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Descriptive Epidemiology of Collegiate Women's Soccer Injuries: National Collegiate Athletic Association Injury Surveillance System, 1988–1989 Through 2002–2003

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Objective: To review 15 years of National Collegiate Athletic Association (NCAA) injury surveillance data for women's soccer and identify potential areas for injury prevention initiatives.

Background: The number of NCAA schools sponsoring women's soccer has grown tremendously, from 271 in 1988–1989 to 879 schools in 2002–2003. During that time, the NCAA Injury Surveillance System has collected game and practice injury data for women's soccer across all 3 NCAA divisions.

Main Results: The rate of injury was more than 3 times higher in games than in practices (16.44 versus 5.23 injuries per 1000 athlete-exposures, rate ratio = 3.2, 95% confidence interval = 3.1, 3.4, $P < .01$), and preseason practices had an injury rate that was more than 3 times greater than the rate for in-season practices (9.52 versus 2.91 injuries per 1000 athlete-exposures, rate ratio = 3.3, 95% confidence interval = 3.1, 3.5, $P < .01$). Approximately 70% of all game and practice injuries affected the lower extremities. Ankle ligament sprains (18.3%), knee internal derangements (15.9%), concussions (8.6%), and leg contusions (8.3%) accounted for a substantial portion of game injuries. Upper leg muscle-tendon strains (21.3%), ankle ligament sprains (15.3%), knee internal derangements (7.7%), and pelvis and hip muscle strains (7.6%) represented most of the practice injuries. Injuries were categorized as attributable to player contact, "other contact" (eg, contact with the ball, ground, or other object), or no contact. Player-to-player contact accounted for more than half of all game injuries (approximately 54%) but less than 20% of all practice injuries. The majority of practice injuries involved noncontact injury mechanisms. Knee internal derangements, ankle ligament sprains, and concussions were the leading game injuries that resulted in 10 or more days of time lost as a result of injury.

Recommendations: Ankle ligament sprains, knee internal derangements, and concussions are common injuries in women's soccer. Research efforts have focused on knee injuries and concussions in soccer, and further epidemiologic data are needed to determine if preventive strategies will help to alter the incidence of these injuries. Furthermore, the specific nature of the player contact leading to concussions and lower extremity injuries should be investigated. Preventive efforts should continue to focus on reducing knee injuries, ankle injuries, and concussions in women collegiate soccer players.

Key Words: athletic injuries, injury prevention, knee injuries, ankle injuries, concussions

The National Collegiate Athletic Associate (NCAA) conducted its first women's soccer championship in 1982. In the 1988–1989 academic year, 271 schools were sponsoring varsity women's soccer teams, with a total of approximately 5976 participants. By 2002–2003, the number of varsity teams had increased 226% to 879, involving 19 871 participants.[1] Participation growth during this time has occurred in all 3 NCAA divisions.

SAMPLING AND METHODS

Over the 15-year period studied, an average of 13.9% of schools sponsoring varsity women's soccer programs participated in annual NCAA Injury Surveillance System (ISS) data collection (Table 1). Women's soccer data were not collected during the 2003–2004 year as a result of pilot testing for conversion to a Web-based system. The sampling process, data collection methods, injury and exposure definitions, inclusion criteria, and data analysis methods are described in detail in the "Introduction and Methods" article in this special issue.[2]

RESULTS

Game and Practice Athlete-Exposures

The average annual numbers of games, practices, and athletes participating for each NCAA division, condensed over the study period, are shown in Table 2. The 3 divisions averaged a similar number of game and practice participants and a similar number of games played annually. Division I and Division II averaged a higher number of practices each year than Division III.

Injury Rate by Activity, Division, and Season

Game and practice injury rates over time combined across divisions, with 95% confidence intervals (CIs), are displayed

Table 1. School Participation Frequency (in Total Numbers) by Year and National Collegiate Athletic Association (NCAA) Division, Women's Soccer, 1988–1989 Through 2002–2003*

