of ankle injuries have been available.[3,4,6] The 4 most common ankle injuries among soccer players were lateral ligament complex (LLC) sprains, tibiofibular (high ankle) sprains, medial (deltoid) ligament sprains, and ankle contusions.[3,4,7,12,13] The LLC sprains were the most frequent of all ankle injuries, whereas high ankle sprains resulted in the worst prognosis.[7,12,13–15] Expanding the available data regarding specific types of injuries will help facilitate future approaches to prevention, treatment, and prognosis.

Another important aspect guiding the efforts of ATs and team physicians is understanding the role that sex plays in the types, rates, and mechanisms of ankle injuries. Discrepancies such as joint laxity, hormones, height, weight, strength, mechanical axis, and levels of contact may contribute to differences in the ankle injuries of male and female athletes.[2,4,8,16] Previous researchers addressed only how sex affected the rate of ankle injury, with no mention of how it might have affected the type or mechanism of ankle injury. Also, the results[3,4,8,16] have been inconsistent, with studies suggesting similar rates in both sexes, increased rates in men, or increased rates in women. Understanding the effect of a player's sex on ankle injuries can help guide future decisions for sex-specific taping techniques, braces, shin-guard rules, preventive muscular strengthening, and treatment.

The purpose of our study was to review 10 years of NCAA soccer players' ankle injuries and identify the differences among the various anatomical structures injured, between men and women, and between the 2004–2005 through 2008–2009 and the 2009–2010 through 2013–2014 seasons.

METHODS

This study was deemed acceptable by the Mayo Clinic Institutional Review Board and the NCAA Research Review Board (No. 16-006901). Deidentified injury data on NCAA ankle injuries from the NCAA Injury Surveillance Program (ISP) were used in the analysis. The Datalys Center for Sports Injury Research and Prevention, Inc (Indianapolis, IN), an independent, nonprofit research organization, received data from NCAA soccer ATs and physicians, analyzed them, and reviewed them to ensure quality.

Data Collection

We briefly describe the inclusion criteria and methods of the NCAA-ISP as they pertain to this research, but more detailed information can be found in "National Collegiate Athletic Association Injury Surveillance System: Review of Methods for 2004–2005 Through 2013–2014 Data Collection."[17]

Athletic trainers reported injury data during organized practices and games from the participating NCAA sports programs. Each game or practice counted as 1 AE. During the 2004–2005 through 2008–2009 seasons, ATs used written questionnaires that they faxed or mailed to the NCAA. During the 2009–2010 through 2013–2014 seasons, ATs used electronic medical records to collect and organize the data. They could return and add or change data throughout the season as they saw fit. Common data elements were deidentified, collected, and added to a central aggregate research database. Data sent to the database were verified, evaluated for consistency, and flagged when invalid values were recorded. The ATs and quality-assurance staff worked together to resolve any concerns about data validity. Consistent and usable data were then added to the aggregate research database.

An AE was reported as 1 student-athlete participating in 1 NCAA-sanctioned practice or game. Injuries that were reported included those that occurred during a team-sanctioned practice or game and were evaluated by an AT or physician. The structure injured was determined via evaluation by an AT or team physician, with or without the aid of magnetic resonance imaging.

Statistical Analysis

We analyzed injury rates using number of injuries per 1000 AEs; *t* tests were conducted to compare means, rate ratios (RRs) to compare injury rates, and injury proportion ratios (IPRs) to compare the proportions of injuries that had certain characteristics. Two examples of RR and IPR equations used to compare men and women are shown. Similar equations were used to compare the anatomical structures injured and the 2004–2005 through 2008–2009 versus 2009–2010 through 2013–2014 seasons. A 95% confidence interval (CI) and P value $<.001$ were used in the analyses to indicate statistical significance.

$$\mathrm{RR} = \frac{\left(\frac{\sum(\text{Injuries in Males during Games})}{\sum(\text{Total Game AEs of Males})}\right)}{\left(\frac{\sum(\text{Injuries in Females during Games})}{\sum(\text{Total Game AEs of Females})}\right)}$$

$$\mathrm{IPR} = \frac{\left(\frac{\sum(\text{LLC Tears in Males})}{\sum(\text{Total Ankle Injuries in Males})}\right)}{\left(\frac{\sum(\text{LLC Tears in Females})}{\sum(\text{Total Ankle Injuries in Females})}\right)}$$

