



In National Collegiate Athletic Association Men's and Women's Soccer Athletes There Is a Low Rate of Lumbar Spine Injury, Women Suffer More Recurrent Injuries than Men, and Most Injuries Occur in the Preseason

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Purpose: To use the National Collegiate Athletic Association Injury Surveillance Program (NCAA-ISP) from the 2009-2010 through the 2014-2015 seasons to report lumbar spine injury rates, characteristics, and time lost from sport in soccer players. **Methods:** Characteristics of lumbar spine injuries by season, competition/practice, and time lost from sport were determined using the NCAA-ISP database. Rates of injury were calculated as the number of injuries divided by the number of athlete exposures (AEs). AEs are any athlete participation in a competition or practice. Incidence rate ratios (IRRs) were calculated to compare rates between event types and time of season. Injury proportion ratios (IPRs) were used to evaluate differences in injury rates between men and women. **Results:** The NCAA-ISP estimated 4,464 LSIs over 5 years. The rate of LSI in men was 2.1/10,000 AEs and 3.0/10,000 AEs in women. Women were 1.43 times more likely to suffer an LSI compared to men. Women were 2.15 times as likely to suffer an LSI in competition compared to in practice while men were 1.10 times as likely. Women were 2.15 times as likely to be injured in the preseason compared to the regular season, while men were 3.76 times as likely. Non-contact injuries were the most common cause of lumbar spine injuries (LSIs) in men (35%); however, contact injuries were more common in women (33%). Most athletes both male (57%) and female (59%) returned to play within 24 hours. **Conclusion:** This study provides information on the characteristics of LSIs in NCAA soccer. The overall injury rate to the lumbar spine is relatively low. Injury rates are highest in the preseason and in competition. Women suffer from more recurrent LSI's than men, and men acquired more injuries through non-contact mechanisms. More than one-half of athletes returned to sport within 24 hours.

Introduction

Soccer is the most popular sport worldwide, with an estimated 265 million active participants.¹ Notably, the number of soccer players has steadily increased in the United States over recent decades. During the 1981-1982 season, there were 80 women's and 521 men's National Collegiate Athletic Association (NCAA) sponsored teams with a total of 1,855 and 25,664 participants, respectively.² By the 2019-2020 season, this number had increased to 1,038 women's and 834 men's teams with 28,673 and 25,664 participants, respectively.

Injuries in NCAA soccer have been reported to occur at rates as high as 84.4 per 10,000 athlete exposures (AEs).^{3,4} Although these injuries most commonly involve the knee, lumbar spine injuries (LSI) also occur and can lead to long recovery periods.⁵ Some injuries,

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such as muscle strains, allow relatively quick return to play. However, more serious injuries, such as disc herniations, spondylolysis/spondylolisthesis, and fractures, may require surgery and months of rehabilitation. In general, athletes tend to return to sport with varying levels of return to preinjury performance depending on the injury and surgical modality. Athletes at high levels of competition are heavier, stronger, and taller than they were in the past, predisposing athletes to an increased risk of injury due to high velocity falls, tackles, and aggressive attempts to command possession.⁶ Furthermore, the specific high-velocity mechanics and rapid changes in direction required from a soccer player place a high demand in flexion, extension, as well as rotation on the spine.⁷

There is a paucity of available literature describing lumbar spine injuries in NCAA soccer players. Previous studies have been limited to other sports, different levels of competition than the NCAA, or are outdated.^{3,6,8–14} Further, none of these studies have compared NCAA male and female soccer athletes with comprehensive analysis of lumbar spine injuries.^{4,15–17} The purpose of this study was to use the NCAA Injury Surveillance Program (NCAA-ISP) from the 2009–2010 through the 2014–2015 seasons to report lumbar spine injury rates, characteristics, and time lost from sport in soccer players. As soccer is a contact sport, we hypothesize that LSIs primarily occur due to contact, in competition, and during the preseason when players are deconditioned.

