

# Avoidance of Soccer Injuries with Preseason Conditioning

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## ABSTRACT

The effect of a preseason conditioning program was studied to evaluate its influence on the occurrence and severity of soccer injuries. Three hundred female soccer players (ages 14 to 18 years) were studied over a 1-year period. Forty-two of these players participated in a 7-week training program before the start of the season. The type, mechanism, and severity of the injury, when the injury occurred, the number of games or practices missed, and type of shoe worn were recorded. All injuries occurred in the lower extremities, with 61.2% occurring at the knee and ankle. Student's *t*-test evaluations revealed that the trained group experienced a significantly lower incidence of injury than the untrained group ( $P = 0.0085$ ). Although not statistically significant, the trained group also had a lower percentage (2.4%) of anterior cruciate ligament injuries compared with the untrained group (3.1%). These results suggest that this type of conditioning has a significant influence on lowering the incidence of injury in female adolescent soccer players.

Soccer has emerged as the most popular sport in the world. With a significant increase in participation over the past 2 decades, soccer has become the fastest growing team sport in the United States.<sup>9,10</sup> Along with this increase in popularity comes an increase in injuries for participants. Thus, soccer injuries have come under scrutiny in the field of sports medicine. Recent studies have been performed to evaluate injuries in soccer players as a group.<sup>1,4,8,10-12,14</sup> It has been found that as many as 68% to 88% of all soccer injuries involve the lower extremity,<sup>1,5-7,11-13</sup> most commonly the knee and ankle.<sup>3,5-7,10,13</sup>

A few studies have focused on injuries in female soccer players, and these studies also show that the majority of injuries occur in the lower extremity.<sup>3,6</sup> Brynhildsen et al.<sup>3</sup> performed a retrospective study of 150 female soccer players and found that injuries to the ankle and knee accounted for 39.5% and 16.9% of the 248 injuries, respectively. Similarly, Engström et al.<sup>6</sup> examined 41 female soccer players and found that 49% of the 78 injuries occurred in the knee and ankle.

Studies indicate that female soccer players are twice as likely to get injured compared with their male counterparts.<sup>11,12,14</sup> Female to male injury rate ratios of 1.1 to 0.51 and 32 to 14 per 1000 hours of participation have been found.<sup>11,14</sup> It has also been noted that female players are more likely to sustain a serious injury than are male players, particularly ACL and patellofemoral joint injuries.<sup>2</sup> Similar sex-specific differences have also been confirmed by DeHaven and Lintner.<sup>4</sup> This information, coupled with the large increase in female participation in sports over recent decades, demands that more attention be put on injuries to female athletes.

Numerous factors contribute to soccer injuries.<sup>2,5-7,9,10,16</sup> These include insufficient training or conditioning, playing surface, event (game or practice), and shoe type. The purpose of this study was to evaluate the role that preseason conditioning had on the occurrence and severity of injury in female soccer players.

## MATERIALS AND METHODS

Three hundred female high school soccer players (age range, 14 to 18 years) were evaluated over 1 year of competitive soccer participation. The year included two separate seasons: the school season from August through November, and the select season that ran March through August. Before the start of the select season, 42 of these players were randomly selected to participate in the Frappier Acceleration Training Program (Frappier Acceleration, Fargo, North Dakota).<sup>15</sup> This training program combines

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sport-specific cardiovascular conditioning, plyometric work, sport cord drills, strength training, and flexibility exercises to improve one's speed and agility. It is customized for each athlete's sport, position, and individual strengths and weaknesses. Acceleration training also helps athletes learn proper techniques in skills that enable them to recognize and avoid movements that place them at risk for injury. This type of training has been thought to be most beneficial at the beginning of the season, after which the acquired gains in strength and speed can be sustained during the season through regular skill exercises.<sup>16</sup> In addition to these gains, it is believed that specific motor units in the neuromuscular system are conditioned to fire in a way that enhances muscular efficiency.

Before participation, informed, written consent was obtained from all participants. The athletes in this study were first given a preparticipation physical and tested on sport-specific skills including vertical jump, broad jump, 10-yard dash, and foot agility via plyometrics. They participated in this 20-session (two treadmill sessions and one plyometric session per week except the first week because of an orientation session) training program over a 7-week period at no cost to them. The treadmill has the ability to incline to 40°. By elevating the grade, runners automatically learn to maintain forceful knee drive, proper pelvic position, high foot carry through, and full extension with every stride. For the plyometrics sessions, the athletes progressed through stages during the 7-week training program. The progression of the movements in the sessions went from 1) unidirectional, 2) bidirectional, 3) multidirectional, and 4) 2-inch increments using foam for obstacles. On completion of the program, the participants were tested on the same sport-specific skills as during the preseason test.