Academic Year	Division I Schools		Division II Schools		Division III Schools		All Divisions		
	Participating	Sponsoring	Participating	Sponsoring	Participating	Sponsoring	Participating	Sponsoring	Percentage
1988–1989	14	72	4	43	21	155	39	271	14.4
1989–1990	11	75	6	44	23	175	40	294	13.6
1990–1991	14	82	11	51	26	185	51	318	16.0
1991–1992	22	91	10	60	30	199	62	350	17.7
1992–1993	20	103	9	69	31	215	60	387	15.5
1993–1994	23	131	7	79	24	236	54	446	12.1
1994–1995	30	154	13	97	36	264	79	515	15.3
1995–1996	31	189	15	127	45	315	91	631	14.4
1996–1997	35	217	16	146	42	331	93	695	13.4
1997–1998	38	233	17	154	38	337	93	724	12.8
1998–1999	24	251	15	177	46	362	8 5	790	10.8
1999–2000	43	260	19	182	41	369	103	811	12.7
2000–2001	35	274	17	199	34	378	86	851	10.1
2001–2002	33	280	25	201	44	387	102	868	11.8
2002–2003	56	288	25	199	77	392	158	879	18.0
Average	29	180	14	122	37	287	80	589	13.9

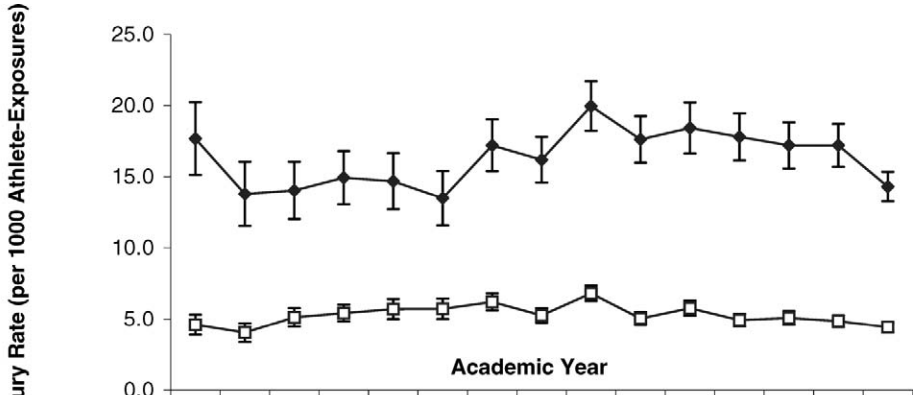
*"Participating" refers to schools that provided appropriate data to the NCAA Injury Surveillance System; "Sponsoring" refers to the total number of schools offering the sport within the NCAA divisions.

Table 2. Average Annual Games, Practices, and Athletes Participating by National Collegiate Athletic Association Division, Women's Soccer, 1988–1989 Through 2002–2003

Division	Games	Athletes per Game	Practices	Athletes per Practice
I	18	16	52	21
II	18	16	50	20
III	17	16	44	20

in Figure 1. Over the 15 years, the rate of injury was 3 times higher in a game than in a practice (16.4 versus 5.2 injuries per 1000 athlete exposures [A-Es], rate ratio = 3.2, 95% CI = 3.1, 3.4). A nonsignificant average annual increase in game (0.40%, $P = .59$) and nonsignificant average annual decrease in practice (−0.90%, $P = .28$) injury rates occurred over the sample period. Based on visual inspection of Figure 1, injury rates appear to have decreased over the past few years.

The total number of games and practices and associated injury rates, condensed over years by division and season (preseason, in season, and postseason), are presented in Table 3. Over the 15-year period, 5373 injuries from more than 20 000 games and 5836 injuries from more than 54 000 practices were reported. Practice injury rates were similar across all 3 divisions ($P = .72$), but game injury rates were higher in Division I than in Division III ($P < .01$). For games, the preseason injury rate was higher than that for the in season, and the in-season rate was higher than the postseason rate (preseason versus regular season: 19.65 versus 16.56 injuries per 1000 A-Es, rate ratio = 1.19, 95% CI = 1.04, 1.36, $P = .01$; in season versus postseason: 16.56 versus 11.67 injuries per 1000 A-Es, rate ratio = 1.4, 95% CI = 1.22, 1.65, $P < .01$). For



	88-89	89-90	90-91	91-92	92-93	93-94	94-95	95-96	96-97	97-98	98-99	99-00	00-01	01-02	02-03
Game injury rate	17.7	13.8	14.0	14.9	14.7	13.5	17.2	16.2	20.0	17.6	18.4	17.8	17.2	17.2	14.3
Practice injury rate	4.6	4.0	5.1	5.4	5.7	5.7	6.2	5.3	6.8	5.0	5.8	4.9	5.1	4.8	4.4

Figure 1. Injury rates and 95% confidence intervals per 1000 athlete-exposures by games, practices, and academic year, women's soccer, 1988–1989 through 2002–2003 (n = 5373 game and 5836 practice injuries). Game time trend $P = .59$. Average annual change in game injury rate = 0.4% (95% confidence interval = −1.1, 1.9). Practice time trend $P = .28$. Average annual change in practice injury rate = −0.9% (95% confidence interval = −2.5, 0.7).

