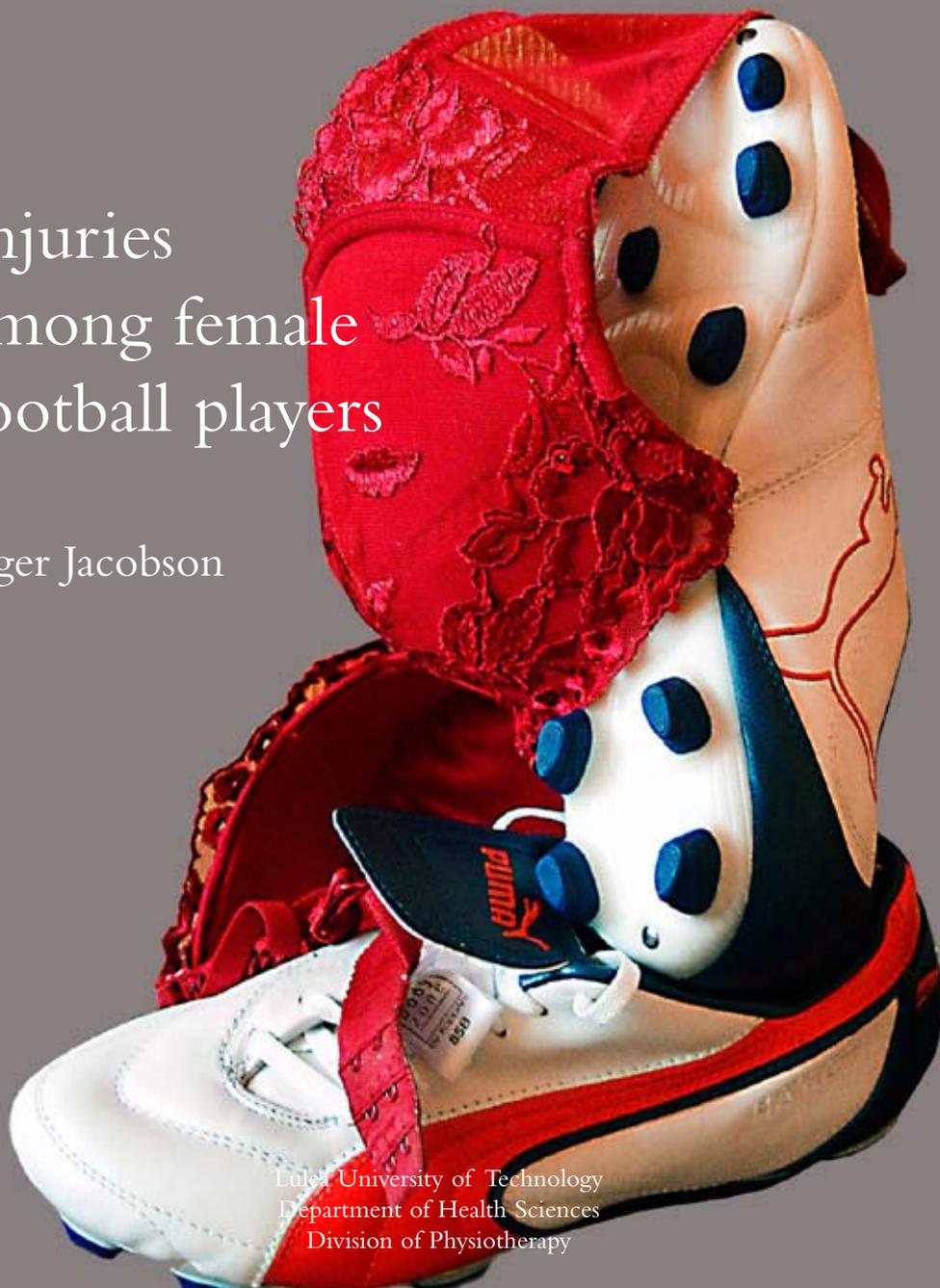


Injuries among female football players

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“Jämlikhet”

En handfull fotbollspelare
tillhör eliten.

Cirka 1000 spelare
är ganska bra.

Men vi är tiotusentals
som ingenting är
och kan inget bli.

När doktorn
tittade på min trasiga menisk
och sa typiskt fotbollspelare
kände jag en viss glädje
trots smärtan.
För doktorn sa ju fotbollsspelare.

(Ur: "Hela bollen ska ligga still" av Bengt "Cidden" Andersson)

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FOREWORD

Since the age of 4, I have been interested and active in sports. First it was ballet, then gymnastics and basketball. When I got older it was softball, alpine skiing, sailing, volleyball, football and horseback riding. While other friends went to the disco, I went to practice, 6-7 days/week. I have experienced all the efforts of hard practice, training camps, competitions, “nervous breakdowns” and the tragedy of being injured.

Early in life I decided to become a physiotherapist. In January 1987, for almost 20 years ago, I graduated from the Department of Physiotherapy at Lund University. I wanted to work with athletes and guide them in their efforts of reaching their athletic goals.

From 1987-1999 I was a physiotherapist for various female (and one male) football teams from the premiere league to the second division, and in 1994-2001 I was also physiotherapist for the national female U21 team. Very soon I noticed that my clinical reality did not agree with the football medicine literature. Almost all studies were on male players and the results were “transformed” to be valid for female players too. My experience told me that there were gender differences between female and male football players, but there were few studies to confirm my feelings.

During a sports medicine conference in 1997, I had a long discussion with Professor Jan Ekstrand (experienced in football medicine) and Associated Professor Yelverton Tegner (experienced in ice-hockey medicine) concerning this matter. I had so many questions but they didn't have the answers. “Why doesn't anyone study female football injuries?” They smiled and just looked at me, until I realized that if you want something done, you have to do it yourself!

The discussion during that conference resulted in this thesis. Yelverton Tegner became my tutor and Professor Jan Ekstrand my opponent at the dissertation. Some of my questions have now gotten answers. This process has finally come to an end and I humbly present my work to you.

Inger Jacobson

ABSTRACT

Background

Football is a popular female team sport played by approximately 40 million women in over 100 countries all over the world. In Sweden football is the largest female team sport with more than 56 000 players over 15 years of age.

Aim

The aims of this thesis were to investigate injuries and injury incidences among female non-elite players in second division as well as elite football players in the premiere league in Sweden over an entire football season with special emphases on regional and level differences; to investigate range of motion (ROM) at the beginning of the football season in relationship to upcoming joint (sprain) and muscle-tendon (strain) injuries; to investigate if the injury incidence varied during the different phases of the menstrual cycle and if there was a difference in injury incidence according to oral contraceptive (OC) pill usage.

Material and methods

Thirty teams (n=522 players) from two different league levels in Sweden, the second division (9 teams from the most Northern league and 9 teams from the most Southern league, comprising 18 teams) and the premiere league (12 teams), were studied during an entire football season. Baseline information was obtained and ROM was measured. During the season menstruation and OC usage, football exposure and injuries were registered.

Result

A total of 466 injuries were studied. The overall injury incidence was 9.6 injuries/1000 hours of football in the second division and 4.6 injuries/1000 hours of football in the premiere league. Traumatic injuries were in majority (59-69%), and the most common type of traumatic injury was sprain, mainly to the ankle. The distribution of injuries varied between regions; the number of total injuries as well as the total injury incidence was higher in the northern than southern region in the second division. Both traumatic and overuse injuries occurred mainly during the early preseason and at the beginning of the competitive spring season.

Increased/decreased ROM in the lower extremity did not appear to be a predisposing risk factor for joint (sprain) or muscle-tendon (strain) injuries of the lower extremity.

A total of 2 586 menstrual cycles were studied. An increased injury incidence was noted during the menstrual phase compared to the pre-ovulatory phase as well as during the post-ovulatory phase compared to the pre-ovulatory phase for non-OC users. An increased incidence of traumatic injuries was also noted during the menstrual phase compared to the pre-ovulatory phase for non-OC users. There were no differences between the OC/non-OC groups concerning injury incidence during practice, game or total football.

Conclusion

Evidence is presented in this thesis that regional factors as well as play-level are associated with injury incidence. Preseason ROM measurements cannot identify players at risk for upcoming sprain or strain injuries. An increased injury incidence during the menstrual phase was found, however, no significant difference in injury incidence between OC-users and non-users were found.

List of papers

This thesis is based on the following papers, which will be referred to in the text by their Roman numbers.

- I Jacobson I, Tegner Y. *Injuries among female football players -With special emphasis on regional differences*. Adv Physiother 2006; 8: 66-74.