RESULTS

Summary of NCAA-ISP Data

On average, 751 men's and 926 women's NCAA soccer programs participated each season during the 2004–2005 through 2008–2009 seasons and 802 men's and 926 women's programs participated per season during the 2009–2010 through 2013–2014 seasons.[17] For the 2004–2005 through 2013–2014 seasons, the NCAA-ISP contains data for 1 459 186 AEs for male and female soccer players. During these 1 459 186 AEs, 2068 ankle injuries were reported, which equates to 1.42 ankle injuries for every 1000 AEs.

Table 1. Ankle-Injury Rates of National Collegiate Athletic Association Male and Female Soccer Players by Event and Time in Season

Event(s)	Injuries per 1000 Athlete-Exposures		Rate Ratio: Males Versus Females	95% Confidence Interval
	Males	Females		
All events	1.43	1.40	1.02	0.94, 1.11
Games	3.21	2.93	1.14[a]	1.01, 1.29
Practices	0.94	0.91	1.04	0.92, 1.17
Preseason	1.38	1.22	1.13	0.95, 1.34
Season	1.53	1.50	1.02	0.92, 1.13
Postseason	0.79	1.12	0.70	0.46, 1.07

[a] Denotes a difference; the rate ratio was increased in males versus females.

Comparing Male and Female Soccer Players

Ankle injuries among male and female soccer players are compared in Tables 1 through 3.

The 2004–2005 Through 2008–2009 Versus 2009–2010 Through 2013–2014 Seasons

The 2004–2005 through 2008–2009 and 2009–2010 through 2013–2014 seasons are described in Tables 4 and 5 and the Figure. Compared with the 2004–2005 through 2008–2009 seasons, the injuries during the 2009–2010 through 2013–2014 seasons had better prognoses. Injuries during the 2009–2010 through 2013–2014 seasons resulted in more players missing <7 days and fewer players missing 7 to 13 days, 14 to 29 days, and ≥30 days postinjury. Also, the average number of days missed was different between these time periods: 11.06 ± 22.67 in 2003–2004 through 2008–2009 versus 5.09 ± 9.45 in 2009–2010 through 2013–2014 ($P < .001$). In addition, injuries during the 2009–2010 through 2013–2014 seasons were less likely to be recurrent.

Anatomical Structures Injured

The injured anatomical structures are compared in Tables 6 through 8. The most common ankle injury was an LLC tear (partial or complete), which accounted for 65.67% (1358/2068) of ankle injuries. Other frequent ankle injuries were tibiofibular ligament (high ankle) sprains (10.3%, 212/2068), ankle contusions (10.1%, 208/2068), and medial (deltoid) ligament tears (9.77%, 202/2068). Further ankle injuries were reported but not included in the data analysis due to their rarity; when combined, they accounted for 4.3% (88/2068) of the total. Examples of these injuries were synovitis (n = 7), lateral malleolar fracture (n = 5), bursitis (n = 5), medial malleolar fracture (n = 4), subluxation (n = 2), dislocation (n = 1), talar fracture (n = 1), and "other ankle injury" (n = 28).

When compared with the other 3 most common ankle injuries, high ankle sprains resulted in a greater proportion of athletes missing ≥30 days of participation (IPR = 1.90, 23/202 versus 112/1866, 95% CI = 1.24, 2.90) and a lower proportion of athletes who returned to activity in <7 days (IPR = 0.61, 78/206 versus 1158/1862, 95% CI = 0.51, 0.73).

Other Notable Results

Ankle injuries occurred at a rate of 3.05 per 1000 AEs during games and 0.93 per 1000 AEs during practices. When compared with practices, games resulted in an ankle-injury RR of 3.33 (95% CI = 3.05, 3.63). New injuries constituted 84.3% (n = 1767) of total ankle injuries, whereas 15.7% (n = 328) were recurrent.