Table 3. Games and Practices With Associated Injury Rates by National Collegiate Athletic Association Division and Season, Women's Soccer, 1988–1989 Through 2002–2003*

	Total No. of Games Reported	Game Injury Rate per 1000 Athlete-Exposures	95% Confidence Interval	Total No. of Practices Reported	Practice Injury Rate per 1000 Athlete-Exposures	95% Confidence Interval
Division I						
Preseason	263	24.04	19.48, 28.59	7495	9.1	8.63, 9.56
In season	6980	17.85	17.07, 18.63	13 619	3.04	2.84, 3.25
Postseason	369	13.99	11.00, 17.01	653	1.92	1.18, 2.66
Total Division I	7612	17.89	17.14, 18.64	21 767	5.2	5.00, 5.41
Division II						
Preseason	140	21.62	15.50, 27.74	3541	9.69	8.97, 10.40
In season	3327	16.67	15.56, 17.78	6169	2.69	2.39, 2.98
Postseason	143	9.21	5.27, 13.15	276	1.47	0.45, 2.49
Total Division II	3610	16.48	15.43, 17.53	9986	5.25	4.93, 5.56
Division III						
Preseason	266	14.18	10.65, 17.72	7424	9.88	9.39, 10.37
In season	8464	15.45	14.78, 16.11	14 636	2.88	2.69, 3.08
Postseason	399	10.41	7.90, 12.92	741	1.01	0.50, 1.52
Total Division III	9129	15.21	14.58, 15.84	22 801	5.25	5.04, 5.46
All Divisions						
Preseason	3203	19.65	17.04, 22.23	21 242	9.52	9.21, 9.83
In season	16 252	16.56	16.10, 17.02	29 562	2.91	2.79, 3.04
Postseason	757	11.67	9.91, 13.43	1360	1.45	1.04, 1.85
Total	20 447	16.44	16.00, 16.88	54 750	5.23	5.09, 5.36

*Wald χ^2 statistics from negative binomial model: game injury rates differed among divisions ($P < .01$) and within season ($P < .01$). Practice injury rates did not differ among divisions ($P = .72$) but did differ within season ($P < .01$). Postseason sample sizes are much smaller (and have a higher variability) than preseason and in season sample sizes because only a small percentage of schools participated in the postseason tournaments in any sport and not all of those were a part of the Injury Surveillance System (ISS) sample. Numbers do not always sum to totals because of missing division or season information.

Table 4. Percentage of Game and Practice Injuries by Major Body Part, Women's Soccer, 1988–1989 Through 2002–2003

Body Part	Games	Practices
Head/neck	13.8	3.9
Upper extremity	6.3	4.2
Trunk/back	8.4	13.2
Lower extremity	67.8	72.0
Other/system	3.7	6.7

practices, the preseason injury rate was significantly higher than that for the in season or postseason (preseason versus in season: 9.52 versus 2.91 injuries per 1000 A-Es, rate ratio = 3.27, 95% CI = 3.09, 3.45, $P < .01$; preseason versus postseason: 9.52 versus 1.45 injuries per 1000 A-Es, rate ratio = 6.57, 95% CI = 4.96, 8.71, $P < .01$).

Body Parts Injured Most Often and Specific Injuries

The frequency of injury to 5 general body parts (head/neck, upper extremity, trunk/back, lower extremity, and other/system) for games and practices, with years and divisions combined, is shown in Table 4. Approximately 70% of all game and practice injuries were to the lower extremity. Head and neck injuries accounted for another 13.8% of game injuries but only 3.9% of practice injuries.

