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Injuries in Norwegian female elite soccer: a prospective one-season cohort study

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Abstract Female soccer has become increasingly popular during the last two decades. According to the International Football Association (FIFA) there are approximately 40 million registered female soccer players in the world. Three studies in elite soccer have shown an injury incidence during games ranging from 12.6 to 23.3 injuries per 1,000 h. A very high incidence of ACL-injuries ranging from 0.31 to 2.2 per 1,000 game hours has also been shown. We followed the Norwegian female elite series during the 2001 season to estimate the incidence and characteristics of injuries. A total of 181 female soccer players on ten teams were followed during the 2001 elite season in Norway. We recorded baseline data, match and training exposure and injury data as type of injury, location and severity of injury. The mean age of the players was 23 years (range 17–34). A total of 189 injuries were recorded and 19 (10%) of these were overuse injuries; 89 (47%) occurred during games and 100 (53%) during training sessions. The incidence of acute injuries was 23.6 per 1,000 game hours and 3.1 per 1,000 training hours. The majority of the injuries occurred in the lower extremities (81%), but there were also a significant number of head injuries (6.3%). The most common injury type was ankle sprain (17.2%). Half of the injuries were minor, with training or game absence of less than 7 days. Midfielders sustained the most injuries (32.6%) with an incidence of 42.4 per 1,000 game hours. We recorded two ACL-injuries and two PCL-injuries during the season. They all occurred during games, and the incidence was therefore calculated to 0.6 per 1,000 game hours for both injury types. The incidences of injuries reported for female soccer varies considerably, with the highest numbers reported from Germany and the present study. These studies have also the highest incidence of minor injuries registered. The location of the injuries is quite similar compared to other reports, but the number of ankle sprains seems to be higher in our study, whereas the number of knee and thigh injuries is lower. There has been much attention to ACL injuries in team handball and hamstring injuries in soccer in Norway, and this could have influenced the team's pre-season training, resulting in a reduction in the incidence of these injury types. The high number of ankle injuries has to be addressed to see whether this is a result of inadequate rehabilitation routines leading to re-injuries, or other factors. The high number of ACL-injuries in these reports is alarming and needs special attention in the future.

Keywords Female · Soccer · Injuries · Incidence · Anterior cruciate ligament

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Introduction

Female soccer has become increasingly popular during the last two decades. According to the International Football

Association (FIFA) there are approximately 40 million registered female soccer players in the world [11]. In the US and many other countries, among these Norway, soccer has become the most popular team sport for women. There are now 105,000 registered female players in Norway (Norwegian Football Association 2005).

Despite the high number of participants, few studies have reported the incidence of injuries in female soccer. In the past 2 years, however, three studies have reported on elite players [6, 8, 11]. Giza et al. [8] followed the first two seasons of the Women's United Soccer Association (WUSA), which was the professional female soccer league in USA from 2001 to 2003. They reported 12.6 injuries per 1,000 game hours and 1.17 per 1,000 training hours. Jacobson and Tegner [11] reported an incidence of 13.9 per 1,000 game hours in Swedish female elite football. Faude et al. [6] observed 23.3 injuries per 1,000 game hours and 2.8 injuries per 1,000 training hours in the German National league in the 2003–2004 season. Engström et al. [5] followed two elite teams (41 players) during 1 year, and found an incidence of injuries during games of 24 per 1,000 hours, and 7 per 1,000 training hours. Östenberg and Roos [12] followed 123 players from different levels during one season. They found 14.3 injuries per 1,000 game hours and 3.7 injuries per 1,000 training hours. Thus, it appears that the injury rate among players at the elite level is high, nearly as high as among their male counterparts.

ACL injuries are a particular concern because of the high incidence reported in many sports compared to men. In soccer, studies from the US college level have shown a significant gender bias and an incidence of 0.31 ACL injuries in females per 1,000 match exposures [1]. However, research from European football has revealed widely different results, with an incidence of ACL injuries ranging from 0.31 to 2.2 per 1,000 game hours [6, 12]). A female elite soccer league has been arranged in Norway, since 1984, representing a high level of play. The Norwegian national team has won the European and World championships, as well as the Olympic gold medals in Sydney 2000. In this study we wanted to follow the Norwegian female elite division during the 2001 season to assess the incidence of injuries, particularly ACL injuries, in female elite soccer players.

Methods

A total of 181 female soccer players, representing all of the ten teams participating in the 2001 season in the elite division in Norway, agreed to participate in the study. The players were informed in person through team meetings before the season, as well as through written information. The period covered by this study included the competitive season from April to October 2001. Before the start of the study, the players answered a questionnaire with personal data, earlier soccer experience and previous and present injuries. All players signed a written consent to participate in the study. The regional ethics committee approved the study.