Methods

Data Collection

The NCAA-ISP database was queried from the 2009/2010 to 2013/2014 collegiate soccer seasons. In this study, the database was queried for soccer players in all divisions who sustained injuries to the low back. The injury surveillance data is prospectively gathered by the Datalys Center for Sports Injury Research and Preven-

result, this creates a nonrandomized data set as the ISP monitors injury patterns.^{13,18}

Athletic trainers (AT) at each participating program record injury and exposure data through their institution's electronic health record (EHR). The collected data come from organized practices, as well as competitions throughout the preseason, regular season, and postseason. For each injury, athletic trainers report details on the injury and surrounding circumstances. This report includes the anatomic site of the injury, the diagnosis, the event type (competition vs. practice), and the date when a player returns to participation. Finally, ATs record the number of participants at each event to determine athletic exposures (AE). The data collection relied on the expertise of the ATs, as well as other members of medical staff that assisted with documentation, to accurately diagnose and report injuries.

Data from each institution's EHR system were subjected to validation. The data were first extracted from each EHR and deidentified. Quality assurance personnel notified ATs if any data were missing and worked with ATs to resolve these issues. Finally, the data were submitted through an automated verification program that performed a series of range and consistency checks, removing outliers, and uploading the polished data into the research database. Results were grouped as contusions, fractures (spondylolysis and spondylolisthesis), muscle spasms, muscle strains, nervous system (sciatica), and miscellaneous if low back injuries were unspecified.

Computing National Estimates

The calculation of national estimates from the ISP database has been previously described.^{14,18} The calculation is performed using poststratification sample weights based on sport, division, and academic year that were applied to each reported injury and AE. Poststratification sample weights were calculated with the following formula:

$$\text{Sample weight}_{abc} = \left(\frac{\text{number of teams participating in ISP}_{abc}}{\text{number of teams in NCAA}_{abc}} \right) - 1$$

tion. The methods used for building this program are previously described and are briefly reviewed below.¹⁸ The NCAA ISP has been validated and previously used as an injury reporting system.¹⁹ The use of this database was approved by the research review board of the NCAA and was found to be exempt from Institutional Review Board approval.

The NCAA ISP query provided a voluntary convenience sample of NCAA soccer programs over the 5-year period. This leads to variability in the number of programs that participate in the dataset each year. As a

Weight_{abc} is the weight for the *a*th sport of the *b*th division in the *c*th year. This weight can then be multiplied by the number of injuries reported by the ISP to represent injury data across the NCAA. In order to correct for underreporting, weights were further adjusted to account for an estimated 88.3% capture rate of injuries in the NCAA-ISP data previously reported in the literature.¹⁹

Statistical Analysis

LSIs were assessed by injury type, time loss, time of season, event type, recurrence, and injury mechanism.

Table 1. Total Injuries, Rates, and Comparison

Injury	Total No. (%) [*]			Injury Rate/10,000 Exposures			IPR Women/Men (95% CI)
	Women's	Women's	Combined	Women's	Men's	Combined	
Contusion (Hematoma)	324 (11.99)	.36	1.05 (.39-2.81)	.36	.35	.35	1.05 (.39-2.81)
Fracture	164 (6.07)	.19	1.66 (.19-14.84)	.19	.11	.15	1.66 (.19-14.84)
Miscellaneous	743 (27.50)	.83	1.01 (.51-2.01)	.83	.82	.82	1.01 (.51-2.01)
Nervous system	32 (1.18)	.04	.66 (.04-10.58)	.04	.06	.04	.66 (.04-10.58)
Spasm	995 (36.82)	1.11	14.1 (3.33-59.82)	1.11	.08	.61	14.1 (3.33-59.82)
Strain	443 (16.4)	.5	.71 (.30-1.69)	.5	.69	.59	.71 (.30-1.69)
Total	2702	3	1.43 (.95-2.17)	3	2.1	2.56	1.43 (.95-2.17)

^{*}National estimates for sports may not sum to total because of rounding from weighted calculation.