The most common body part and injury type combinations for games and practices with years and divisions combined are displayed in Table 5. All injuries that accounted for at least 1% of reported injuries over the 15-year sampling period were included. In games, ankle ligament sprains (18.3%), knee internal derangements (15.9%), and concussions (8.6%) accounted for the majority of injuries. Contusions to the upper and lower leg and upper leg muscle-tendon strains also were significant categories. In practices, upper leg muscle-tendon strains (21.3%), ankle ligament sprains (15.3%), knee internal derangements (7.7%), and pelvis and hip muscle strains (7.6%) represented more than 50% of all reported injuries, with concussions accounting for only 2.2%. A participant was almost 12 times more likely to receive a concussion in a game than in a practice (1.42 versus 0.12 injuries per 1000 A-Es, rate ratio = 11.8, 95% CI = 11.4, 12.3), more than 6 times more likely to sustain a knee internal derangement in a game than in a practice (2.61 versus 0.40 per 1000 A-Es, rate ratio = 6.5, 95% CI = 6.3, 6.8), almost 4 times as likely to sustain an ankle ligament sprain in a game than in a practice (3.01 versus 0.80 per 1000 A-Es, rate ratio = 3.8, 95% CI = 3.6, 3.9), and equally likely to sustain an upper leg muscle-tendon strain in a game or a practice (1.14 versus 1.11 per 1000 A-Es, rate ratio = 1.0, 95% CI = 1.0, 1.1).

Mechanism of Injury

The 3 primary injury mechanisms—player contact, other contact (eg, contact with balls, goals, or the ground), and noncontact mechanisms—in games and practices, with division and years combined, are presented in Figure 2. Most game injuries (approximately 54%) resulted from player contact. The remaining game injuries were equally distributed between noncontact mechanisms and other contact mechanisms (ap-

Table 5. Most Common Game and Practice Injuries, Women's Soccer, 1988–1989 Through 2002–2003*

Body Part	Injury Type	Frequency	Percentage of Injuries	Injury Rate per 1000 Athlete-Exposures	95% Confidence Interval
Games					
Ankle	Ligament sprain	984	18.3	3.01	2.82, 3.20
Knee	Internal derangement	852	15.9	2.61	2.43, 2.78
Head	Concussion	463	8.6	1.42	1.29, 1.55
Upper leg	Muscle-tendon strain	374	7.0	1.14	1.03, 1.26
Lower leg	Contusion	246	4.6	0.75	0.66, 0.85
Upper leg	Contusion	198	3.7	0.61	0.52, 0.69
Unspecified†	Unspecified	139	2.6	0.43	0.35, 0.50
Pelvis, hip	Muscle-tendon strain	120	2.2	0.37	0.30, 0.43
Knee	Contusion	91	1.7	0.28	0.22, 0.34
Patella	Patella or patella tendon injury	91	1.7	0.28	0.22, 0.34
Foot	Contusion	90	1.7	0.28	0.22, 0.33
Lower leg	Muscle-tendon strain	69	1.3	0.21	0.16, 0.26
Lower back	Muscle-tendon strain	68	1.3	0.21	0.16, 0.26
Ankle	Contusion	59	1.1	0.18	0.13, 0.23
Nose	Fracture	57	1.1	0.17	0.13, 0.22
Pelvis, hip	Contusion	55	1.0	0.17	0.12, 0.21
Foot	Ligament sprain	53	1.0	0.16	0.12, 0.21
Practices					
Upper leg	Muscle-tendon strain	1243	21.3	1.11	1.05, 1.18
Ankle	Ligament sprain	892	15.3	0.80	0.75, 0.85
Knee	Internal derangement	449	7.7	0.40	0.36, 0.44
Pelvis, hip	Muscle-tendon strain	444	7.6	0.40	0.36, 0.43
Unspecified†	Unspecified	271	4.6	0.24	0.21, 0.27
Patella	Patella or patella tendon injury	166	2.8	0.15	0.13, 0.17
Head	Concussion	130	2.2	0.12	0.10, 0.14
Lower leg	Muscle-tendon strain	129	2.2	0.12	0.10, 0.14
Lower back	Muscle-tendon strain	94	1.6	0.08	0.07, 0.10
Knee	Tendinitis	91	1.6	0.08	0.06, 0.10
Heel/Achilles tendon	Tendinitis	83	1.4	0.07	0.06, 0.09
General body	Heat illness	70	1.2	0.06	0.05, 0.08
Lower leg	Inflammation	70	1.2	0.06	0.05, 0.08
Lower leg	Contusion	67	1.2	0.06	0.05, 0.07
Lower leg	Stress fracture	67	1.2	0.06	0.05, 0.07

*Only injuries that accounted for at least 1% of all injuries are included.
†"Unspecified" indicates injuries that could not be grouped into existing categories but that were believed to constitute reportable injuries.