For every 1000 AEs, injuries occurred at a rate of 1.30 during the preseason, 1.51 during the season, and 0.95

Table 2. National Collegiate Athletic Association Ankle Injuries by Sex

Injury Characteristic		Injuries, % (No./Total)		Injury Proportion Ratio	95% Confidence Interval
		Males	Females		
Diagnosis					
	Lateral ligament complex tear	62.70 (617/984)	68.36 (741/1084)	0.92[a]	0.86, 0.98
	Medial (deltoid) ligament tear	10.26 (101/984)	9.32 (101/1084)	1.10	0.85, 1.43
	Contusion	11.59 (114/984)	8.67 (94/1084)	1.34[b]	1.03, 1.73
	High ankle sprain	10.47 (103/984)	10.06 (109/1084)	1.04	0.81, 1.34
Mechanism					
	Contact with another player	50.51 (497/984)	39.48 (428/1084)	1.28[b]	1.16, 1.41
	Noncontact	41.36 (407/984)	48.06 (521/1084)	0.86[a]	0.78, 0.95
	Contact with apparatus (ball/goalpost)	6.81 (67/984)	11.90 (129/1084)	0.57[a]	0.43, 0.76
	While being slide tackled	7.01 (69/984)	3.69 (40/1084)	1.90[b]	1.30, 2.78
New or recurrent?					
	New	85.47 (841/984)	85.42 (926/1084)	1.00	0.97, 1.04
	Recurrent	14.13 (139/984)	14.58 (158/1084)	0.97	0.78, 1.20
Caused ___d to be missed					
	0–6	56.30 (554/984)	56.64 (614/1084)	0.99	0.92, 1.07
	7–13	21.65 (213/984)	20.94 (227/1084)	1.03	0.88, 1.22
	14–29	13.01 (128/984)	12.36 (134/1084)	1.05	0.84, 1.32
	≥30	5.39 (53/984)	5.44 (59/1084)	0.99	0.69, 1.42

[a] Denotes a difference; the injury proportion ratio was decreased in males versus females.
[b] Denotes a difference; the injury proportion ratio was increased in males versus females.

Table 3. Days Missed According to Anatomical Structure Injured in National Collegiate Athletic Association Soccer Players by Sex

Anatomical Structure Injured	Days Missed, No. (95% Confidence Interval)		*P* Value[a]
	Males	Females	
All ankle injuries	8.68 (7.65, 9.72)	10.06 (8.59, 11.53)	.32
Contusion	4.33 (3.52, 5.13)	6.58 (2.92, 10.24)	.22
High ankle sprain	12.86 (10.31, 15.40)	16.97 (11.07, 22.87)	.22
Lateral ligament complex tear	8.56 (7.14, 9.99)	9.87 (8.09, 11.66)	.15
Medial (deltoid) ligament tear	9.97 (7.31, 12.63)	7.41 (5.64, 9.19)	.19

[a] *P* values showed no difference between sexes.

during the postseason. A player was more likely to injure the ankle during the season than during the preseason (RR = 1.17; 95% CI = 1.05, 1.29) and more likely to injure the ankle during the preseason than during the postseason (RR = 1.37; 95% CI = 1.09, 1.71). However, when we looked only at practice injuries, the rate was 1.19 injuries per 1000 AEs during the preseason and 0.76 injuries per 1000 AEs during the season. The RR of injury during preseason practices compared with season practices was 1.57 (95% CI = 1.39, 1.79).

From 2004–2005 through 2013–2014, a total of 943 ankle injuries occurred during games. The second half accounted for 56.8% (536/943) and the first half for 43.2% (407/943), suggesting that ankle injuries were more likely to occur during the second half (RR = 1.32; 95% CI = 1.20, 1.44).

The 3 most common mechanisms of ankle injuries were noncontact (44.87%, 928/2068), contact with another player (44.73%, 925/2068), and contact with an apparatus, presumably the ball or goalpost (9.48%, 196/2068).

Of the 2068 total ankle injuries, days lost were reported for 1982. Of these, 58.93% (1168/1982) resulted in 0 to 6 days missed, 22.20% (440/1982) resulted in 7 to 13 days missed, 13.22% (262/1982) resulted in 14 to 29 days missed, and 5.65% (112/1982) resulted in ≥30 days missed.