Discussions of injury rates in any sport are subject to bias because of the variability in the interpretation of injury rate. For the purpose of this study, an injury was defined as that which caused the athlete to miss a game or a practice, as in accordance with Keller et al.<sup>9</sup> Therefore, only those injuries resulting in lost time from games or practices were included in the statistics. Injury information was assessed by the school's athletic trainer and recorded on an injury incident report form. These data included type of injury, mechanism of injury, severity of injury, event in which the injury occurred, and type of shoe worn during the injury. The athletic trainers were blinded as to which athletes participated in the preseason training program.

Type of injury was recorded with respect to the anatomic region, while the mechanism was noted as contact or noncontact. Severity of the injury was categorized according to the number of games or practices missed and rated on a scale from 1 to 6 (Table 1). The event during which the injury occurred (game or practice) and type of shoe worn (turf, soccer, running, or gym) were recorded.

Incident report forms were collected at the end of the year and all data were compiled into a spreadsheet. Statistical analysis consisted of Student's *t*-test evaluations with the level of significance set at  $P < 0.05$ .

TABLE 1  
Grading of Injury Severity by Number of Missed Practices and Games

Grade	Criterion
1	Missed 1 game/practice
2	Missed 2-3 games/practices
3	Missed 4-7 games/practices
4	Missed 2-4 weeks
5	Missed 1-2 months
6	Season-ending injury

## RESULTS

### Injuries

The occurrence of injury was significantly less in the trained group than in the untrained group ( $P = 0.0085$ ). Fourteen percent of the athletes who participated in the preseason training program sustained injuries (7 injuries in 6 of the 42 athletes), compared with 33.7% of those who did not participate (91 injuries in 87 of the 258 athletes). The injuries suffered by the trained group included two ankle sprains, one ACL tear, one medial collateral ligament sprain, one knee bursitis, one quadriceps muscle strain, and one iliotibial band strain. The distribution of injuries for athletes in the untrained group included 21 ankle sprains, 8 ACL tears, 7 quadriceps muscle strains, 6 medial collateral ligament tears, 6 cases of chondromalacia patellae, 4 Achilles tendon strains, 4 leg contusions, 3 ankle fractures, 3 hamstring muscle strains, 3 quadriceps contusions, 3 meniscal tears, 3 knee contusions, 2 hip flexor strains, 2 ankle contusions, 2 posterior tibia strains, 2 hip contusions, 1 knee strain, 1 patellar subluxation, 1 patellar dislocation, 1 gastrocnemius muscle strain, 1 stress fracture, 1 groin strain, 1 foot sprain, 1 heel contusion, 1 tibia fracture, 1 hip pointer, 1 calf strain, and 1 case of posterior tibia tendinitis.

### Type of Injury

All injuries occurred in the lower extremities, with most (61.2%) involving the knee and ankle. This same pattern was observed when the subjects were stratified into the groups, as 71.4% of injuries occurred at the knee and ankle for the trained group and 60.4% for the untrained group. The classification of these injuries by group and anatomic region is summarized in Table 2, and the breakdown of knee injuries specifically is illustrated in Table 3.

TABLE 2  
Location of Injuries for the Trained and Untrained Groups

Area of injury	Total (N = 98)		Trained (N = 7)		Untrained (N = 91)	
	N	%	N	%	N	%
Knee	32	32.7	3	42.9	29	31.9
Ankle	28	28.6	2	28.6	26	28.6
Other	38	38.8	2	28.6	36	39.6

TABLE 3  
Frequency of Different Knee Injuries for the Trained and Untrained Groups

Knee injury	Total (N = 300)		Trained (N = 42)		Untrained (N = 258)	
	N	%	N	%	N	%
ACL tear	9	3.0	1	2.4	8	3.1
MCL sprain or tear	7	2.3	1	2.4	6	2.3
Chondromalacia patellae	6	2.0	0	N/A	6	2.3
Meniscal tear	3	1.0	0	N/A	3	1.2
Contusion	3	1.0	0	N/A	3	1.2
Bursitis	1	0.3	1	2.4	0	N/A
Strain	1	0.3	0	N/A	1	0.4
Patellar subluxation	1	0.3	0	N/A	1	0.4
Patellar dislocation	1	0.3	0	N/A	1	0.4

#### Mechanism of Injury (Contact Versus Noncontact)

Thirty-seven percent of the injuries (36 of the total 98) occurred as a result of contact with another player. Three of the seven (42.9%) injuries sustained by the trained group were caused by contact. The remaining 33 contact injuries happened to the players in the untrained group (36.3% of their 91 injuries were caused by contact with another player).

#### Severity

The average severity score for the trained athletes was 2.86, with one athlete sustaining a season-ending injury (ACL tear). The average severity score for the untrained athletes was 3.23. Eleven of these athletes experienced season-ending injuries. The breakdown of injuries by severity is illustrated in Figure 1.