- II Jacobson I, Tegner Y. *Injuries among Swedish female elite football players - A prospective population study*. Scand J Med Sci Sports; [DOI: 10.1111/j.1600-0838.2006.00524.x]

- III Jacobson I, Tegner Y. *Range of motion in relation to upcoming sprain and strain injuries among female football players*. (Manuscript)

- IV Jacobson I, Arenbalk C, Brynhildsen J, Tegner Y. *Injures among female football players in relation to the menstrual cycle and oral contraceptive use*. (Submitted)

Definitions and abbreviations

- *ACL* Anterior cruciate ligament.
- *Body mass index (BMI)* Weight (kg)/height² (m).
- *Disturbing physical complaints* Physical complaints causing reduced capacity in practice or game that prevented the athletes from playing football at their full capacity.
- *FIFA* Fédération Internationale de Football Association.
- *Foul play* A situation during game time that was interrupted by the referee and that led to a free kick / penalty kick.
- *Injured player* The player was defined as injured until she considered herself able to participate fully in practice and/or game time.
- *Injury* Damage to the body sustained during practice or game session causing absence from at least the following practice and/or game session.
 - *Slight injury* Absent from practice and/or game 1-3 days.
 - *Minor injury* Absent from practice and/or game 4-7 days.
 - *Moderate injury* Absent from practice and/or game 8-28 days.
 - *Major injury* Absent from practice and/or game > 28 days.
- *Injury incidence* The number of injuries / 1000 hours of football activity occurring during a study period.
- *Menstruation cycle*
 - *Menstruation phase* From the first day of the menstrual bleeding and 7 days forward.
 - *Pre-ovulatory phase* From the end of menstruation phase until the beginning of the post-ovulatory phase. The number of days in this phase varies.
 - *Post-ovulatory phase* 14 days before the next menstrual bleeding and 7 days forward.
 - *Pre-menstruation phase* 7 days before menstruation.
- *OC* Oral contraceptives.

- *Overuse injury* Injury without any known trauma.
- *Present physical complaints* Physical complaints at the time of examination. These physical complaints did not prevent the athletes from playing football at their normal capacity.
- *Re-injury* A new injury sustained within 2 months after an earlier injury at the same bodily location.
- *ROM* Range of motion.
- *Sprain* A ligament injury.
- *Strain* A distension injury to the muscle-tendon unit.
- *SvFF* Svenska Fotbollförbundet (Swedish Football Association).
- *Traumatic injury* Injury with a known trauma.
- *UEFA* Union of European Football Associations.

BACKGROUND

Football is a worldwide sport that has been played for centuries. More organized games have their origin in the middle of the nineteenth century in the English public schools^{29,67}. The International Football Association, Fédération Internationale de Football Association (FIFA), was founded in 1904 and involves 204 countries with a total of about 200 million licensed football players (www.fifa.com). The European football organization, Union of European Football Associations (UEFA), represents 52 countries with 20 million licensed players (www.uefa.com).

In Sweden football has its roots and inspiration from England during the 19th century¹⁰⁹. It appears that the first football games took place in Sweden during the 1880s. Football games started to be organized in the late 1880s and in December 1904 the Swedish Football Association, Svenska Fotbollförbundet (SvFF), was founded, although it got its official name two years later.

When women started to participate more in sports, this also included football. Through time the number of female football players has increased. Football is now a popular female team sport played by approximately 40 million women in over 100 countries all over the world (www.fifa.com). In Sweden football is the largest female team sport with more than 56 000 licensed players aged 15 years or more (www.svenskfotboll.se).

Both men and women of various age groups play outdoor football. Each team consists of 10 field players and one goalkeeper. There is one head referee and two assisting referees on the side. A regular game consists of two halves each lasting 45 minutes with a 15-minute break at half time.

An outdoor football game is played on a field with a grass surface that is maximally 68m wide and 105m long. The fields may also be artificial turf or gravel. Indoor football is often played in gymnasiums or in other arenas on artificial turf during the preseason⁶⁷. The size of the fields may differ. For the younger age groups, games are generally played on smaller fields and for a shorter time.

The plastic-coated ball weighs 396 to 453 grams with a circumference of 68 to 71 cm. The speed of the ball can reach nearly 130 km/h⁴ and can hit with an impact of more than 2000N¹⁴⁴. In Sweden two sizes of football balls are used. Number 5 is used for adults (male and female) and number 4 for girls under 15 years of age and for boys under 12 years of age. SvFF classifies premiere league, first division and second division for both female and male players as national levels and administrates these levels. Third and fourth divisions as well as youth female teams are administrated by the district organisations of SvFF (www.svenskfotboll.se).

Physical characteristics

Davis and Brewer reviewed the literature and found that the average age of elite female football players ranges from 20.3 to 24.5 years of age, the height from 158.1 to 169.0 cm and the weight from 55.4 to 63.2 kg²⁹.

Physiology of female football players

Few investigations have been undertaken concerning match analysis of women's football. Match analysis of male games demonstrated that football is a demanding game that is intermittent in nature^{29,116}. Players cover a considerable total distance, frequently working at a high intensity with limited recovery periods. However, the requirements appear similar for men and women. The distance covered and average sprint duration for women was similar to that observed in male players¹³. To cope with such demands, players must have a high level of aerobic endurance while also having the capacity to recover rapidly from high intensity exercise if they are to be successful.

Bone mass

One topic of discussion during the last decades has been the development of osteoporosis. One factor of special interest in this development is the influence of childhood physical activity patterns on the skeletal maturation¹³³.

In a cross-sectional study, bone mass and muscle strength of the thigh were investigated in 51 young female football players (age 14-19 years) and compared with 41 age-matched non-

active females¹³³. The football players had significantly higher bone mineral density (BMD) of the total body, of the lumbar spine, as well as of the dominant and non-dominant hip (all sites). The largest differences were found in the greater trochanter on both sides. The older football players (>16 years) had higher BMD than the younger players in all measured areas¹³³.

McCulloch et al. investigated 12 young female football players 13-17 years old and found a tendency toward higher BMD of the calcaneal bone among the football players (both female and male) compared to competitive swimmers⁹⁷. Alfredson et al. showed no significant relationship between muscle strength of the thigh and BMD among adult female football players¹.

Injuries in football

Football is considered a contact sport, and it puts many demands on the technical and tactical skills of the individual player. Because of the characteristics of football, injuries must be expected³⁸. *Football injuries*, in general, are all types of physical damage to the body occurring in relation to football⁶⁷. *Football injury incidence* is mostly expressed as the number of new football injuries per 1000 hours of exposure in football^{9,11,48,49,63,72,99,107,125}. Risks may vary with position played or intensity and nature of activity during practice or games.

Various studies of the incidence of football injuries present different classifications of football injuries. Differences in classification could at least partly explain the differences in incidences found. Up until now, the most common way to classify injury and injury severity have been through:⁶⁷

- anatomical tissue diagnosis,
- sporting time lost,
- working time lost (social and financial consequences)
- insurance claims
- medical treatment

Anatomical tissue diagnosis

Traumatic and overuse injury

A classification into acute or chronic traumatic and overuse injuries may be used since different mechanisms are involved in the aetiology of these injuries. An injury is defined as traumatic if it had a sudden onset associated with a trauma^{112,131}. An overuse injury is an injury where the symptoms had a gradually onset without any known trauma¹³¹. Overuse injuries in football predominate during preseason but occur more frequently at the end of each competitive season⁴⁹. Strains are generally considered to be acute overuse injury³⁹.

Two senior female football teams were studied prospectively during one year⁴⁹. Of the major injuries (n=12), 10 were due to trauma and 7 were knee ligament or meniscus tears. Traumatic injuries (72%) occurred mainly during games with predominance at the beginning of the competitive season. Almost 80% of all the traumatic injuries occurred during physical contact with an opponent. Overuse injuries constituted 28% of all injuries and occurred mainly during preseason training and at the beginning and end of the competitive season⁴⁹.

In a German study of 165 female players in the national league, 84% of all injuries were traumatic and 16% were owing to overuse⁵¹. A prospective study by Söderman et al. showed that 79% of the traumatic injuries occurred during games and 21% during practice. The overall injury incidence of traumatic injuries they reported was 4.4/1000 hours of football and for overuse injuries 6.8/1000 hours of football. Out of 11 major injuries, 9 were traumatic knee ligament injuries¹³¹. Overuse injuries constituted 24-34% of all injuries and the traumatic injuries (66-76%) occurred mainly during games^{131,132}.

Hyperextension of the knee joint, lower concentric hamstrings/quadriceps ratio, low postural sway of the lower extremities and higher exposure to football was found to significantly increase the risk for traumatic injuries of the lower extremities in female football players¹³². Poor flexibility, high training load and muscle tightness was identified as risk factors in male football^{39,115,148}.