DISCUSSION

Our research showed how the time period (2004–2005 through 2008–2009 versus 2009–2010 through 2013–2014 seasons), anatomical structure injured, and sex of the athlete affected the injury rate, mechanism, and prognosis.

Overall Results

These findings correlate with those of many other investigators[3,4,7,12,18] who found that ankle injuries during games occurred at a rate 3 times greater than during practices (RR = 3.33; 95% CI = 3.05, 3.63). Furthermore, these results align with data from other studies[19,20] suggesting that injuries occurred more often during the second half of soccer games than during the first half (RR = 1.32; 95% CI = 1.20, 1.44). The increased injury rate during the second half could be attributed to athlete fatigue.[19–21]

Regarding the time of year in which injuries occurred, soccer players were more likely to be injured during preseason practices than during regular season practices (RR = 1.57; 95% CI = 1.39, 1.79). This value is consistent with the results of other authors[3,4,7] and could indicate that players beginning the preseason are less conditioned and, therefore, more likely to be injured.

Fortunately, when ankle injuries occur in these athletes, they often result in only a brief period of time being missed. In fact, many soccer players returned to the event in which they sustained the ankle injury.[7,9] Furthermore, of the 1982 injuries for which we have a record of days lost, 58.93% (n = 1168) resulted in 0 to 6 days missed, and only 5.65% (n = 112) resulted in ≥30 days missed. However, the time lost varied significantly depending on the anatomical structure injured.

Injured Anatomical Structure

Of the 4 most common ankle injuries, contusions resulted in the smallest number of days missed (males = 4.33 days, females = 6.58 days) and high ankle sprains resulted in the most days missed (males = 12.86, females = 16.97; Table 3). Lateral ligamentous complex tears and medial (deltoid) tears were associated with similar numbers of days missed after injury (Table 3). Among the 4 frequent ankle injuries, high ankle sprains had the worst prognosis.[14,15] In our study, when compared with the other 3 common ankle injuries, high ankle sprains were most likely to cause an athlete to miss ≥30 days (IPR = 1.90; 95% CI = 1.24, 2.90). Also, only 37.9% (n = 78) of athletes who had a high ankle sprain returned within a week of injury. High ankle sprains

Table 4. Injury Rates During 2009–2010 Through 2013–2014 Season Events Compared With 2004–2005 Through 2008–2009 Season Events for National Collegiate Athletic Association Soccer Players

Injury Event(s)	Injuries per 1000 Athlete-Exposures		Rate Ratio (95% Confidence Interval): 2009–2010 Through 2013–2014 Versus 2004–2005 Through 2008–2009
	2004–2005 Through 2008–2009	2009–2010 Through 2013–2014	
All events	1.44	1.35	0.94 (0.85, 1.04)
Games	3.15	3.27	1.04 (0.91, 1.19)
Practices	0.93	0.78	0.84 (0.72, 0.97)[a]
Preseason	1.38	1.03	0.75 (0.60, 0.94)[a]
Season	1.53	1.46	0.96 (0.85, 1.07)
Postseason	0.79	1.37	1.75 (1.14, 2.68)[b]

[a] Denotes a difference: the rate ratio was decreased in 2009–2010 through 2013–2014 versus 2004–2005 through 2008–2009.
[b] Denotes a difference: the rate ratio was increased in 2009–2010 through 2013–2014 versus 2004–2005 through 2008–2009.

Table 5. Characteristics of Ankle Injuries During the 2004–2005 Through 2008–2009 Seasons Versus the 2009–2010 Through 2013–2014 Seasons in National Collegiate Athletic Association Soccer Players