Injury rate was calculated as the number of injuries divided by the number of AEs and reported as a ratio per 10,000 AEs. This calculation was reported as an overall rate and as individual rates for event type and time of season.

Incidence rate ratios (IRRs) were calculated to compare injury rates between event types and time of season. The following formula is an example of an IRR comparing injury rate in competition versus practice, previously used by other studies.^{11,13,14}

$$IRR = \frac{\left(\frac{\sum \text{Number of competition injuries}}{\sum \text{Competition AEs}} \right)}{\left(\frac{\sum \text{Number of practice injuries}}{\sum \text{Practice AEs}} \right)}$$

Injury proportion ratios (IPRs) were used to compare differences in injury rates between men and women. The following formula is an example of an IPR comparing lower back injuries that were caused by disk herniation in men and women:¹³

$$IPR = \frac{\left(\frac{\sum \text{disk herniation in men}}{\sum \text{total LSIs in men}} \right)}{\left(\frac{\sum \text{disk herniation in women}}{\sum \text{total LSIs in women}} \right)}$$

Any results with 95% CIs that did not contain 1.0 were considered statistically significant. For participation restriction time, intervals were reported as <24 hours, 1-6 days, 7-21 days, and >21 days.¹¹ Data were analyzed using IBM SPSS and Microsoft Excel.

Results

The overall LSI rate for all of the studied athletes was 2.59 per 10,000 AEs. The LSI rate was 3.0 per 10,000 AEs for women and 2.1 per 10,000 AEs in men. According to the calculated IPR, women were 1.43 times (95% CI, 0.95-2.17) more likely to suffer an LSI compared to men. Unspecified low back injuries accounted for 39% of the injuries in men and 30% of the injuries in women.

When comparing the injury rates of specific LSI types between men and women, men were more likely to receive injury to the nervous system, such as sciatica (IPR, 0.66 [CI, 0.04-10.58]), as well as to have a lumbar strain (IPR, 0.71 [CI, 0.30-1.69]). Women were more likely to suffer fractures such as spondylolysis and

spondylolisthesis, hematomas, muscle spasms, and muscle strains. Reported unspecified low back injuries, referred to as "Miscellaneous", accounted for 39% (688/1762) of the injuries in men and 27.5% (743/2702) of the injuries in women (Table 1).

Event Type and Season of Play

Overall, the LSI rate was 0.86/10,000 AEs in competition and 1.71/10,000 AEs in practice (Fig 1). However, women were more than twice as likely to suffer an LSI in competition compared to in practice (IRR: 2.15, CI, 1.34-3.46), while men were only 1.10 times as likely (CI, 0.51-2.37). Comparing across the sexes, women were more than twice as likely as men to be injured in a competition (IPR: 2.24, CI, 1.06-4.73), while this ratio was closer in a practice setting (IPR: 1.15, CI, .69-1.89).

When organizing AEs such as practice and competition by time of season for the sport, both men and women had the highest rate of injury in the preseason with rates of 4.8 and 4.9 per 10,000 AEs, respectively (Table 2). Women were 2.15 times (95% CI, 1.31-3.52) as likely to be injured in the preseason compared to the regular season, while men were 3.76 times (95% CI,

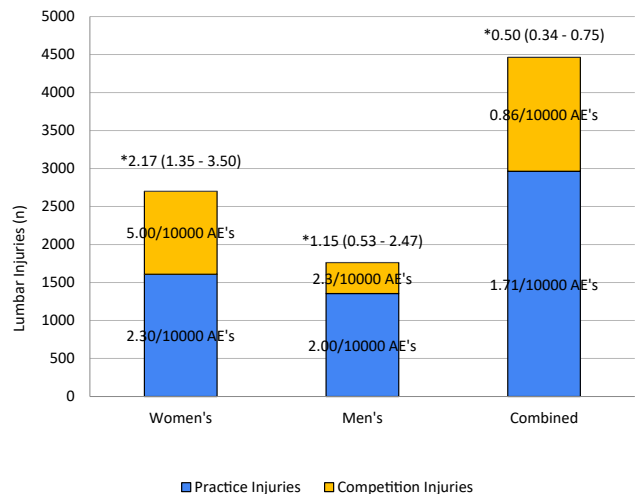


Fig 1. Injury rate/athlete exposures in practice and competition. *Competition/Practice Injury Rate Ratio (95% CI).