Type of injury

Classification of injuries implies that an evaluation by a medical qualified person has been performed. The following categories are generally used:

- sprain (of joint capsule and ligaments)
- strain (of muscle and tendon)
- contusion (bruising)
- dislocation or subluxation
- fracture (of bone or tooth)
- abrasion (graze)
- laceration (open wound)
- inflammation
- tendinopathy
- concussion (brain injury)

Location of injury

In studies involving both female and male players, lower extremity injuries represent 61-90% of the total number of injuries, and the most common locations are to the ankle and the knee^{39,48,49,51,76,92,107,108,124,125,131}. Studies have also shown a high incidence of head, face and upper extremity injuries among young players^{91,92,108}.

Ankle injuries

The ankle is the most frequent site of football injuries in both sexes^{21,39,45,49,64,76,92,99,107,108,115,121,125,131,145}. Twenty to twenty-five percent of all football injuries are ankle sprains^{49,131,132}. If a male player have previously sustained an ankle sprain, he has a 2.3 greater risk of getting another ankle injury⁴⁵. Fifty-six percent of ankle injuries involved male players with a history of ankle sprain¹⁰⁷.

Knee injuries

The other main injury location in football is the knee and many studies have been performed accordingly^{9,17,33,39,48,49,64,73,77,99,112,115,121,145}. In a retrospective questionnaire study of

arthroscopic evaluated anterior cruciate ligament (ACL) injuries (n=972), 176 patients were organized football players (24% women)¹⁸. The mean age at the time of injury was 19 years for women and 26.5 years for men. Women had an injury incidence rate of 0.10 injuries /1000 game hours, which was significantly higher than for men. Most of the injuries for females occurred during games and 58% were a result of body contact with a player of the opposite team. Almost two-thirds of the ACL injuries occurred among girls between the age of 15 and 18 years. Furthermore the study showed that junior level girls, age 15-18, had 5.4 times higher risk of injury compared with boys at the same age; this is likely due to that girls at this age played in the senior league¹⁸. Sixty-four percent of the injured women over the age of 19 were able to return to football. The lowest results for return to play were for the women under the age of 19 years. Reconstructive surgery was performed on 74% of the injured players. All female players who returned to football had had reconstructive surgery. No relationship between ACL injuries and field position was found¹⁸.

In another study sixty-eight percent of female ACL injuries required surgery⁵. Torn cartilage, including meniscus tears, were also significantly higher in female footballers as compared with males. Women twice as often had an ACL injury as a result of player contact and three times more often through non contact mechanisms than their male counterparts. Both women and men are three times more likely to have an ACL injury during game compared to practice⁵. The increased risk of ACL injuries among women is most likely multi-factorial, with no single structural, anatomic or biomechanical feature solely responsible⁵.

Thigh injuries

One of the most frequent injuries reported in female football is strain injuries to the thigh^{51,131}, however no specific study on thigh injuries among female football players was found.

Hip/groin injuries

One study was found that described osteoarthritis (OA) to the hip in female football¹¹¹. This study did not find an increased risk of hip OA among female football players. The result of case control studies of former male football players suggest long term exposure to football seems to be a risk factor for developing OA of the hip^{77,83,147}.

Head injuries

A football player receives several thousand blows to the head during her football career¹⁴².

Heading is one of the more difficult skills in football. Learning, especially in the early stages, can be a painful experience. The brain is very easily altered in shape, or distorted by rotation of the head about an axis. Sudden rotational acceleration of the movable head emerges as the most dangerous mechanisms of injury³⁴.

In a recent study of serum concentrations of two markers of brain damage (S-100B and NSE), venous blood sample were obtained from four female elite football teams (n=44) before and after a competitive game. The serum concentration of both S-100B and NSE were increased after the game and the changes of concentration correlated significantly with both the number of headers and the number of other trauma events that had occurred during the game¹³⁶, which is accordance with a parallel study of male football players¹³⁷.

For male football, head injuries were shown to account for 4 to 22% of football injuries¹⁴³. Football was found to be the sport most commonly associated with serious head injuries that required admission to a neurological unit⁸⁵. The most common head injury situation reported was collision with another player or getting hit in the head by the ball³⁶. Traumas to the head can cause neuropsychological symptoms regarding attention, concentration, memory and judgement, and thus is to be diagnosed as a concussion^{8,93,94,143,144}. Clinical and neuropsychological investigations of football players with minor head trauma have revealed organic brain damage¹⁴³. The emotional and intellectual problems experienced by patients with severe head injuries, and the great difficulties these patients encounter in their return to society, have been documented^{20,59,146}. There are studies that indicate some degree of permanent organic brain damage; probably the cumulative result of repeated traumas from heading the ball^{20,59,146}. Neuropsychological examinations have demonstrated mild to severe deficits regarding attention, concentration, memory and judgement in 81% of the players¹⁴⁴.

Thus studies show that a brain injury is quite frequent in football and can in some cases cause severe, persisting impairment of brain functions^{62,142-144}. This is an area of sports medicine and especially football that needs to be further investigated to impose rules concerning head traumas. International consensus reports concerning diagnosis and treatment of concussions in sport have recently been published^{8,96}.

Sporting time lost

The National Athletic Injury/Illness Reporting System (NAIRS) classifies injuries according to the length of limitation of athletic participation into minor (1 to 7 days), moderate (8 to 21 days) and serious (over 21 days or permanent damage) injuries. A slightly different classification has been used by a number of others where they classified injuries into minor (1 to 7 days), moderate (1 week to 1 month) and severe (over 1 month)^{39,48,49,107,123,131}.

Sporting time lost might be influenced by the availability and quality of medical care and rehabilitation and might thus not be such a valid criterion for the severity of injuries⁶⁷. Good medical care and rehabilitation may work in opposite directions towards sporting time lost. They may lengthen the period of sporting time lost because proper time for rehabilitation used. Sportswomen and sportsmen tend to return to sports too soon, before the injury is completely healed and an adequate rehabilitation has taken place. Otherwise good medical care may stimulate the healing process by eliminating harmful factors like haematoma or oedema, thereby leading to a quicker return to play⁶⁷.

In a prospective study of two female teams (n=41), during one year, the number of injuries were recorded concerning sporting time lost. Forty-nine percent of the injuries (n=78) were minor (<1 week of absence), while 36% were moderate (1 week to 1 month) and 15% were major (>1 month of absence)⁴⁹. The traumatic injuries occurred mainly during games and were the most common injuries (72%) while 28% were overuse injuries⁴⁹.

In prospective studies of female adolescents players 34% of the injuries were minor, 49-52% were moderate and 14-18% were major^{131,132}.

In a prospective study of male football injuries among senior players (n=64), the number of injuries during one year was 85. Of all injuries 27% were considered as minor, 39% as moderate and 34% as major. Sixty-five percent were due to trauma and 35% were overuse injuries⁴⁸. The conclusion of these studies is that female players have more minor injuries and less major injuries than male players. Furthermore, female players seem to be injured by trauma slightly more often than male players.

Working time lost

One way of describing the consequence of a sport injury to society is to register the working time loss. This gives an indication of the financial consequences of sport injuries. However, in describing the effect of sport in this way can be biased by many factors like type of work, the sick leave economic compensation etc.

In Sweden, a total number of 1416 compensated work-related sick leave days for 68 injuries (both females and males) were recorded with a mean duration of 20.8 sick leave days for each injury. For all sports, the average length of sick leave was found to be 21.5 days, female and male comprised³¹.

In a prospective study 715 patients (69 women and 646 men) with football injuries were registered and treated in the emergency department of a Danish hospital during 1 year. A total of 31% had been absent from work, but only 8% of the patients had a loss of income because of their injury. The average absence from work for male players was five days per person. The average absence for female players was not presented⁶⁴.

Insurance claim

In two studies, a football injury was defined as an injury sustained during football for which an insurance claim is submitted^{17,123}. Registration of football injuries through insurance files and medical channels has the disadvantage that predominantly more serious and acute injuries will be recorded. With this definition of injury the less serious and overuse injuries are likely to be missed¹⁴⁵.

The Swedish insurance company Folksam insures all licensed football players in Sweden. All football injuries reported to the insurance company during the years 1986-1990 have been evaluated⁸⁷. In female football most injuries reported to the insurance company were in the age group of 16-20 years and the players were in the higher divisions. Injury incidence per 1000 hours of football was 0.37 for players in the elite and first divisions, 0.21 for the second division and lower, 0.06 for junior girls and 0.07 for girls. The location of injuries was to the knee (43%), foot (19%) and head (7%). The causes of injury for females were collision (20%), kick / hit (16%) and being slammed to the surface (12%). Almost all of the injuries leading to sequel were knee injuries (n=238 out of 277) and primarily ACL injuries. Out of all

knee injuries reported to this insurance company (n=3735), 937 were related to football play. The ACL injuries represented one third of the football related knee injuries⁸⁷.