Exposure registration

The team coaches recorded the type and duration of all training sessions and the number of players participating. Games were also recorded, as well as drop-outs of the study.

Injury registration

In accordance with the consensus statement on injury definitions and data collection procedures [7], the team physiotherapists recorded all injuries that caused the player to be unable to fully take part in the next match or training session ("time loss" injury). Only injuries that occurred during organized training sessions and games were recorded. The locations, type of injury and diagnosis (OSICS, The Orchard Sports Injury Classification System) [17], as well as player position were recorded. Acute injuries were defined as injuries with a sudden onset associated with a known trauma, whereas overuse injuries were those with a gradual onset without any known trauma. The injuries were classified into three main categories according to their severity (days of absence from full training or game); minor (1–7 days), moderate (8–21 days), and major (more than 21 days) [10].

Statistics

Continuous data are described as means and standard deviations (SD), unless otherwise noted. Frequency tables are used for categorical data. The incidence rates are calculated as the number of injuries per 1,000 h of exposure. The SPSS statistical program version 13.0 for Windows (SPSS Inc., Chicago, IL, USA) was used to calculate the statistics.

Results

The mean age of the player cohort was 23 ± 4 (range 17–34) years. Their mean height and weight were 169 ± 5 (155–184) cm and 63 ± 6 (50–80) kg, respectively. Their debut playing organized soccer was between the ages of

4 and 15 years (mean 8 ± 2). The mean career duration in the elite division was 4 ± 3 (0–15) years at the investigation period.

More than half of the players (53.5%) had been injured during the 6 months before the start of the 2001 season, and the most common previous injuries were muscle strains (39.3%) and ligament sprains (34.4%).

The total training volume was 149 h per player during the season, which amounts to an average of 5 h per week. The total exposure during matches averaged 20 h per player during the season. This means that the total exposure for the whole group of players was 3,663 h of match play and 26,956 h of training.

A total of 189 injuries were recorded, affecting 93 (52%) of the 181 players included in the study. Of these, 170 (90%) were acute injuries and 19 (10%) overuse injuries. Eighty-nine (47%) injuries occurred during games and 100 (53%) occurred during training sessions. The incidence of acute injuries was 23.6 per 1,000 game hours and 3.1 per 1,000 training hours. The incidence of overuse injuries was 0.8 per 1,000 game hours and 0.7 per 1,000 training hours.

The type and location of injuries are shown in Table 1. The majority of the injuries occurred in the lower extremities (81%), but head injuries were also frequent (6.3%). The most common injury type was ankle sprains (17.2%). The injury severity is shown in Fig. 1 (N = 180, data missing on nine injuries). A total of 4.4% of all the injured players were injured for the rest of the season, whereas an additional 3.9% gave up playing soccer as a result of long lasting injury. A majority of these injuries were knee and ankle sprains and ruptures, fractures and tendinosis. We recorded 2 ACL-injuries and 2 PCL-injuries during the season, all occurred during games. This corresponds to an incidence of 0.6 per 1,000 game hours for both types of injuries.

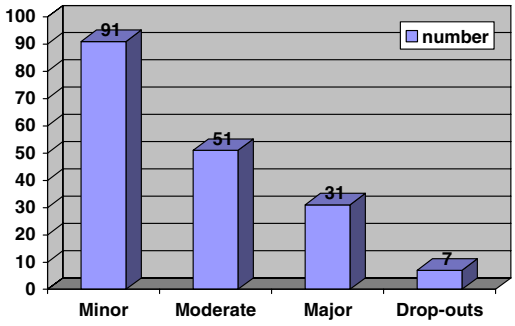

Fig. 1 Injury severity in 180 cases included drop-outs because of long lasting injury

Player position was recorded for 86 out of the 89 players injured during match play. Midfielders sustained most injuries (28, 32.6%) with an incidence of 42.4 injuries per 1,000 game hours, followed by defenders (29, 33.7%, 23.5 injuries per 1,000 game hours), strikers (15, 17.4%, 22.7 injuries per 1,000 game hours), wing players (10, 11.6%, 15.2 injuries per 1,000 game hours), and goalkeepers (4, 4.7%, 12.1 injuries per 1,000 game hours).