Table 2. Injuries in Relation to Time of Season

	Women's		Men's		Combined		
	No. of Lumbar Injuries	Injury Rate/10,000 Exposures	No. of Lumbar Injuries	Injury Rate/10,000 Exposures	No. of Lumbar Injuries	Injury Rate/10,000 Exposures	IPR Women/Men (95% CI Range)
Preseason	1066	4.9	1034	4.8	2100	4.88	1.02 (.57-1.83)
Regular Season	1446	2.3	730	1.3	2176	1.82	1.78 (.97-3.29)
Postseason	190	3.7					

1.89-7.51) as likely. When comparing the two sexes, the injury rate in preseason was comparable with an IPR of 1.02 (95% CI, .57-1.83); however, women were more likely to be injured in regular season (IPR: 1.78 [95% CI, .97-3.29]).

Injury by Division and Athlete Position

Across both sexes, the injuries by division were the same. Athletes in Division III soccer were most likely to suffer from an LSI (4.16/10,000 AEs for women and 2.69/10,000 AEs for men), followed by Division I (3.23/10,000 AEs for women and 2.18/10,000 AEs for men), with Division II soccer players least likely (1.12/10,000 AEs for women and .73/10,000 AEs for men) (Fig 2).

Injuries were also compared across player positions between men and women. For women, defensive backs had the most injuries (28%). For men, forwards had the most injuries (43%) (Table 3). When comparing across sexes, female defensive backs, goalkeepers, midfielders, and forwards were 2.08, 4.95, .73, and .55 times more likely to be injured than males in the same positions, respectively (defensive backs: 95% CI: .83-5.22; goalkeepers: 95% CI .62-39.6; midfielders: 95% CI: .34-1.58; forwards: 95% CI: .25-1.17) (Fig 3).

Nature of Injury

Non-contact events were the most common cause of LSIs in men (35%), while contact injuries were most

common in women (33%) (Fig 4). When comparing the sexes, women and men were roughly equally likely to have a contact injury (IPR: 1.02 [95% CI, .50-2.09]). Men were more likely to suffer a noncontact injury (IPR: .92 [95% CI, .43-1.99]) while women more commonly had LSI from overuse (IPR: 1.34 [95% CI, .55-3.29]). Overall, 87.4% (n = 1540) of injuries in men and 72.1% (n = 1945) of injuries in women were new, while the remainder were recurrent 12.6% (n = 223) in men; 27.9% (n = 754) in women) (Table 4). When comparing the sexes, women were more than twice as likely to suffer from recurrent injuries (IPR: 2.21 [95% CI, 0.75-6.49]), while men were more likely to suffer from new injuries (IPR: .82 [95% CI, .52-1.30]).

Time Lost from Play and Need for Surgery

Most athletes, both male (57%; n = 975) and female (59.0%; n = 1,557), returned to play within 24 hours after their injury (Table 5). Among men who required longer than 24 hours to recover with contusions (22.2%; n = 131), fractures (15.7%; n = 93), and strains (7.8%; n = 46), all returned to play within 6 days (Table 6). Women were roughly as likely to recover within 24 hours as men (IPR: 1.04 [95% CI, .61-1.76]); however, they were less likely to suffer injuries that required 1-6 days (IPR: .84 [95% CI, .40-1.77]) and more than 21 days (IPR: .82 [95% CI, .09-7.34]). No male athlete with LSI needed surgical intervention while .93% of women with LSI required surgery.