The risk of sustaining an ACL injury, according to the Folksam statistics, showed an increased relative risk for female compared to male players. Female elite players also had an increased risk in comparison with female non-elite players. The ACL injuries occurred at a younger age in females than in males. Fifty percent were treated with reconstructive surgery. Thirty percent of the players with ACL injury were active in football play after 3 years, compared to 80% of an uninjured control population of football players (Figure 1)¹²⁰.

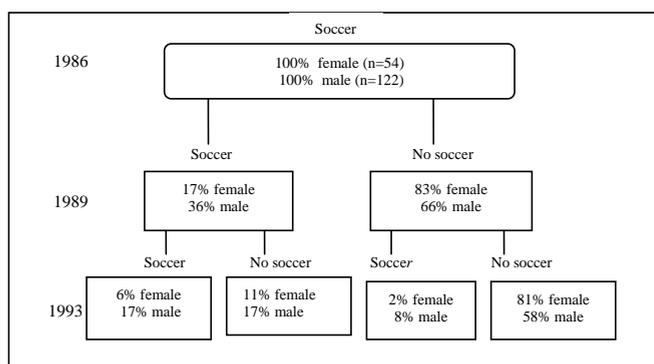


Figure 1: The changes in rate of participation in football during 7 years for male and female football players with ACL injuries (with permission)¹²⁰.

Medical treatment of football injuries

In a Swedish study of two female football teams (second and third league levels), 28% of injuries required hospital facilities, 38% of injuries were treated with physical therapy and in 14% NSAID was prescribed mainly for overuse injuries⁴⁹.

Data on the duration and nature of treatment can be used to determine the severity of an injury¹⁴⁵. In the study by van Mechelen et al., the authors state that registration of the duration and treatment of an injury enables comparison of the effectiveness of different treatment programs in terms of sporting time lost and cost-benefit. They also state that studies using duration and nature of treatment as parameters of the severity of injuries are most probably biased by the level of play and the socio cultural background with corresponding differences in availability of access to medical care and rehabilitation¹⁴⁵.

In a prospective study of acute sports injuries (both female and male) over one year from the total population of a municipality with 31 620 inhabitants in Sweden, a total of 571 sports injuries were recorded. These represented 41% of all the visits to the open wards of the hospital and 29% of the days spent in a hospital³¹.

Risk factors

A sports injury is the result of a complex interaction of various risk factors in the course of time⁶⁷. Female athletes are at increased risk for certain sports-related injuries, particular those involving the knee⁶⁶. The exact reason for gender variation in injury incidence is not known, but factors include gender differences in coaching, conditioning, strength training, structure, hormones and specific sport biomechanics and the contact nature of some sports. In quick stopping and cutting sports, e.g. football, females have an increased incidence of ACL injuries within comparison to males, the average female athlete has less access to good coaching, athletic trainers and facilities, which also might influence the risk for injury^{15,66}.

One study, made in Switzerland, shows the overall rate of injury over a three year period among 350 000 Swiss athletic participants in 32 sports. The exposure of risk per 10 000 hours was calculated. In females the injury incidence was as follows: handball (7.6), football (6.7) and basketball (4.9), alpine skiing (3.9), volleyball (3.8) and alpinism (3.0). The overall risk was significantly higher in males, but the higher risk was explained by the predominance of male football. After standardization for total exposure the results were even reversed, with female sports displaying a higher overall risk³².

In identifying risk factors, or circumstances, of sports injuries, the choice of research design is very important. Up till now, the most common risk factors concerning female football in literature are as follows:

- Age
- Field position
- Play-level
- ROM
- Exposure
 - Practice and game

- Tournaments
- Camps
- Indoor football
- Surface
- Menstruation
- Oral contraceptive pill usage
- Nutrition
- Earlier injuries and persisting symptoms

Age

For female football players the effect of age on the incidence of injury is still unclear. Studies show conflicting data as to the increase in the incidence of injury with increasing age groups^{49,91,124}. In the age group 14 to 16 years (girls and boys) there appear to be a sudden increase in the incidence of injury^{9,63,92,124,125,131,138}. One study found a decline of injuries per 1000 hours of play in the age group 17 to 19 years⁹¹. Pubertal maturity and growth spurt may lead to increases in body height and muscle mass, and to higher speed and momentum, thereby leading to joint reaction forces and higher impact forces on collision⁷⁵.

Studies have found that youth players, both girls and boys, sustain more contusions and less overuse injuries (sprains and tendonitis/bursitis) than do the senior female and male players^{39,48,49,91,107}. In youth football, girls have a lower percentage of laceration and a higher percentage of sprains than boys do⁹¹. Studies find no differences between girls and boys in injury pattern, but differences do exist between senior female football players and male football players^{39,48,49}.

The incidence of injury per 1000 play hours for senior female football players in the study by Engström et al.⁴⁹ was in-between the incidence figures presented for the age group 17 to 19 years in the two other studies^{91,124}. Junior female football players show a higher incidence of injury than junior male football players^{9,12,91,92,108,124,138}. For elite senior players the higher incidence of injury in females has been attributed to a lower level of playing techniques and skills and a relative lack of physical fitness, and young, small girls playing against older and larger girls are surely more accident-prone¹⁰⁸.

Söderman et al. stated in their questionnaire study of 743 knee injuries reported to the Folksam insurance company during the years 1994-1998, that too many young female football players injure their ACL when playing at the senior level¹³⁴. Young, talented players often play in senior teams, due to shortage of senior players and “in order to stimulate” the younger player. The suggestion by Söderman et al. was that female football players under the age of 16 should only be allowed to occasionally participate in practice sessions at a senior level¹³⁴.

Field position

In a recent study, the injury incidence was higher in defenders (9.4 injuries/1000 hours) and strikers (8.4/1000 hours) than goalkeepers (4.8/1000 hours) and midfielders (4.6/1000 hours)⁵².

Engström et al. calculated the injury incidence for female/male football players. For female players the injury incidence was equal according to field position^{48,49} but differed among male players^{39,65}. Male goalkeepers more often injured their fingers, heads, elbows or hands while non-goal keepers more often injured their ankles and thighs⁸⁴.

Play-level

Östenberg & Roos found that players over 25 years were shown to be at significant higher risk of injury¹¹². One reason discussed was that elite players in their study were older than non elite players and that the differences in play levels could be the explanation for the higher risk of injury¹¹². The elite players are probably more exposed to injury due to higher training intensity and participation in more games than players in lower divisions⁴⁸.

Range of motion/joint laxity/ muscle flexibility

Different terms and definitions have been used to describe movements of the extremities. The most common terms used were range of motion, joint laxity and muscle flexibility^{35,40,41,47,101,135,148}.

One earlier study of female football players have measured *range of motion (ROM)*¹³⁵. The ranges investigated were dorsiflexion of the foot with flexed knee, hip flexion and hip abduction¹³⁵ (Table 1).

ROM for male football players has been investigated^{39,101,148} (Table 1). Möller and Ekstrand^{39,101} measured bilateral dorsiflexion of the foot, with straight and flexed knee, hip extension, hip flexion and knee flexion by using a flexometer⁴⁷ and a double armed goniometer for hip abduction¹⁴⁸. Measurements of hip rotation have also been performed³⁵.

In a study by Östenberg & Roos¹¹², general *joint laxity* among female football players was assessed using the modified Beighton test. A score of 4 points or more indicated increased general joint laxity. Increased joint laxity was found to be a significant risk factor for female football injuries¹¹².

Witvrouw et al. investigated the *muscle flexibility* of the hamstrings, quadriceps, adductor and gastrocnemius muscles using a flexometer¹⁴⁸ (Table 1). Male football players with a hamstring (n = 31) or quadriceps (n = 13) muscle injury were found to have significantly lower flexibility in these muscles before their injury as compared with the uninjured group. No significant differences in muscle flexibility were found between players who sustained an adductor muscle injury (n = 13) or a calf muscle injury (n = 10) and the uninjured group¹⁴⁸.

Table 1: Range of motion among female and male football players.