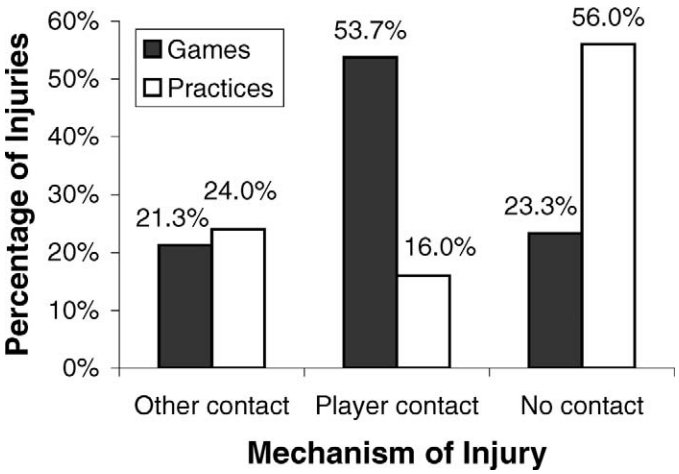


Figure 2. Game and practice injury mechanisms, all injuries, women's soccer, 1988–1989 through 2002–2003 (n = 5373 game injuries and n = 5836 practice injuries). "Other contact" refers to contact with items such as balls, goals, or the ground. Injury mechanism was unavailable for 2% of game injuries and 5% of practice injuries.

proximately 22% each). Noncontact injury mechanisms were the primary mechanism for injuries sustained during practices (56%).

Severe Injuries: 10+ Days of Activity Time Loss

The most common injuries that resulted in at least 10 consecutive days of restricted or total loss of participation and their primary injury mechanisms, combined across divisions and years, are shown in Table 6. Time loss of 10+ days was, for this analysis, considered a measure of severe injury. Approximately 22% of game and 17% of practice injuries restricted participation for at least 10 days. In both games and practices, knee internal derangements accounted for the highest percentage of these more severe injuries (44.1% and 25.5%, respectively).

Ankle ligament sprains accounted for similar percentages of game (13.3%) and practice (13.8%) 10+ day time-loss injuries. Concussions represented 6.0% of severe game injuries. The most frequent severe game injuries were all associated with player contact, whereas the top severe practice injuries were associated with noncontact injury mechanisms.

Table 6. Most Common Game and Practice Injuries Resulting in 10+ Days of Activity Time Loss, Women's Soccer, 1988–1989 Through 2002–2003

Body Part	Injury Type	Frequency	Percentage of Severe Injuries	Most Common Injury Mechanism
Games (21.8% of all injuries required 10+ days of time loss)				
Knee	Internal derangement	518	44.1	Player contact
Ankle	Ligament sprain	156	13.3	Player contact
Head	Concussion	70	6.0	Player contact
Other		431	36.7	
Total		1175		
Practices (16.5% of all injuries required 10+ days of time loss)				
Knee	Internal derangement	245	25.5	No contact
Ankle	Ligament sprain	133	13.8	No contact
Upper leg	Muscle-tendon strain	92	9.6	No contact
Other		491	51.1	
Total		961		