Discussion

The main findings of this study were that LSI occurred at a rate of 2.59/10,000 AEs in men and women combined. Both sexes were more likely to sustain LSI in

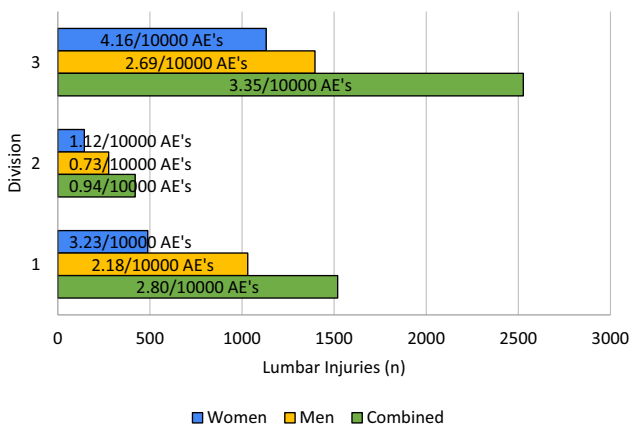


Fig 2. Injury rate/athlete exposures by National Collegiate Athletic Association division.

Table 3. Injury by Position

Position	Weighted Women's Injuries (%)	Weighted Men's Injuries (%)	IPR Women/Men (95% CI Range)
Defensive back	744 (28)	233 (13)	2.08 (.83-5.22)
Forward/attack	628 (23)	752 (43)	.54 (.25-1.17)
Goalkeeper	349 (13)	46 (2.6)	4.95 (.62-39.60)
Midfielder	597 (22)	531 (33)	.73 (.34-1.58)
Unknown	381 (14)	200 (11)	1.24 (.40-3.91)
Total	2699	1762	

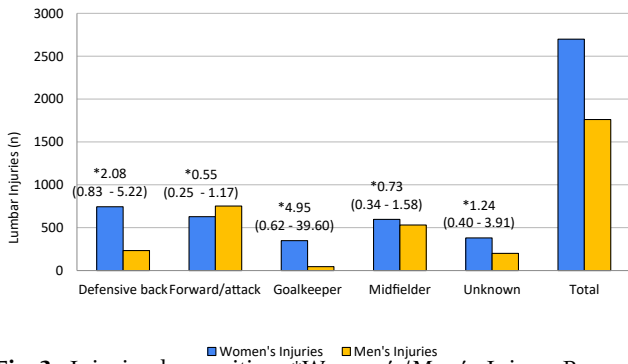


Fig 3. Injuries by position *Women's/Men's Injury Proportion Ratio (95% CI).

competition than in practice. However, women were more likely than men to suffer LSI in both categories. Injuries were most common in preseason, and this rate was comparable across sexes. However, women are more likely than men to be injured in regular season. Men most commonly suffer noncontact LSIs, while women most commonly suffer LSI from contact. Women are more likely than men to suffer from recurrent injuries and the majority of players with LSI returned to play within 24 hours of injury.

Both men and women NCAA soccer players had higher rates of LSI in competition compared to practices. Previous studies have supported these findings within soccer and across other sports, and it is likely because of an increased intensity needed during competition. Click or tap here to enter text. Makovicka et al. found this same result for LSI in NCAA football and basketball players.^{13,14} Distefano et al. found the same result in high school and NCAA soccer athletes in females.¹⁵ As did Kerr et al. in males, although these two latter studies examined for injury as a whole, rather than only LSI.¹⁷ It is important for coaches to be cognizant of these findings to ensure proper rest and utilization of athletes in order to mitigate injury risk. A possible solution could be using GPS tracking

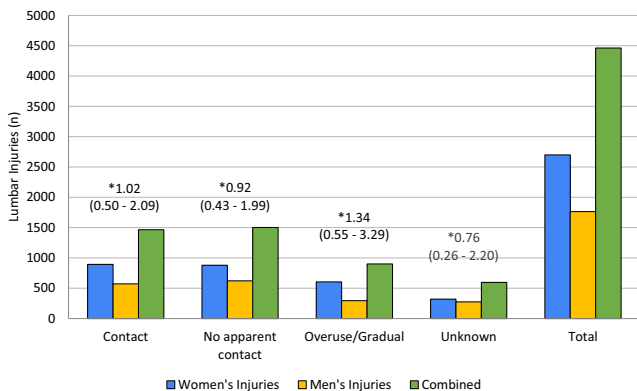


Fig 4. Injuries by mechanism. *IPR Women/Men (95% CI Range).