	Söderman (2000) (IV)		Möller (1984) (VI)	Möller (1984) (VII)			Ekstrand (1982) (I)		Witvrouw et al. (2003)		
	Senior female football players (n=62)	Senior female football players (n=78)	Senior male football players (n=48)	Senior male football players with normal ROM (n=20)	Senior male football players with tight muscles (n=26)	Senior male football players (n=10)	Senior male football players (n=180)	Male reference group (n=86)	Senior professional football players (uninjured, n=79)	Senior professional football players (injured, n=67)	p
	Mean ± SD dom/nondom	Mean ± SD dom/nondom	Mean ± SD	Mean ± SD	Mean ± SD	Mean ± SD	Mean ± SD	Mean ± SD	Mean	Mean	
Dorsiflexion (flexed knee)	32.8 ± 6.5 / 32.7 ± 6.0	33.2 ± 5.6 / 32.7 ± 6.0	26 ± 1	26 ± 4		24 ± 4					
Dorsiflexion (straight knee)			23 ± 1	22 ± 2		21 ± 4	21.4 ± 4.0	24.8 ± 4.0	54.3	53.6	ns
Hip extension			84 ± 1	85 ± 3	73 ± 3	81 ± 5	80.9 ± 5.6	85.7 ± 4.6			
Hip flexion	84.3 ± 10.7 / 82.4 ± 9.8	83.7 ± 9.7 / 82.6 ± 9.2	78 ± 1	78 ± 4	68 ± 4	76 ± 8	80.8 ± 7.1	85.7 ± 4.6	94.6	88.1	ns
Knee flexion			142 ± 1	140 ± 6	127 ± 4	140 ± 10	137.2 ± 8.3	146.6 ± 7.5	128.8	120.8	*
Abduction	40.0 ± 5.6 / 40.5 ± 5.6	41.0 ± 6.9 / 41.0 ± 6.7	40 ± 1	37 ± 4	28 ± 3	33 ± 4	33.5 ± 5.5	37.1 ± 4.6	53.3	51.3	ns

Exposure

Practice and games

The distinction between the risk of injuries in games and practice is presented in a number of studies^{11,39,45,48,49,107,112,131}. Female football players seem to have a higher injury incidence during game compared to practice, but the overall injury incidence is also higher compared to male players (male: 3 injuries/1000 practice hours and 13 injuries /1000 game hours⁴⁸ compared to females: 7 injuries/1000 practice hours and 24 injuries /1000 game hours⁴⁹). The majority of traumatic injuries for male players occur during games and are equally distributed between the first and second halves with predominance toward the end of each halves⁴⁸.

Söderman et al. found the injury incidence to be 1.5 /1000 practice hours and 9.1 /1000 game hours comprising an overall injury incidence of 6.8 /1000 hours of football¹³¹. In a study of 123 senior female football players, Östenberg & Roos found that 47 players sustained 65 injuries during the competitive season¹¹². Furthermore, the total injury incidence was 3.7 injuries /1000 practice hours and 14.3 /1000 game hours¹¹².

Tournaments

The incidences of injuries are most often higher during tournaments and camps than that reported for studies of injuries during ordinary football competitions^{63,70,71,125}. The injury incidence among youth players varies between 4.4-32.0 injuries/1000 football hours for girls and 3.6-19.1 for boys^{3,108,124}.

The overall injury incidence for women during the World Cup in 1999 was 38.7/1000 game hours. An increase was noted during the Olympic Games of 2000 and 2004 (64.6/1000 game hours and 105.0/1000 game hours, respectively)^{70,71}.

Camps

Training camp for male players in the preparation period for a competition was associated with an injury incidence of almost three times the risk of injury in practice during the competition period³⁹. No comparative data for adult females have been found.

Indoor football

In Sweden, indoor football is a part of the preseason training. There are several tournaments on artificial turf or in gymnasiums. The rules and size of the field differ from time to time. Therefore, it is very hard to compare different studies conducted during these tournaments. The location of injuries and the types of injuries were quite similar to those seen in outdoor football, but the injury incidence was shown to be higher, with ankle sprains being the most common and knee ligament injuries representing the most severe^{9,49,63,107}.

Surface

The use of artificial turf is a current topic of discussion^{44,110}. One study found significantly more injuries on artificial turf than on grass or gravel in correlation to the number of hours in games and practice⁶.

Menstruation cycle

A normal menstruation cycle varies between 24 to 35 days¹⁴⁰ and is divided into four phases; menstruation phase; pre-ovulatory phase; post-ovulatory phase and pre-menstrual phase. The menstruation phase is from the first day of the menstrual bleeding and 7 days forward. The pre-ovulatory phase is from the end of the menstruation phase until the beginning of the post-ovulatory phase. The number of days in this phase varies between 3-14 days. The post-ovulatory phase is 14 days before the next menstrual bleeding and 7 days forward. This phase starts with ovulation that is defined to take place 14 days before the menstruation bleeding. The pre-menstruation phase is the phase 7 days before menstruation¹⁴⁰. Each phase is thus 7 days except for the pre-ovulatory phase that varies.

Some of the hormones that exist in the menstruation cycle are estrogen, progesterone, relaxin, FSH (follicle stimulating hormone) and LH (luteinizing hormone). Of these hormones, estrogen, relaxin, FSH and LH has its highest concentration around day 12, just before ovulation. Estrogen and relaxin has another peak around day 21. At this time the progesterone concentration is also high¹⁵⁰. Testosterone levels also varies during the menstrual cycle, with an increase in the ovulation phase¹¹⁸.

Amenorrhea is a physiological or pathological change of the menstrual cycle⁸⁶. It means that the menstruation bleeding does not appear¹⁴⁰ and can for example be a result of extreme hard physical training²⁶. Oligomenorrhé is defined as abnormal length (>35 days) between the menstruation phases⁸⁶, often without ovulation¹⁴⁰ and often associated with lower estrogen concentration than normal during the entire menstrual cycle. There seems to be a correlation between low body fat percentage and amenorrhea/oligomenorrhé⁹⁵. The average body fat level in normal female is 29% while female elite football players have 20 to 22% body fat^{25,28,29}.

Sport performance is complex. The ongoing hormonal activity for the female athlete is one factor that can contribute to differences in performance between male and female athletes^{78,80,99,100,106,113,114,150}. Components that probably are affected by the menstrual cycle and its fluctuating hormone levels are motoric psychology (eye/hand coordination and cognitive factors - treating information from our senses), sensor motoric components (reaction time), sensory perception (level of pain), neuromuscular functions such as strength, cardiovascular factors (heart frequency and volume) as well as metabolic factors (body temperature, oxygen uptake) and aerobic/anaerobic capacity⁸⁰. A decrease of in any of above mentioned capacities could increase the risk of injury^{27,99,100,106,113,150}.

Variations of sex hormones in the menstrual cycle seem to have an effect on the performance of knee joint kinesthesia and neuromuscular coordination⁵⁷. In a study of 25 healthy active women an impaired knee joint kinesthesia was detected in the pre-menstrual phase and the performance of square-hop test was significantly improved in the ovulation phase compared to the other phases⁵⁷.

In a recent thesis, a significant variation in knee joint kinesthesia, neuromuscular coordination and postural control during the menstrual cycle was demonstrated, while no differences in muscular strength or endurance were observed. The conclusion was that impaired neuromuscular performance and balance may contribute to the increased incidence of sports injuries in female athletes⁵⁴.

Fridén et al. investigated muscle strength and endurance among 15 moderately active female university students for 2 consecutive menstrual cycles and found no significant variation in muscle strength or muscle endurance during the phases of the menstrual cycle⁵⁵.

Dalton concluded that for females that had been in an accident that had led to hospitalisation, almost half of these accidents occurred during the menstrual phase or the 4 days just before. It was further concluded that the menstrual cycle could be a risk factor for injuries. The explanation could be decreased judgement and decreased reaction time²⁷.

The incidence of ACL injuries is higher among females than among male athletes^{5,49,120}. In the end of the 1990s it was demonstrated that sex steroid receptors are present in the ACL and as a consequence many studies have paid attention to possible hormonal effects on ACL injuries^{88,126,127}. *Estrogen* receptors are found in osteoblast and osteoclast, which are the cells that influence bone tissue. These receptors are associated with osteoporosis later in life¹⁵⁰.

In a study by Liu et al. the influence of estrogen on ACL cellular metabolism was studied⁸⁸. They found that the levels of estrogen in the ACL during the menstrual cycle seem to affect the occurrence of fibroblastic cells in the ACL. Fibroblastic cells produce collagen, a protein that reconstructs connective tissue. They also found that the productions of fibroblastic cells as well as the collagen level were reduced in relation to increasing estrogen levels. The change was significant. Their conclusion was that changes of the estrogen levels in the blood, which appear during a normal menstruation cycle or by influence of oral contraceptive pills containing synthetic estrogen, could cause changes in the fibroblastic metabolism in ACL. The structural changes that do occur could lead to decreased strength in the ligament resulting in injuries⁸⁸. Another study found a high incidence of ACL injuries when the estrogen levels in the blood were high, i.e. during ovulation¹⁵⁰. This finding differs from the study by Mykleburst et al., who found a significant increased injury incidence during the pre-menstrual phase¹⁰³.

Estrogen is also known to affect pain modulation on a spinal level² and the general well being as well¹⁰. As a consequence, the player might be more likely to report injuries during low-estrogen states, i.e. the pre-menstrual/menstrual period of the menstrual cycle.