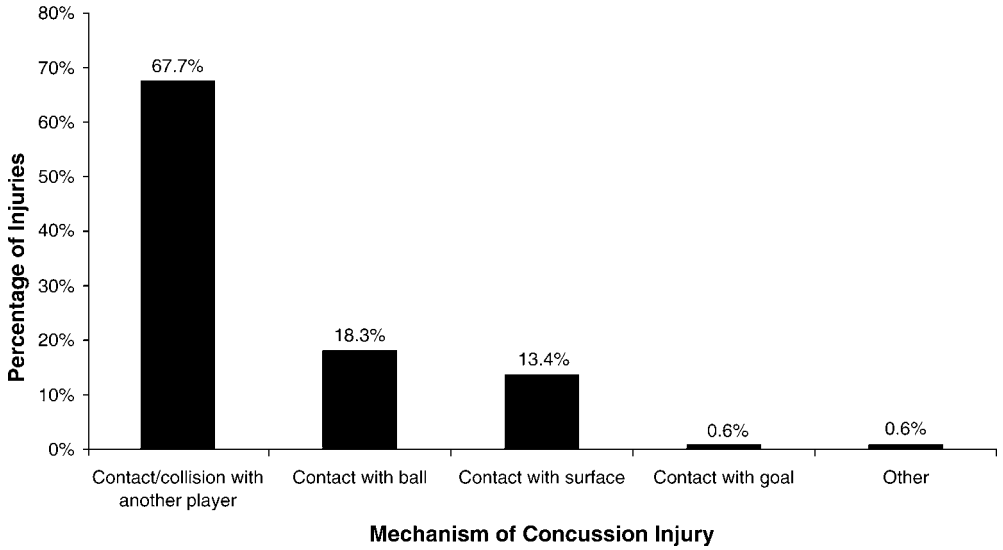


Figure 3. Game concussion injury mechanisms, women's soccer, 1988–1989 through 2002–2003 (n = 463).

Game Injuries

The mechanisms of game concussions over all years are displayed in Figure 3. A total of 67.7% of reported concussions were due to player contact; another 18.3% were associated with contact with the ball, and 13.4% were associated with contact with the playing surface. Less than 1% were associated with contacting the goal.

The mechanisms of anterior cruciate ligament (ACL) injuries over all years are presented in Figure 4. These injuries accounted for 6% of game injuries and 2% of practice injuries. Most game (53%) and practice (65%) ACL injuries resulted from noncontact mechanisms.

Regarding activity at the time of injury, across all types of game injuries, approximately 13% were associated with either attempting or receiving a slide tackle (data not shown).

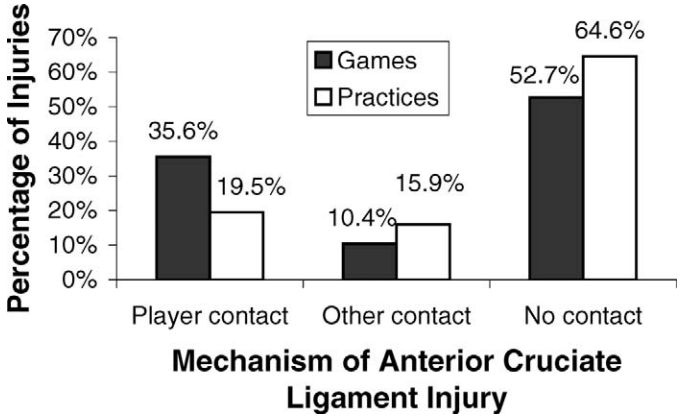


Figure 4. Game and practice anterior cruciate ligament injury mechanisms, women's soccer, 1988–1989 through 2002–2003 (n = 298).

COMMENTARY

Despite tremendous growth in participation, the injury rate and injury profile in women's collegiate soccer players have remained relatively stable over the past 15 years, with a nonsignificant increase in game injury rates and a nonsignificant

decrease in practice injury rates over the sample period. Although it would be difficult to confirm, we speculate that the recent emphasis on preventive strategies and programs that include flexibility, plyometric, strength, and neuromuscular training specifically designed for reducing ACL injuries and ankle sprains may have contributed to the fact that injury rates have not risen, despite an increase in the intensity of competition over the 15-year period. The game injury rate was just over 3 times higher than that observed during practice, and this relationship has also remained stable over time. This relationship is also consistent with recent reports of adolescent soccer players indicating a predominance of lower extremity injuries that are, for the most part, minor.[3–5]

For a variety of reasons, however, caution should be used when comparing this current NCAA ISS data with previous descriptive injury studies. Often the injury definitions and methods were different among studies. Several authors did not use a time-loss definition for injury, and many did not incorporate A-Es as the denominator. Furthermore, data collection for previous studies was not performed by certified athletic trainers, and the data entry intervals were not consistent with those used in this current NCAA ISS report. The NCAA ISS system is unique in that it relies on certified athletic trainers to collect data, and data entry occurs in a timely fashion, as opposed to investigations by other researchers, who may have relied upon nonmedical personnel for providing data such as that included in insurance claims or coaches' reports.