Characteristic		Injuries, % (No./Total)		
		2004–2005 Through 2008–2009	2009–2010 Through 2013–2014	Injury Proportion Ratio (95% Confidence Interval)
Diagnosis				
	Lateral ligament complex tear	66.82 (1043/1561)	62.13 (315/507)	0.93 (0.86, 1.00)
	Medial (deltoid) ligament tear	8.71 (136/1561)	13.02 (66/507)	1.49 (1.13, 1.97)[a]
	Contusion	9.48 (148/1561)	11.83 (60/507)	1.25 (0.94, 1.66)
	High ankle sprain	11.47 (179/1561)	6.51 (33/507)	0.57 (0.40, 0.81)[b]
Mechanism				
	Contact with another player	44.71 (698/1561)	44.77 (227/507)	1.00 (0.90, 1.12)
	Noncontact	45.04 (703/1561)	44.38 (225/507)	1.01 (0.91, 1.13)
	Contact with apparatus (ball/goalpost)	9.74 (152/1561)	8.68 (44/507)	0.89 (0.65, 1.23)
	While being slide tackled	4.80 (75/1561)	6.71 (34/507)	1.40 (0.94, 2.07)
New or recurrent?				
	New	83.79 (1308/1561)	90.53 (459/507)	1.08 (1.04, 1.12)[a]
	Recurrent	16.14 (252/1561)	8.88 (45/507)	0.55 (0.41, 0.74)[b]
Caused ___d to be missed				
	0–6	52.53 (820/1561)	68.64 (348/507)	1.31 (1.21, 1.41)[a]
	7–13	20.31 (317/1561)	12.43 (63/507)	0.61 (0.48, 0.79)[b]
	14–29	14.09 (220/1561)	8.28 (42/507)	0.59 (0.43, 0.81)[b]
	≥30	6.53 (102/1561)	1.97 (10/507)	0.30 (0.16, 0.57)[b]

[a] Denotes a difference: the injury proportion ratio was increased in the 2009–2010 through 2013–2014 versus the 2004–2005 through 2008–2009 seasons.

[b] Denotes a difference: the injury proportion ratio was decreased in the 2009–2010 through 2013–2014 versus the 2004–2005 through 2008–2009 seasons.

are usually caused by eversion or external rotation (or both).[14,15] The prolonged period of pain and instability from these injuries can be attributed to the anterior tibiofibular ligament, which is typically injured during high ankle sprains. This ligament is a syndesmosis that keeps the tibia and fibula connected and functioning in unison.[14,15] As an athlete runs and cuts, large forces traverse the tibia and fibula, applying significant stress to the relatively small anterior tibiofibular ligament.[14,15] These large forces cause lingering periods of pain and instability after high ankle sprains.[14,15]

Similar to the current literature,[3,4,7] we found that the LLC was the most commonly injured anatomical structure, accounting for 65.67% (n = 1358) of ankle injuries. The mechanism of LLC injuries is inversion of the ankle joint.[7,14,18] Structurally, the fibula, which lies on the lateral aspect of the ankle, extends farther distally than the tibia, allowing the ankle to invert more readily than evert.[9] This relatively easy inversion allows athletes to "roll" the ankle in supination, often resulting in an LLC tear.[9] The LLC includes the anterior talofibular, calcaneofibular, and posterior talofibular ligaments.[7] The anterior talofibular