The knowledge concerning estrogen receptors and the effect of estrogen on bone tissue and muscles is still limited. Post-menopausal low estrogen serum-concentrations have been proposed to be associated with impaired postural control which might be one explanation to that the increased incidence of postmenopausal fractures is shown before osteoporosis has

been developed^{37,104}. In the young female athlete, an impaired postural control during the low-estrogen, pre-menstrual/menstrual phase might instead be reflected as an increased susceptibility to traumatic injuries.

The mechanisms behind changes are not known. Previous studies have suggested that the variation of estradiol and progesterone during the menstrual cycle influence neurological function^{128,129,151}. Increased levels of progesterone metabolites during the pre-menstrual phase are also known to affect various transmitter and hormone systems, thereby affecting the motor function¹³⁰.

The effects of *progesterone* are less studied than estrogen. Progesterone stimulates the collagen synthesis that increases the collagen density¹²². In many ways progesterone has the opposite effect compared to estrogen and the relation between the two is often the effect of the tissues⁸⁰. Neuromuscular coordination, reaction time and other qualities that are important to physical performance are supposed to be negatively influenced by progesterone. In large doses progesterone can cause anaesthesia (reduced sensibility for heat, cold and pain) among humans as well as animals¹⁰⁰.

Normal collagen tissue has hormone receptors for both estrogen and progesterone. The quality of the collagens changes probably, as mentioned before, according to the concentration of estrogen but also according to *relaxin*. The effect of the relaxin hormone might be another explanation to why ACL injuries, according to some, increases around ovulation¹⁵⁰.

Wojtys et al. initially reported more ACL injuries during the ovulatory (high estrogen) phase of the menstrual cycle¹⁵⁰ and they confirmed the results in a bigger study¹⁴⁹. On the other hand, Möller-Nielsen and Hammar⁹⁹, Myklebust et al.¹⁰³ as well as Slauterbeck and Hardy¹²⁷ found a higher incidence of ACL injuries during the low-estrogen phase (just before and during the menstrual period). Karageanes et al. studied knee laxity during three different phases of the menstrual cycle but were not able to conclude any significant differences between the different phases of the menstrual cycle⁷⁴.

Differences in the mechanical properties of ligaments as a consequence of different hormonal concentrations may play a part in the panorama of female sports injuries. Also, the increased frequency of injuries during the low-estrogen, pre-menstrual phase, found by Möller-Nielsen

and Hammar⁹⁹, Myklebust et al.¹⁰³, and Slauterbeck & Hardy¹²⁷ might reflect a difference in postural control.

Pre-menstrual symptoms

Pre-menstrual symptoms (PMS) is defined as physical as well as psychological discomforts during the pre-menstrual phase that disappears at the time of menstruation¹¹³. Most women (75-90%) of fertile age experience cyclical changes during the menstrual cycle, but only 6-10% seek medical help for the symptoms¹³⁹. Cyclic mood changes are present among 25-70% of all women in fertile age⁵³. The psychological symptoms can be defined as change of mood, depression, irritability, headaches, soreness in the breasts, low back pain/discomfort, and general swelling of the body. Fumblingness due to decreased coordination is another common symptom. The cause of PMS is not completely understood, as the symptoms are not clearly associated to the sudden changes in hormonal levels. It has been shown that physical training can influence the PMS symptoms positively¹⁴⁰.

Coordination and motor control are supposed to be influenced by estrogen and progesterone. Women with PMS are likely to be affected^{100,150}. This was also shown by Posthuma et al. in a study of women with and without PMS¹¹⁴. The group of women with PMS had reduced motor control during the pre-menstrual phase in comparison to the group without PMS.

In a recent study of 13 women, the 8 women that were classified as having PMS, were found to have significantly greater postural sway and a greater threshold for passive motion in the knee joint than women without PMS⁵⁶. An impaired postural control during the luteal phase was also found in another study of a group of women with PMS⁵⁸. These findings may be related to previous studies of reported higher incidence of injuries and psycho motoric slowing in the luteal phase and the first days of menses in athletic women^{99,103} and the greater risk of injury among women with PMS^{58,99}.

Oral contraceptive usage

The oral contraceptive pill (OC) contains synthetic hormone steroids containing estrogen and gestagen. The gestagen component is related to progesterone. The oral contraceptive pill inhibits the release of LH and FSH resulting in inhibited ovulation¹⁴⁰.

The most common type of OC are the so called combined pills of which there exist three types; a) the monophasic type with a constant dose of estrogen and gestagen steroid during the cycle; b) the biphasic type with constant dose of estrogen during the whole cycle but with increased gestagen dose post-ovulatory and pre-menstrual; c) the triphasic type with a slightly increased dose of estrogen during the pre-ovulatory phase while the gestagen dose initially is low to increased during the post-ovulatory and pre-menstrual phase⁵³.

The OC pill can exhibit a positive effect as the blood loss is often reduced during menstruation bleeding. The reduced amount of blood could lead to increased amount of haemoglobin and ferritin as well as a reduced activity among the leucocytes that interact with the immune system. This reduction in blood/haemoglobin during menstruation might not influence the normally active female athlete, but it could affect the elite athlete¹⁰⁰.

Many women retain fluid during the pre-ovulatory phase which can lead to an increased body weight of 1-2 kg. For a runner, this could reduce the efficiency with 2-4%. The OC pill could reduce fluid retention and in this way counteract a reduced physical performance¹⁰⁰.

In a 12-month prospective study of 180 football players in the first, second and third divisions, football injuries related to the menstrual cycle and the use of OC was studied⁹⁹. An increase in injury incidence was seen in the pre-menstrual and menstrual period compared to the rest of the cycle. Women with pre-menstrual symptoms such as irritability, sore breasts and/or abdominal/back pain ran a higher risk of traumatic injuries in the pre-menstrual and menstrual phase than women without symptoms ($p < 0.01$). When ignoring the cycle phase, a lower rate of traumatic injury was seen in the group using OC compared with non OC users ($p < 0.05$)⁹⁹.

It is indicated that female football players using OC have less traumatic sports injuries probably due to better neuromuscular coordination among oral contraceptive users due to the

alleviation of certain pre-menstrual symptoms within this group^{99,100}. Oral contraceptives reduce blood-loss during the menstrual period. This tends to give a higher haemoglobin level and hence increased oxygen transport, which is beneficial for the working muscle, thereby increasing the aerobic working time. The estrogen component of OC has a beneficial effect on bone mineral content making the bone stronger and reducing the risk of stress fractures. On the other hand, a possible increase in joint laxity when using OC may be disadvantageous and increase the risk for injury^{99,100}. As the concentrations of female sex hormones vary in a cyclic pattern during the normal menstrual cycle, but are stable during oral contraceptive use, it has been postulated that variations in the exposure to female sex hormones may affect the risk of injury¹⁰⁰.

Nutrition

The energy expenditure during a female football game has been estimated to be approximately 70% VO₂ max, which corresponds to an energy production of around 4600 kJ (1100 kcal)¹⁹. As with male football players, carbohydrate consumption is essential to support demands of playing and training and to facilitate recovery.

In a study of 28 elite female football players called up for the national team, the prevalence of iron deficiency and iron deficiency anaemia were investigated⁷⁹. Haemoglobin, serum iron, serum total iron binding capacity, and ferritin were determined. Of the investigated female football players, 57% had iron deficiency and 29% iron deficiency anaemia 6 months before the FIFA Women's World Cup. The study concluded that iron deficiency and iron deficiency anaemia is common in female football players at the top international level. Some players might suffer from relative anaemia and measurement of haemoglobin alone is not sufficient to reveal this condition.

Epidemiological studies indicate that the incidence of eating disorders has increased considerably in recent years⁸¹. Adolescent girls and women living in societies in which extremely thin bodyweight ideals for female are more often afflicted. Often severely restrictive dieting occurs, which is a risk factor for developing athletic anorexia nervosa or bulimia nervosa. Thus, the occurrence of eating disorders in female athletes may simply be a reflection of more general cultural problems relevant primarily to females, and evident in affluent societies in which food is plentiful. Training and other stress factors associated with

restrictive dieting as well as low body fat level can cause menstrual irregularities and amenorrhea⁵⁰. No studies were found concerning eating disorders in female football players.

Persisting symptoms

For 150 female football players with persistent symptoms from past injuries, mechanical instability of the ankle was shown in 20 players (13%) with previous ankle sprains²¹. Eleven players (7%) with previous knee sprains had persistent symptoms. Four players had persistent instability (positive Lachman test) suggesting an old ACL rupture. Almost 50% of the players who had suffered from shin splints or had a history of iliotibial tract tendinosis still had symptoms. None of the players with previous strains had persistent symptoms. Four out of five players with previous dislocation of the patellae had persistent symptoms²¹.

In a recent German study of 143 female football players, the risk of a new ACL rupture was found to be increased in players with a previous rupture, but this was not the case for ankle or knee sprains⁵².