Despite these limitations of previous studies, the current injury distribution is similar to that reported at other levels of soccer play, demonstrating that more than two thirds of all injuries occurred in the lower extremities. Ankle sprains were the most common game injury, and knee internal derangements resulted in the greatest time loss,[3,4,6,7] as demonstrated in both outdoor and indoor soccer games[8,9] and at all levels of competition.[3,4,7]

For games, the regular-season injury rate was significantly higher than that for the postseason, whereas for practices, the preseason injury rate was significantly higher than that for the regular season or postseason. Some speculate that increased ability is associated with a higher incidence of injury, but these current results indicate no difference, at least in practice injury rates, among Divisions I through III. Furthermore, the assumption that Division I athletes are more skilled than those in Divisions II or III has not been established.

The most common injuries in games were ankle ligament sprains, knee internal derangements, and concussions. These results are not surprising and underscore the need for prevention of lower extremity injuries and concussions. Soccer players are often resistant to using ankle braces or to having their ankles taped for activity, but the high incidence of ankle ligament sprains emphasizes the importance of preventive programs to identify athletes with injuries that may not have been properly rehabilitated or for whom taping or bracing might be appropriate. These programs have been successful in decreasing injuries in soccer players.[10]

For practices, the most common injuries were upper leg muscle-tendon strains, ankle ligament sprains, and knee internal derangements, again underscoring the need for future research to determine methods to prevent these injuries. Concussions and other facial injuries did not occur commonly in practices.

These data also highlight the frequency and effect of knee ligament injuries in female soccer players. These injuries remained mostly noncontact in both practices and games. This game ACL injury mechanism is consistent with that recently reported by Fauno and Wulff Jakobsen,[11] who noted that for 113 confirmed ACL game injuries, the mechanism was predominantly noncontact.

The prominence of ACL injuries in women's sports has driven research initiatives aimed at identifying risk factors, which could help us to develop preventive measures.[12–17] In 1999, Hewett et al[18] provided neuromuscular training to soccer, basketball, and volleyball players for sessions of 60 to 90 minutes, administered 3 times per week for 6 weeks, and demonstrated a 72% decrease in noncontact ACL injuries. This type of injury risk information has led many NCAA schools to incorporate preventive neuromuscular control exercises and agility tasks during practices and conditioning. These programs all have strength, flexibility, agility, aerobic conditioning, plyometrics, and risk awareness training in common.[16] Preliminary reports do support the effectiveness of such neuromuscular training programs in preventing ACL injury.[12,14,17] Mandelbaum et al[17] demonstrated that in 14-year-old to 18-year-old soccer players, an intervention program (Prevent Injury and Enhance Performance Program) emphasizing proprioception and neuromuscular training was associated with a 74% reduction in ACL tears over the subsequent 2 years. The intervention program included 20 minutes of soccer-specific agility drills, plyometrics, lower extremity and trunk stretching, strengthening exercises, and general warm-up activities. However, additional research using randomized, controlled designs is necessary to evaluate the effectiveness of these types of programs in reducing the rate of ACL injuries in female collegiate athletes.

Although knee internal derangement injuries resulted in the greatest time loss per incident, ankle ligament sprains remained the most common injury seen in practices and games. Ankle ligament sprains are typically considered less severe than knee internal derangements, but they accounted for a considerable portion of time-loss injuries. Significant research has focused on the effectiveness of preseason screening for ankle laxity and/or inadequate rehabilitation from prior ankle injuries in preventing future ankle sprains in soccer.[10,19] Unfortunately, many of these injuries are recurrent and occur even when protective strapping is in place.[20] Neuromuscular training strategies, however, do offer promise in reducing ankle injury and reinjury. McGuine and Keene[21] found that a combined preseason and in-season balance training program significantly reduced the rates of both first-time and recurrent ankle sprains. Given the frequency and severity of ankle injuries in women's collegiate soccer players, athletic trainers should focus on the implementation and the effect of preventive measures in limiting the occurrence and recurrence of ankle sprains.