Table 4. Injury Recurrence

	Lumbar Spine Injuries (%)			IPR Women/Men (95% CI Range)
	Women's	Men's	Combined	
New	1,945 (72)	1,540 (87)	3,485 (78)	0.82 (.52-1.30)
Recurrence	754 (28)	223 (13)	977 (22)	2.21 (.75-6.49)
Total	2,699	1,763	4,462	

information to rest players who have exceeded certain safety limits. Studies by Ehrmann et al. and Xiao et al. used GPS tracking devices and found increased distance and intensity correlate to injury risk in athletes.^{20,21}

Lumbar spine injuries occurred at higher rates in the preseason compared to the regular season. Although women and men had comparable rates in injury in the preseason, women were more likely than men to be injured in the regular season. The increased risk of injury in the preseason is a phenomenon that occurs in other sports, although not all, and is hypothesized to be due to deconditioning in the preseason as compared to in-season time periods. Players may be exerting themselves beyond capacity when their bodies are not adjusted to a high level of intensity, which could predispose to injury. This was again corroborated by Makovicka et al. in NCAA football and basketball players, as well as by Kerr et al. and Distefano et al. in NCAA soccer athletes.^{13-15,17} The Federation Internationale de Football Association (FIFA) 11+ injury prevention program was developed in 2006 to combat injury rates in soccer. It consists of a complete warm up routine that emphasizes core strength, as well as proper proprioceptive and stabilization training. FIFA 11+ has been demonstrated to significantly reduce injury rates across multiple levels of the sport.^{22,23} Findings such as these highlight the necessity to begin injury prevention programs that begin earlier than the regular season.

Previous studies do not show a consensus on which field position is most likely to be injured across different levels of play.^{5,24,25} This is potentially because players within position groups such as a defender may have differing roles. For example, a wing defender is more likely to play full field versus a central defender who is more likely to stay closer to their own goal. In our study at the NCAA level, female defensive backs were most likely to suffer LSIs, while male forwards were most likely injured. A potential explanation for this finding relates to defenders accumulating more injuries secondary to increased physicality while tackling or heading the ball. Across both genders and other studies, goalkeepers were least likely to become injured.²⁵ This may be explained by less field movement and better protection from referees compared to other positions.

Men most commonly suffered noncontact injuries, while women were most commonly injured through contact. When comparing the two sexes, men were more likely to suffer a noncontact injury, while women

Table 5. Time Loss Comparison

	Lumbar Spine Injuries (%)			IPR Women/Men (95% CI Range)
	Women's	Men's	Combined	
<24 Hours	1,557 (59)	975 (57)	2,532 (58)	1.04 (.61-1.77)
1-6 Days	758 (29)	590 (34)	1,348 (31)	.84 (0.40-1.77)
7-21 Days	129 (4.9)			
>21 Days	195 (7.4)	155 (22)	350 (8.0)	.82 (.09-7.34)
Total	2,639	1,720	4,359	