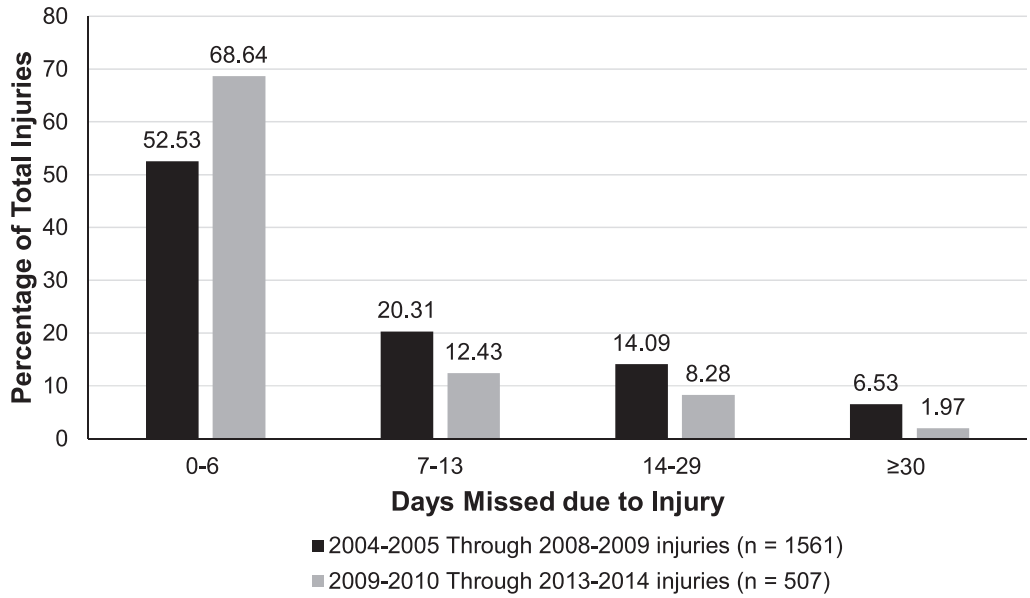

Figure. Comparison of days missed after ankle injury between the 2004–2005 through 2008–2009 seasons and the 2009–2010 through 2013–2014 seasons. Note: This is a graphic depiction of the last 4 rows of Table 5. The 95% confidence intervals shown in Table 5 suggest differences in the injury proportion ratios (IPRs) at each "Days Missed due to Injury" interval.

Table 6. Rates of Lateral Ligament Complex and Deltoid Ligament Tears, Contusions, and High Ankle Sprains in National Collegiate Athletic Association Soccer Players by Event

Injury	Injury Rate per 1000 Athlete-Exposures		Rate Ratio (95% Confidence Interval)
	Games	Practices	
Lateral ligament complex tear	2.01	0.606	3.32 (2.98, 3.69)[a]
Medial (deltoid) ligament tear	0.323	0.082	3.90 (2.96, 5.15)[a]
Contusion	0.401	0.065	6.16 (4.63, 8.18)[a]
High ankle sprain	0.356	0.082	4.34 (3.31, 5.70)[a]

[a] Denotes a difference: the rate ratio was increased during games versus practices.

ligament is the weakest of the LLC ligaments and, therefore, the most likely to be injured during inversion.[9,14] Also, the anterior talofibular is the primary lateral ligament stressed in plantar flexion and inversion, which occurs when the ankle is in its most vulnerable position due to the narrower geometry of the posterior talus.[9,14]

Although some LLC tears resulted from contact with another player, they were more likely to occur without contact (Table 7). This could be due to hyperinversion, as when an athlete landed from a jump, cut, or stepped on uneven ground.[9,14] Conversely, medial ligament ankle tears were more likely to be due to contact with another player (Table 7). This can be explained, once again, by the relative length of the fibula compared with the tibia.[9] Because the fibula extends farther than the tibia, hypereversion of the ankle is more difficult and more likely to require an external force, such as contact with another player.

Lateral ligament complex tears, deltoid tears, contusions, and high ankle sprains were more frequent during games than during practices, but contusions showed the highest RR during games (Table 6). This is probably because contusions were more likely to result from contact than noncontact (Table 7). Given that games are often associated with greater intensity than practices, games may also lead to increased contact, thereby causing a higher incidence of contact injuries.[3,4]

When we categorized the 4 most common ankle injuries as new or recurrent, all were typically described as new (Table 8). However, it is important to recognize that these data may be inaccurate because ATs and team physicians do not always know an athlete's medical history and may incorrectly classify a recurrent injury as new. Still, advances in physical therapy, strengthening exercises, taping, and bracing probably contributed to the lower number of recurrent injuries.

Males Versus Females

For males and females, the injury rates (Table 1) and the time to return to activity after ankle injury (Table 2) were similar. Yet males were more likely to be injured by contact with another player (IPR = 1.28; 95% CI = 1.16, 1.41) and while being slide tackled (IPR = 1.90; CI = 1.30, 2.78) and less likely to incur a noncontact ankle injury (IPR = 0.86; CI = 0.78, 0.95) or an injury due to contact with an apparatus (IPR = 0.57; 95% CI = 0.43, 0.76). Also, males were more likely to be injured during games (RR = 1.14; 95% CI = 1.01, 1.29) and to sustain contusions (IPR = 1.34; 95% CI = 1.03, 1.73). The similar rates of ankle injuries among NCAA soccer players have been well described in the literature.[3,4] The increase in game injuries, contact injuries, and contusion injuries may be due to the increased contact in men's sports compared with women's sports.[22,23]

In comparing the anatomical structure injured, males and females showed similar IPRs for high ankle sprains and medial (deltoid) tears (Table 2), but males were less likely to experience an LLC tear (IPR = 0.92; 95% CI = 0.86, 0.98). The slight increase in LLC tears among females could result from the increased LLC laxity that has been described previously.[22,23]

Prior authors[2,4,8,16] showed discrepancies in joint laxity, hormones, height, weight, strength, mechanical axis, and level of contact among males and females that may contribute to ankle injuries. Recognizing the differences in injuries between sexes may lead to the creation of and changes in sex-specific rule revisions and ankle exercises.