Concussions are another frequent and important injury in collegiate female soccer players, accounting for 8.6% of game injuries overall and 6.0% of game injuries resulting in more than 10 days of time loss. The primary mechanism of head injury in this study, player contact, was also identified as such by previous authors investigating collegiate soccer.[22,23] Fuller et al[23] studied videotapes of international men's and women's soccer games (19 802 player-hours of match-exposures) and evaluated the mechanisms of head and neck injuries. Concussions accounted for 11% of the injuries, and the most common mechanisms involved (sometimes overlapping) challenges while both athletes were in the air (55%) and the use of the upper extremity (33%) or the head (30%). Of all player ac-

tions, unfair use of the upper extremity was most commonly associated with injury. Similarly, Anderson et al[24] reported that heading duels accounted for 58% of head injuries, with upper extremity contact accounting for 41% and contact with the opponent's head accounting for 32% (again, the types of contact can overlap). Although player-to-player contact has been consistently identified as a head injury mechanism, contact with the ball has not. Fuller et al[23] found that only 1 cervical strain of 248 head and neck injuries could be attributed to purposeful heading of the ball. Anderson et al[24] did not identify heading the ball as a mechanism for head injury. These results support those of previous researchers, who have failed to identify purposeful heading as a primary cause of concussion.[22,25–28]

Specific circumstances and player actions have been recognized as risk factors. The risk of injury is considered to be highest in the first and last 15 minutes of play, when players are fighting for possession of the ball in the attacking and defending areas close to the goal.[29] Players are at an increased risk for injury when they receive or deliver a tackle or charge and when they are involved in play that is unfair or illegal.[23,29–32] Anderson et al[32] reported that 20% of head injuries due to elbow-to-head contact were related to illegal, purposeful use of the upper extremity during an aerial heading challenge. Fauno and Wulff Jakobsen[11] noted that 11% of ACL injuries were associated with the administration of a red or yellow card to the opponent. Therefore, as in other contact and collision sports, proper enforcement of the rules by officials is likely important in decreasing the risk for injury.

Player contact appeared to account for the majority of game injuries, whereas injuries from noncontact mechanisms (no direct contact to the injured body part) were predominant in practices. This may be because overuse injuries are more likely to be reported by players during practices and less likely to be reported during games.

Muscle-tendon strain injuries are common in soccer because of the nature of the sport, which involves running, sprinting, and sport-specific skills that often require the player to kick or strike the ball with full force. Strains involving the lower extremity predominate, again because of the acceleration and deceleration forces required during running and cutting and the overuse of these muscles with soccer-specific play. Many of these muscle strains can be addressed with better stretching and other injury prevention measures.

Given the contact nature of soccer, contusions are also common, frequently involving the lower extremity. Large muscle contusions involving the quadriceps are typical.

For both games and practices, fractures are relatively uncommon in women's soccer players. When they do occur, they are more likely during games and are also more likely to affect the upper extremity. The mechanism of these injuries, although not reported, is most likely due to falling on an outstretched hand (hand, wrist, and finger injuries) or landing on the shoulder (clavicle fracture). Lower leg fractures are uncommon and most often occur as a result of trauma to the lower leg. Shin guards may be useful in protecting against lower leg injuries and fractures.

Prior injury has also been associated with an increased risk of injury.[11,33–35] This factor emphasizes the need to evaluate athletes before the competitive season to identify those at risk based on a previous injury history, specifically focusing on injuries that have not been effectively rehabilitated. Hagglund et al[33] found a 2-fold to 3-fold increase in injury in soccer players with a history of hamstring strain, groin injury, or knee joint trauma, with the injury occurring in the previously injured site. Injury prevention strategies specific to hamstring injuries,[36] ankle sprains,[19,20,37,38] and ACL injuries[14,17,18,39] are all promising areas of further research. Inadequate rehabilitation and preexisting ligamentous laxity from prior injuries are thought to be risk factors for knee and ankle injuries,[19,38] underscoring the importance of detecting these problems in preseason evaluations. Athletic trainers can play a significant role in screening for injury history, preexisting injuries, and injuries that have not been appropriately rehabilitated.

In summary, most of the injuries in women's soccer affected the lower extremities, with ankle ligament sprains and knee internal derangements representing the most common game injuries. Furthermore, concussions continue to be a concern during games. Despite increased focus and research addressing knee internal derangements and concussions in women's sports, evidence to indicate that preventive measures have reduced the risk of these injuries is limited. The lack of a significant upswing in injury rates over the past few years, despite the escalating intensity of competition, may reflect the benefits of injury prevention strategies. However, additional research is needed to evaluate mechanisms of concussion and knee injuries and the preventive effect of current programs, such as those emphasizing neuromuscular control or cognitive testing, on injury prevention.

DISCLAIMER

The conclusions in the Commentary section of this article are those of the Commentary authors and do not necessarily represent the views of the National Collegiate Athletic Association.

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