more commonly had LSI from overuse and recurrent injuries. Noncontact type injuries may consist of sprains, strains, and contusions, for example. These are mainly attributed to poor conditioning, inappropriate warm-up, muscle fatigue, and muscle imbalances.²² Improving these injury rates can potentially be accomplished by programs such as FIFA 11+ and other methods of adequately preparing athletes' strength, endurance, and technique. Overuse injuries are those with no identifiable event responsible for the injury and occur from repetitive use and stress without adequate time to heal properly. Previous studies, such as Yang et al., have also demonstrated higher rates of overuse injuries in NCAA female athletes.²⁶ Makovicka et al. found a lower rate of overuse LSI in female NCAA basketball players compared to males; however, there was a higher rate of recurrent injuries in females similar to this study.¹³ This is not very well understood; however, a partial explanation may be found in structural and biochemical differences between the sexes. This study also found that women are more likely to return to play earlier than men, which could partially explain a greater risk for overuse and recurrent injuries. Proper prevention of overuse and recurrent injury must involve effective rehabilitation and restricting play until an athlete is ready to return. Prevention of contact injuries can involve both coaching strategies and penalties given by referees that discourage foul play and promote safe competition.

Although many injuries to the lumbar spine are potentially serious, in this study, nearly 60% of soccer players of both genders returned to play within 24 hours of injury. Compared to men, women were less likely to suffer injuries that required longer than 24

hours to return to play. Secondary to improved training modalities, professional soccer athletes continue to improve athleticism, and the same could be hypothesized at the collegiate level.²⁷ Not only does this lead to higher-energy injuries, but increased power also imparts increased stress on the body and could also partially explain the increased frequency of non-contact injuries in men compared to women.

Limitations

As with all retrospective databases, the NCAA ISP has its limitations.^{13,14} There is selection bias, as the ISP is a voluntary program and is not randomized. Programs from any division can participate, and the NCAA website only requires a specific EMR system as criteria for program inclusion. As such, it may not be representative of all NCAA soccer players, especially at high levels of competition such as Division I programs or programs that are consistently highly ranked. The data entries relied on athletic trainers entering the data accurately, so it is subject to reporting bias. ATs log into the system once per week to log injury data, so it could be subject to recall bias. There is no mention of the qualifications of these trainers or their experience level, which may also lead to bias. The validation methods report an injury capture rate of about 88%.¹⁹ Furthermore, the sample size was small, as was the number of reported injuries. The combination of these factors could limit the generalizability of study findings across all NCAA programs. The reported data lack more specific temporal details, such as at what point in a competition or practice injuries specifically occurred. The data does not stratify injuries among differing seasons to competition or practice. It also lacks demographic data such as age, year in school, years of soccer experience, prior injury history, health issues, and drug/tobacco/alcohol use. Finally, the NCAA ISP does not provide information on preinjury or postinjury prevention and rehabilitation efforts that programs may have used.

Conclusion

This study provides information on the characteristics of LSIs in NCAA soccer. The overall injury rate to the lumbar spine is relatively low. Injury rates are highest in the preseason and in competition. Women suffer from

Table 6. Time Loss by Injury Comparison

Injury type	Women's (%)					Men's (%)				
	<24 Hours	1-6 Days	7-21 Days	>21 Days	Total	<24 Hours	1-6 Days	7-21 Days	>21 Days	Total
Contusion (Hematoma)	249 (16)	41 (5.4)	35 (27)	0	325 (12)	160 (16)	131 (22)		0	291 (17)
Fracture	62 (4.0)	35 (4.6)	0	67 (34)	164 (6.2)	0	93 (16)		0	93 (5.4)
Miscellaneous	305 (20)	249 (33)	32 (25)	93 (48)	679 (26)	168 (17)	320 (54)		155	643 (37)
Nervous system	32 (2.1)	0	0	0	32 (1.2)	46 (4.7)	0		0	46 (2.7)
Spasm	547 (35)	352 (46)	62 (48)	35 (18)	996 (38)	66 (6.8)	0		0	66 (3.8)
Strain	362 (23)	81 (11)	0	0	443 (17)	535 (55)	46 (7.8)		0	581 (34)
Total	1,557	758	129	195	2,639	975	590		155	1,720

more recurrent LSI's than men, and men acquired more injuries through noncontact mechanisms. More than one-half of athletes returned to sport within 24 hours.

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