In a cohort study of female football players who sustained an ACL injury in 1986 (12 years earlier, mean age at injury was 19 years), 67 players consented to have weight-bearing knee radiographs taken as well as answering three patient administered questionnaires (KOOS, SF-36, Lysholm's scoring scale)⁸⁹. The result showed that 69% of the injured players had radiographic changes, and 34% fulfilled the criteria for radiographic knee osteoarthritis. Weekly pain was presented in 33% of the players. Whether surgical treatment was employed or not did not influence symptoms or the prevalence of radiographic changes⁸⁹. Former male football players with long term exposure to football also seemed to be a risk factor for developing osteoarthritis of the knee^{77,119}.

Persistent symptoms and neurological and neuropsychological changes have been studied in active and former male football players¹⁴³. Persistent symptoms such as headache, dizziness, irritability, and impaired memory were common. In a similar study of male football players no signs of chronic brain damage were found⁶². An explanation to the different results between studies could be the different style of play and use of heading by the players from different countries as well as differences in study methodology^{62,93,94,143,144}.

Regional aspects

Since Sweden is a country of vast geographical differences, regional aspects are interesting to study as a risk factor. It is about 1800 km long from north to south, and 500 km wide from east to west. In the north, the western area has a mountain climate while the eastern area has a coastal climate. In the south, the climate is mainly maritime. The annual mean temperature for the northern part of Sweden is 2° C and for the southern part is 7° C (www.smhi.se). In January, when the preseason practices and games begin, the mean temperature in the northern region is -13° C and in the southern region is +2° C. In April, when the league begins, the mean temperature in the north is 0° C, and in the south is +5° C. In July, during the summer break, the mean temperature for both the northern and southern regions is almost the same, i.e. +15-16° C. At the end of the season in October, the temperature in the northern region has fallen to +3° C and to +9° C in the southern region (www.smhi.se).

The cold and long winter, especially in the northern part of Sweden, makes it nearly impossible to practice and play games on grass until late April or the beginning of May. The preseason period in the north therefore consists mainly of technique training indoors in gymnasiums or on artificial surface. When the season starts the natural grass is seldom ready and the games are often played on a gravel surface or artificial turf. The summers are shorter in the north but temperatures do not differ more than a few degrees between the north and south. Games at the end of the season, as in the beginning, are often played on a gravel surface or artificial turf. In the southern part of Sweden the preseason training often takes place outdoors, on a gravel surface. The natural grass season usually starts in March and ends in November. Therefore, regional differences concerning the possibility of playing football do exist.

To my knowledge, no epidemiological study has addressed the regional aspects of injury for female football. In a study on male football players, a difference between proportions of injuries, and that the distributions of several accident games were significantly higher in one district (Drôme-Ardèche) compared to another (Haute Savoie) in the same region in France was reported. However, no relationship between bad or cold weather and risk of injury was found¹⁷.

AIM

Studies have investigated injury incidence among female football players and these studies suggest that there are apparent differences in injury incidence between age groups and between different play-levels. Since Sweden is a country with distinct geographical regions the injury incidences are likely to vary between regions. The aim of this thesis was therefore to investigate injuries and injury incidences among female non-elite players in the second division as well as elite football players in the premiere league in Sweden during an entire football season with special emphases on regional and level differences (I, II).

Range of motion (ROM) in relation to upcoming injuries has been a topic of discussion for many years. The role of ROM as a risk factor of injury for female players is still unclear. In male studies, it has been shown that decreased ROM might lead to strain injuries. Therefore the aim was to investigate ROM at the beginning of the football season to study the relationship to upcoming joint (sprain) and muscle-tendon (strain) injuries (III).

Epidemiological data have provided theoretical evidence for the role of female sex hormones in relation to injuries. The relationships between menstruation cycle and football injuries as well as oral contraceptive usage and injuries are still unclear. Studies so far have failed to reach consensus concerning the effects of the different hormonal concentrations during the menstrual cycle, as well as the role oral contraceptive usage plays. Therefore, the aim was to investigate if the injury incidence in a group of female football player varies during the different phases of the menstrual cycle and if there was a difference in injury incidence according to contraceptive pill usage (IV).

SUBJECTS

Thirty-two teams from two different league levels – the second division (20 teams) and the premiere league (12 teams) in Sweden were invited to participate in this prospective cohort study. Thirty teams accepted the invitation (18/20 teams, comprising 253 players, from second division and 12/12 premiere league teams, comprising 269 players; 522 players in all). For each team in the second division the coach or trainer selected the best team (group of 15 players) at the time to participate in the study. For the premiere league, all players in the team were studied (Figure 2).

All 522 players were studied prospectively during a whole football season in regard to football exposure and upcoming injuries (I, II) (Figure 2).

Of all 522 players included in the study 455 players (87%) – 252 in second division and 203 players in premiere league, were measured for ROM before the start of season. The players were all examined within a 6-week period before the start of their football season. All 455 players were studied prospectively during the entire football season in regard to football exposure and upcoming injuries (III) (Figure 2).

A total of 319 players (61%) registered menstrual periods and oral contraceptive usage during the entire or part of the investigated year. All 319 players were studied prospectively during the entire football season in regard to football exposure and upcoming injuries (IV) (Figure 2).

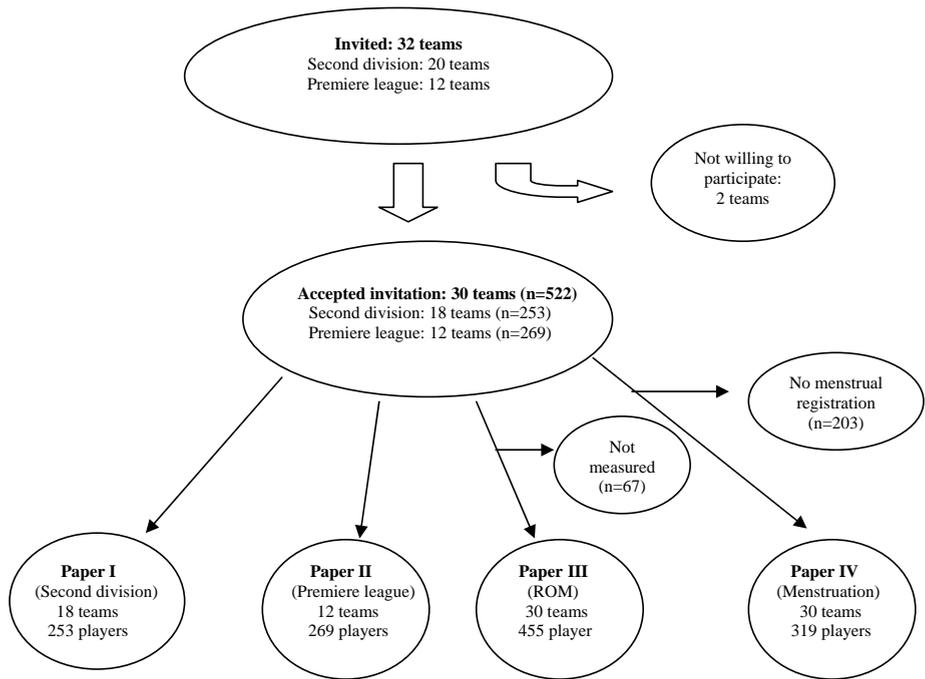


Figure 2: Study groups.

Dropouts

In the study of injuries in the second division 55 players quit playing football due to varying circumstances such as moving (n = 20), loss of interest (n = 11), injury (n = 7), did not agree with the coach (n = 7), pregnancy (n = 3), work (n = 2), change of team (n = 2), studies (n = 1), travel (n = 1) and choice of other sport (n = 1). These 55 players were included in the study until their individual time of drop-out. At the end of the study period 198 players (78 %) remained (I, III).

In the studies of players in premiere league (II, III) one team (27 players) chose to drop out after participating for two months of the investigational period. After six months, another team (18 players) did not want to continue to register and report injuries, thereby leaving 224 players.

During the season, another 29 players quit playing football in the premiere league due to varying circumstances such as injury (6), moving to USA to play football (4), work (3), loss of interest (2), physical complaints (2), disagreements with the team/coach (2), not making the team (2) or unknown reasons (8). At the end of the season, 195 players of the original 269 (72%) remained (II, III).

In the study of menstruation and oral contraceptive usage (IV), a total of 319 players (319/522, 61%) registered menstrual periods during the entire or part of the year. Forty-two players (42/319, 13 %) registered menstruation periods only part of the year. These 42 players were included in the study until individual time of dropout.

METHODS

At the beginning of the season in 1998 (second division) and in 2000 (premiere league), the author visited all of the teams to give a presentation and inform about the study. The players all received verbal and written information about the study and gave their informed consent prior to the investigation. After the information, clinical examinations were conducted. All players were examined from the end of November to the beginning of January, all within a 6-week period during their preseason. During the investigated seasons (second division in 1998 and premiere league in 2000) the teams were followed prospectively.