The 2004–2005 Through 2008–2009 Seasons Versus the 2009–2010 Through 2013–2014 Seasons

The rates of injuries were similar during the 2 time periods. However, the time missed and the proportions of recurrent injuries were different. Injuries during the 2009–2010 through 2013–2014 seasons resulted in fewer players missing ≥30 days (IPR = 0.3; 95% CI = 0.16, 0.57) and more players returning to play within 1 week (IPR = 1.31; 95% CI = 1.21, 1.41) than those during the 2004–2005 through 2008–2009 seasons. Injuries during the 2009–2010 through 2013–2014 seasons were also less likely to be recurrent (IPR = 0.55; 95% CI = 0.41, 0.74). During the 2004–2005 through 2008–2009 seasons, more days were missed because of injury (11.06 ± 22.67) compared with the 2009–2010 through 2013–2014 seasons (5.09 ± 9.45; *P*

Table 7. Proportions of Lateral Ligament Complex and Deltoid Ligament Tears, Contusions, and High Ankle Sprains That Occurred Due to Contact With Another Player Versus Noncontact in National Collegiate Athletic Association Athletes

Injury	No./Total		Injury Proportion Ratio (95% Confidence Interval)
	Noncontact	Contact With Another Player	
Lateral ligament complex tear	677/1214	537/1214	1.26 (1.16, 1.37)[a]
Medial (deltoid) ligament tear	73/168	95/168	0.77 (0.61, 0.96)[b]
Contusion	22/200	178/200	0.12 (0.08, 0.18)[b]
High ankle sprain	99/187	88/187	1.13 (0.92, 1.38)

[a] Denotes a difference: the injury proportion ratio was increased for injuries caused by noncontact versus contact with another player.
[b] Denotes a difference: the injury proportion ratio was decreased for injuries caused by noncontact versus contact with another player.

Table 8. Proportions of New Versus Recurrent Lateral Ligament Complex and Deltoid Ligament Tears, Contusions, and High Ankle Sprains in National Collegiate Athletic Association Soccer Players

Injury	Recurrent	New	Injury Proportion Ratio (95% Confidence Interval)[a]
Lateral ligament complex tear	217/1358	1141/1358	0.19 (0.17, 0.22)
Medial (deltoid) ligament tear	26/202	176/202	0.15 (0.10, 0.21)
Contusion	9/128	119/128	0.08 (0.04, 0.14)
High ankle sprain	33/212	179/212	0.18 (0.13, 0.25)

[a] For entire column, denotes a difference: the injury proportion ratios were decreased for recurrent versus new injuries.

$< .001$). Decreases in the number of recurrent ankle injuries and the days lost per injury may reflect continuing advances in rehabilitation and injury prevention.[6,10,19,24] Athletes were able to return to soccer more quickly in the most recent time period, perhaps because ATs and team physicians prescribed early proprioceptive training and earlier use of physical therapy as opposed to immobilization, which was commonly prescribed in the past.[6,10,19,24] It is interesting that even though athletes were returning to play more quickly, they sustained fewer recurrent injuries. Advances in prevention such as taping, bracing, and injury-specific weight-training regimens may be responsible.[6,10,19,24]

Previous researchers[2] showed similar decreases in injury severity and recurrence when comparing the 2004–2009 seasons with the 1990–1996 seasons. Also, fewer ankle injuries occurred during the 2004–2009 seasons than the 1990–1996 seasons.[2] The rate of ankle injuries from 1990–1996 in NCAA soccer was 1.73 per 1000 AEs versus 1.44 per 1000 AEs during the 2004–2009 seasons.[2] Although our data demonstrated a decreased injury rate of 1.35 per 1000 AEs during the 2009–2010 through 2013–2014 seasons, this value was not statistically different from the rate of 1.44 per 1000 AEs during the 2004–2009 seasons (RR = 0.94; 95% CI = 0.85, 1.04). However, as stated earlier, the rate of recurrence and time loss both decreased significantly.