#### Practice Versus Game

Overall, more injuries occurred during practice sessions (52%, 51 of 98) than during games (44.9%, 44 of 98). The other three injuries were either chronic or not soccer related. However, examination of the two groups individually yielded conflicting results. Similar to the group as a whole, less than half of the injuries in the untrained group

(42.9%, 39 of 91) occurred during a game. This is in contrast to the 71.4% (5 of 7) suffered by the trained group during a game.

#### DISCUSSION

Ekstrand and Gillquist<sup>5</sup> state that soccer injuries occur as a result of several factors. These include player factors (joint instability, muscle tightness, conditioning, and rehabilitation), equipment (type of shoe and shin guards), playing surface (grass versus artificial turf), rules (sportsmanship and adherence to rules), as well as other miscellaneous factors. Manipulation of one or more of these factors in a positive way should decrease the incidence of injury. With the rise of female participation in athletics and the concurrent rise in number of injuries, it is imperative to ascertain ways to minimize the rate and severity of these injuries.

The most significant finding in this present investigation was that subjects in the untrained group had a significantly higher ( $P < 0.05$ ) incidence of injury compared with the trained group (33.7% versus 14.3%, respectively). For the group as a whole, 31% of the athletes sustained an injury, with 5 of the total 300 athletes experiencing two injuries. In comparison, Engström et al.<sup>6</sup> found a much higher injury incidence of 80% in 41 female soccer players. One possible explanation for the difference in results is that patients were elite soccer players participating at a higher level of intensity with more frequent games and practice sessions, therefore they had a greater chance of injury. In another study that reported injury rate in terms of percent injured per total number of participants, a remarkably low injury rate of 4.38% was found.<sup>10</sup> However, it must be noted that this particular study observed youth soccer players for a period of only 4 months.

As previously established, the most common injuries in soccer are to the lower extremity, especially to the knee and ankle.<sup>3,5-7,10,13</sup> The present study supports these findings, as the majority of injuries (61.2%) were to the knee and ankle (32.7% and 28.6%, respectively). Schmidt-Olsen et al.<sup>13</sup> observed 496 youth soccer players for 1 year and found that 49.1% of their 312 injuries were to the knee and ankle. Of the total injuries, 26% occurred at the knee and 23.1% at the ankle. In a similar report, examination of 124 male soccer players over a 1-year

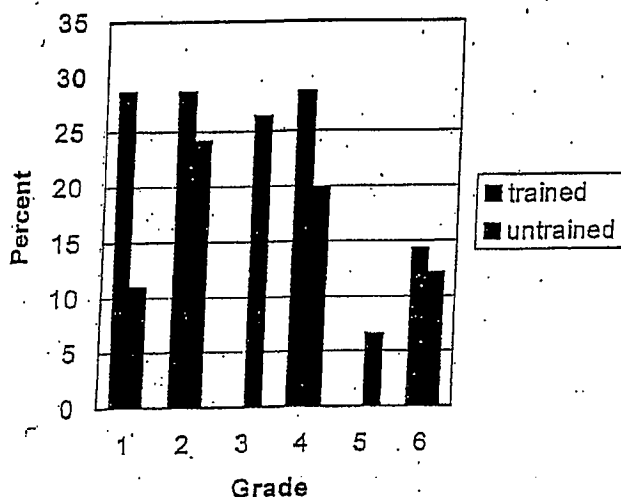


Figure 1. Breakdown of severity of injuries by grade.

period demonstrated the incidence of knee and ankle injuries to be 37%, based on 256 injuries.<sup>5</sup> Engström et al.<sup>6</sup> showed an incidence of injury to the knee and ankle of 49% (38 of 78 injuries), while a retrospective study of 150 female soccer players by Brynhildsen et al.<sup>3</sup> yielded a frequency of 56.4%, based on 248 injuries.

In our study, 9 of the 12 season-ending injuries involved the ACL, and 8 of these injuries were experienced by athletes in the untrained group. Considering the prevalence of knee injuries and the severity of ligament involvement, the fact that the untrained group was found to have a higher percentage of ACL injuries than the trained group (3.1% versus 2.4%) was an important finding. Although statistical significance was not found, we can theorize that this was due to the small sample size of the trained group and that significance could be established with a larger group.

The objective of this study was to determine the role of a preseason conditioning program on the occurrence and severity of injury in adolescent female soccer players. This study demonstrated a significantly lower incidence of injury in female soccer players who underwent preseason conditioning through the Frappier Acceleration Training Program. Although soccer injuries cannot be prevented completely, it is possible to avoid some types and minimize the overall number and severity. Prevention of soccer injuries should focus primarily on conditioning of the lower extremity in sport-specific activities.

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