Discussion

The incidence of injuries in modern elite female soccer was unknown until two reports were published in 2005 [6, 8], one from the WUSA and one from the German national league. These studies differ considerably regarding the incidence of acute injuries during games. In the study of

Table 1 Type and location of injuries

	Fractures and bone stress	Joint and ligament	Muscle and tendon	Contusions Laceration and skin lesion	Central/peripheral nervous system	Overuse	Other	SUM
Head and face	2	–	–	2	7	–	1	12
Neck and cervical spine	–	–	1	1	–	–	–	2
Shoulder and clavicle	–	1	3	–	–	–	–	4
Upper arm, elbow, hand, finger	–	3	–	1	–	–	1	5
Sternum, rib, upper back	1	–	1	–	–	–	1	3
Lower back and abdomen	–	–	7	–	–	–	3	10
Hip and groin	–	–	14	–	–	3	–	17
Thigh	–	–	30	–	–	3	–	33
Knee	–	15	5	3	–	8	–	31
Lower leg	2	–	4	3	–	5	–	14
Ankle	2	38	–	–	–	1	4	45
Foot and toe	3	2	3	4	–	1	–	13
SUM	10	59	68	14	7	21	10	189

Giza et al. [8] from WUSA, the incidence of acute injuries per 1,000 game hours was 12.6, whereas the incidence reported by Faude et al. [6] from German elite soccer was 23.3 per 1,000 game hours. In 2006, the study of Jacobson and Tegner [11] showed similar results as the WUSA study with an injury incidence of 13.9 per 1,000 game hours in Swedish female elite soccer. Our results are similar to the German study and the study by Engström et al. [5] from Sweden (24 injuries per 1,000 game hours), with a markedly higher incidence than the reports from WUSA and Sweden. However, the WUSA report corresponds with studies from youth and lower divisions soccer in Scandinavia [12, 18]. One possible explanation for this difference could be that the recruitment base of WUSA was primarily the best players from college soccer. These college soccer players (age 18–22) may not have had the speed and strength compared to older and more developed players in the elite leagues in Europe, and therefore did not sustain injuries to the same degree. The style of refereeing and consequently enforcement of the FIFA rules may also have played a role. The average age of the players was identical in the German and our studies, and could be an explanation of this difference, but no such information was given in the WUSA report. Arnason et al. [2] have shown that older players were at a higher risk of injuries in male soccer. In the study of Jacobson and Tegner [11], the mean age of the players was the same as in our study and could not explain the difference seen in injury rates. Our neighboring country also has very similar conditions for playing soccer. We have the same weather conditions, the league systems are similar and the pre-seasonal preparations are much the same. However, one potential explanation for the observed differences may be the method of registration of the injuries. Both in the studies of Jacobson and Tegner [11] and Giza et al. [8] the injury registration was done by the team leaders and athletic trainers, respectively. In the German study [6] and our, the registration was done by the team physiotherapists. Jacobson and Tegner [11] discussed the problems with injury registration in their study and stated: "in this study, leaders of two teams did not have the motivation to fulfill the request of reporting injuries". In the WUSA report, only the injuries recorded by the team athletic trainer and reported to the league insurance company were counted. If the player sustained a minor injury and was not participating in one or two training sessions, this could have been missed by the league insurance database. We would then expect a lower number of minor injuries in this report, but no such information is given. In the Swedish study the slight and minor injuries accounted for 39% of the injuries, whereas both the German study and our showed that half of all the injuries was minor. The use of physiotherapists in our studies can explain the increased report on minor injuries, and therefore the increase in the total number of injuries. Fuller et al. presented in 2006 [7] a consensus statement on injury definitions and data collection procedures in studies of soccer injuries. This will hopefully make new studies in this field easier to compare.

Most of the injuries occurred in the lower extremities (80.1%) as seen by other authors [1, 5, 6, 14]. The location of the injuries is also similar to these reports, but the number of ankle sprains is higher in our study, whereas the number of knee and thigh injuries is less. There has been much attention to ACL-injuries in team handball [15, 16] and Hamstring injuries in soccer [13] in Norway, and this could have influenced the team's pre-season training resulting in a reduction in the incidence of knee and thigh injuries. The high number of ankle injuries is now being addressed to see whether this is a result of inadequate rehabilitation routines leading to re-injuries, or other factors. Bahr et al. [3] showed a twofold reduction in incidence of acute ankle sprains in volleyball after the introduction of an injury prevention program for players who already had sustained an injury.

According to the National Collegiate Athletics Association (NCAA) Surveillance Survey females are at a 2.3 times risk of sustaining ACL-injuries in soccer compared to men [9]. The incidence of ACL-injuries was 0.13 per 1,000 athletic exposures for men versus 0.31 for women. Bjordal et al. [4] reported a twofold risk for sustaining an ACL-injury for women playing soccer (0.1 per 1,000 game hours) versus men (0.057 per 1,000 game hours), but they also found an increased risk (0.41 per 1,000 game hours) in the men's upper three divisions. In Norwegian team handball Myklebust et al. [16] reported an incidence of ACL-injuries of 0.31 per 1,000 player hours in the elite division versus 0.06 per 1,000 player hours among men. In competition women had a sevenfold risk of sustaining an ACL-injury compared to men (1.6 per 1,000 game hours for women versus 0.23 per 1,000 game hours for men). The reports from our study and the two resent studies from WUSA [8] and Germany [6] are alarming with incidences of ACL-injuries from 0.6 to 2.2 per 1,000 game hours. In our study we positively know that one player injured her ACL just days before the start of the season, and another just after the end of the season. They are therefore not included in this study. Even though the numbers of ACL-injuries in our study are few, together with the other reports it [6, 8, 11] seems to show a relatively high incidence of ACL-injuries in elite female soccer compared to other sports and compared to men's soccer. There is clearly a need for studies of injury mechanisms in female soccer, and for preventive intervention studies. Soccer has become an all-year sport in the Scandinavian countries with indoor and outdoor activities on artificial turfs during the winter time, but also training periods and tournaments in southern Europe. Any registration of soccer injuries in the future