In addition, the 2004–2005 through 2008–2009 seasons resulted in more preseason injuries than the 2009–2010 through 2013–2014 seasons (Table 4). One possibility for this decrease is that coaches, ATs, and team physicians were more aware of the increased preseason injury rates and attempted to decrease the intensity and full-contact periods during preseason practices. Another potential reason for this decrease is the use of off-season strength and conditioning programs to help the athletes begin preseason workouts in better condition.

Furthermore, decreases in preseason and practice injuries between the 2004–2005 through 2008–2009 seasons and the 2009–2010 through 2013–2014 seasons may also be due to changes in NCAA rules and guidelines, including a document released May 13, 2009, "Defining Countable Athletically Related Activities."[25] This document was released between the 2 time periods we analyzed and specifically describes which team activities are considered organized team practices.[25] These rule changes may have reduced the number of hours of practice, possibly leading to a lower rate of fatigue-related injuries during the 2009–2010 through 2013–2014 seasons.

Another effort to protect athletes addressed by the NCAA was the update and implementation of rules regarding shin guards, which were first mandated for NCAA soccer players in 1991.[3] Since then, the size and use of shin guards have undergone changes.[3] The most current update[3] regarding shin-guard rules (established in 2007) stated that they must "meet the standards established by the National Operating Committee on Standards for Athletic Equipment (NOCSAE)." Shin guards prevent contusions and fractures. Because of the small number of fractures among NCAA soccer players (n = 9), these injuries were not included in our study. However, shin guards have failed to decrease the number of contusions. In fact, the proportion of contusions increased slightly from the 2004–2005 through 2008–2009 seasons to the 2009–2010 through 20013–2014 seasons (IPR = 1.25; 95% CI = 0.94, 1.66), though the confidence interval suggests that the difference was not significant. This finding correlates with previous results that showed no changes in contusion rates with the implementation of shin guards.[3]

LIMITATIONS

Previous investigators[26] determined that in the years 2005–2007, of the programs that provided data to the NCAA-ISP, 88.5% of NCAA soccer injuries were reported. Thus, the data we used in this study represent a majority but not all of the injuries that occurred during these seasons. Our data only accounted for injuries reported by ATs and medical staff. It is possible that injuries were reported incorrectly; for example, a new AT who had not previously worked with a particular athlete could have marked an injury as new when it was actually recurrent. The immobility and rehabilitation measures used for recovery in these athletes were not described, and time-out-of-play data did not control for these extenuating variables. Also, LLC tears, medial (deltoid) ligament tears, and high ankle sprains were not differentiated as partial or complete. Another inherent limitation of the data used in this study was that the diagnoses were made by many different ATs and physicians, and we do not know whether physical examinations or magnetic resonance imaging were undertaken.

Many more schools participated in the NCAA-ISP for the 2004–2005 through 2008–2009 seasons versus the 2009–2010 through 2013–2014 seasons, though generalizations are still possible due to the persistently high volume in the latter group. Also, only the number of AEs was measured and not participation time per event. Therefore, if a practice lasted twice as long as a game, it was measured as only 1 AE. Similarly, if an athlete played in only the last few minutes of a game, it was still counted as an AE. Had AEs been defined in minutes, the increased RR of game injuries would have likely been higher. Also, there was a discrepancy in the recording between the 2004–2009 seasons and the 2009–2014 seasons. The 2009–2014 seasons included injuries that resulted in no time loss. However, the 2004–2009 seasons did not include injuries that resulted in no time loss. Therefore, when comparing average days lost between these time periods, the analysis may be biased.

CONCLUSIONS

Although the rate of ankle injuries did not change between the 2004–2005 through 2008–2009 and 2009–2010 through 2013–2014 seasons, the prognoses improved. Of the 4 most common ankle injuries, high ankle sprains resulted in the worst prognosis. Overall, male and female NCAA soccer players injured their ankles at similar rates; however, males were more likely to have contact injuries.

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