should therefore not be limited to the competitive season, but include the whole year.

Conclusion

The incidence of acute injuries in Norwegian elite female soccer is 23.6 per 1,000 game hours and 3.1 per 1,000 training hours. The type and location of the injuries are similar to other reports both in female and men's soccer, but there are more serious knee injuries compared to men, and more ankle sprains compared to other studies in female soccer. Differences in the incidence of acute injuries between our study and the study of Jacobson and Tegner [11] are difficult to explain because the players, the pre-season preparations and the leagues are so similar. The only reasonable reason could be differences in study design and registration routines. It is important in the future that all studies follow the consensus statement of Fuller et al. [7] on injury definitions and data collection procedures.

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References

1. Arendt E, Dick R (1995) Knee injury pattern among men and women in collegiate basketball and soccer. NCAA data and review of literature. Am J Sports Med 23(6):694–701
2. Arnason A, Sigurdsson SB, Gudmindsson A, Holme I, Engebretsen L, Bahr R (2004) Risk factors for injuries in football. Am J Sports Med 32(1 Suppl):5S–16S
3. Bahr R, Lian Ø, Bahr IA (1997) A twofold reduction in incidence of acute ankle sprains in volleyball after the introduction of an injury prevention program: a prospective cohort study. Scand J Med Sci Sports 7(3):172–177
4. Bjordal JM, Arnly F, Hannestad B, Strand T (1997) Epidemiology of anterior cruciate ligament injuries in soccer. Am J Sports Med 25:341–345
5. Engström B, Johansson C, Törnkvist H (1991) Soccer injuries among elite female players. Am J Sports Med 19:372–375
6. Faude O, Junge A, Kindermann W, Dvorak J (2005) Injuries in female soccer players. A prospective study in the German national league. Am J Sports Med 33:1–7
7. Fuller CW, Ekstrand J, Junge A, Andersen TE, Bahr R, Dvorak J, Hägglund M, McCrory P, Meeuwisse WH (2006) Consensus statement on injury definitions and data collection procedures in studies of football (soccer) injuries. Br J Sports Med 16(2):97–106
8. Giza E, Mithöfer K, Farrell L, Zarins B, Gill T (2005) Injuries in women's professional soccer. Br J Sports Med 39:212–216
9. Hutchinson MR, Ireland ML (1995) Knee Injuries in female athletes. Sports Med 19(4):288–302
10. Inklaar H (1994) Soccer injuries I. Incidence and severity. Sports Med 18:55–73
11. Jacobson I, Tegner Y (2007) Injuries among Swedish female elite football players: a prospective population study. Scand J Med Sci Sports 17(1):84–91
12. Östenberg A, Roos H (2000) Injury risk factors in female European football. A prospective study of 123 players during one season. Scand J Med Sci Sports 10:279–285
13. Mjølsnes R, Arnason A, Østhagen T, Raastad T, Bahr R (2004) A 10-week randomized trial comparing eccentric vs. concentric hamstring strength training in well-trained soccer players. Scand J Med Sci Sports 14(5):311–317
14. Morgan BE, Oberland MA (2001) An examination of injuries in major league soccer. The inaugural season. Am J Sports Med 29(4):426–430
15. Myklebust G, Engebretsen L, Brækken IH, Skjølberg A, Olsen OE, Bahr R (2003) Prevention of ACL injuries in female team handball players—a prospective intervention study over three seasons. Clin J Sports Med 13:71–78
16. Myklebust G, Mæhlum S, Holm I, Bahr R (1998) A prospective cohort study of anterior cruciate ligament injuries in elite Norwegian team handball. Scand J Med Sci Sports 8(3):149–153
17. Orchard J (1993) Orchard sports injury classification system (OSICS). Sport Health 11:39–41
18. Söderman K, Adolphson J, Lorentzon R, Alfredson H (2001) Injuries in adolescent female players in European football: a prospective study over one outdoor soccer season. Scand J Med Sci Sports 11(5):299–304