Baseline information

Four hundred-sixty one players (461/522) answered a baseline protocol (Appendix 1) with open questions concerning age, height, weight, regularity of menstruation, usage of medicines, usage of OC, use of cigarettes or snuff, dominant foot, playing position, present physical complaints and disturbing physical complaints. Body mass index (BMI) was calculated as weight (kg)/height² (m). Thereafter the physical examination was conducted. At the time of examination the player had the opportunity to discuss the answers of the baseline information questionnaire with the author.

Range of motion measurements

Passive ROM in the lower extremity was measured by using a flexometer⁴⁷ or a double armed goniometer (hip abduction)¹⁴⁸. The flexometer was adapted to the body with a long or short burdock band. Measurements were conducted bilaterally. The ranges investigated were dorsiflexion of the foot with straight and flexed knee, hip extension, hip flexion, knee flexion, abduction^{41,47} and hip rotation³⁵, as described earlier in the literature (Figure 3-10). The author conducted all the measurements.



Figure 3: Dorsiflexion of the foot with straight knee



Figure 4: Dorsiflexion of the foot with flexed knee



Figure 5: Hip extension



Figure 6: Hip flexion



Figure 7: Knee flexion



Figure 8: Hip abduction



Figure 9: Internal hip rotation



Figure 10: External hip rotation

Practice and game exposure

The players were studied over a period of 10 months that included both the preseason (January -April) as well as the competitive season (April- October) in 1998 (second division) and 2000 (premiere league). In order to study total football exposure for the premiere league players, the women's national team as well as the national team U21 (under 21 years), were also studied.

Participation in club/team scheduled practice and game sessions as well as injuries were registered by the respective trainer/coach using standardized attendance protocols³⁹ (Appendix 2). Individual participation and injuries in the national women's and U21 teams were registered by the physiotherapist for each team.

The attendance protocol was reported once a week from the club teams, or after every national gathering, to the author. The duration of each scheduled practice was approximated to 90 minutes (second division) or 120 minutes (premiere league) and a scheduled game session was 90 minutes. Only football activities were recorded.

In order to minimize bias during data collection the author kept weekly contact by telephone and fax with all teams throughout the whole season.

Injury report

Injuries were reported once a week from the club teams, or after every national gathering, to the author. The reported injured players were interviewed by telephone by the author using a standardized protocol that included location of injury, injury mechanism, type of injury, occasion of injury, playing position, dominant foot, ball contact, foul play, re-injury, medical consultation, treatment, etc.³⁹ (Appendix 3). Injuries occurring during football activities were recorded. Injuries occurring at the end of the investigational period were followed up according to their full duration or up to 18 months beyond the investigational period.

Ethical approval

The study was approved by the Ethical Committee of the Medical Faculty at the University of Umeå (§328/97, dnr 97-278). The medical committee of the Swedish Football Association (SvFF), the teams, the trainers/coaches and the players all received verbal and written information about the study and gave their informed consent prior to the investigation.

Statistics

The statistical procedures were performed with SPSS (Statistical Package for Social Science, SPSS Inc., Chicago, USA, version 11.0) for personal computer. The statistical methods used in the different papers are presented in Table 2. The p-value level for significance was set at 0.05.

Presentation of *descriptive statistics* (e.g. mean age, mean height, etc), has been done in all studies (I-IV). These data describes and summarize the important characteristics of the population studied.

Differences between groups were analyzed using statistical methods to imply the null hypothesis, i.e. that the two population distributions are identical⁹⁸. The *t-test* (also called Student's t-test) was used for comparing a pair of means to detect differences in the location of two normal population frequency distributions. This is based on the assumption that the two populations are normally distributed with equal variances⁹⁸ (I, IV).

When analyzing enumerative data, with non-continuous scale, the *chi square test* was used (I, III, IV). *Fisher's exact test* was used when the samples sizes were small ($n < 30$ and more than 5 samples/group) (I). Research has shown that nonparametric statistical tests are nearly as effective in detecting differences among populations as the parametric methods when normality is satisfied. Furthermore, nonparametric statistical tests may be more powerful in detecting population differences⁹⁸.

Considering the paired-difference within groups concerning assumptions, the *Wilcoxon signed-rank test* (also called Mann-Whitney U test) was used (IV). Under the null hypothesis of no differences in the distributions between the two groups, half the differences in pairs

would be negative and half positive. The Wilcoxon signed-rank test has been found to be almost as powerful as the t-test³⁰.

To examine possible associations or relationships between two variables, the *Pearson bivariate correlation coefficient* was calculated (III).

Injury incidence was calculated as the number of injuries per 1000 hours of football activity occurring during a study period. All calculations were based on individual exposure.

Table 2: Statistical methods used in paper I-IV.

Statistical method	Paper I	Paper II	Paper III	Paper IV
<i>Descriptive statistics</i>	x	x	x	x
Differences between groups				
* <i>t-test</i>	x			x
* <i>Chi-square</i>	x		x	x
* <i>Fisher's exact test</i>	x			
Within groups differences				
* <i>Wilcoxon signed-rank test</i>				x
Correlation				
* <i>Pearson bivariate correlation</i>			x	

RESULTS

Physical characteristics

Physical characteristics of all players are outlined in table 3. The players in the Northern league were significantly younger than those in the Southern league (20 ± 3 vs. 22 ± 4 years) ($p < 0.01$). The mean age of the players in the second division was 21 ± 4 years, which was significantly younger than players in the premiere league (23 ± 4 years, $p < 0.001$). Players in the premiere league were also taller ($p < 0.05$) (Table 3).

Table 3: Age, height, weight and BMI of female football players (n=522).

	North (n=126)		p	Second division (n=253)		p	Premiere league (n=269)		p	Football players (n=522)	
	Mean \pm SD	Mean \pm SD		Mean \pm SD	Mean \pm SD		Mean \pm SD	Mean \pm SD			
Age (yr)	20.3 \pm 3.3	21.7 \pm 4.3	**	21.0 \pm 3.8	23.1 \pm 3.8	***	21.9 \pm 4.0				
Height (cm)	166.3 \pm 5.3	166.4 \pm 5.1	ns	166.4 \pm 5.2	167.9 \pm 5.2	*	167.0 \pm 5.3				
Weight (kg)	60.6 \pm 6.6	61.6 \pm 7.5	ns	61.1 \pm 7.0	62.2 \pm 6.8	ns	61.6 \pm 7.0				
BMI	21.9 \pm 1.8	22.2 \pm 2.5	ns	22.0 \pm 2.2	22.1 \pm 1.9	ns	22.1 \pm 2.1				

* = $p < 0.05$

** = $p < 0.01$

*** = $p < 0.001$

Six players in the Southern league were smokers compared to none in the Northern league ($p < 0.05$) and more players in north had no dominant leg ($p < 0.01$). The most common playing position was midfielder (41%) and most players (87%) were right footed. No differences were found between playing position or dominant foot between the leagues (Table 4).

Table 4: Basic characteristics of female football players (n=461).

	North (n=126)		p	Second division (n=253)		p	Premiere league (n=208)		p	Football players (n=461)	
	n (%)	n (%)		n (%)	n (%)		n (%)	n (%)			
Regular menstruation	119 (94%)	114 (90%)	ns	233 (92%)	183 (88%)	ns	416 (90%)				
Oral contraceptives	66 (52%)	58 (46%)	ns	124 (49%)	95 (46%)	ns	219 (47%)				
Smokers	0 (0%)	6 (5%)	*	6 (3%)	1 (0%)	ns	7 (2%)				
Snuff users	6 (5%)	6 (5%)	ns	12 (5%)	10 (5%)	ns	22 (5%)				
Right footed	102 (81%)	111 (87%)	ns	213 (84%)	186 (89%)	ns	399 (87%)				
Left footed	7 (6%)	10 (8%)	ns	17 (7%)	13 (6%)	ns	30 (6%)				
No dominant leg	18 (14%)	5 (4%)	**	23 (9%)	9 (4%)	ns	32 (7%)				
Goalkeeper	10 (8%)	14 (11%)	ns	24 (9%)	24 (12%)	ns	48 (10%)				
Defender	36 (29%)	48 (38%)	ns	84 (33%)	64 (31%)	ns	148 (32%)				
Midfield	58 (46%)	50 (39%)	ns	108 (43%)	79 (38%)	ns	187 (41%)				
Forward	22 (17%)	15 (12%)	ns	37 (15%)	41 (19%)	ns	78 (17%)				

* = $p < 0.05$

** = $p < 0.01$

Diseases and medication

Ninety-four players (20%) reported to have allergy. Thirty-five of 461 players (8%) reported to have asthma. In the second division 17 of these players (13%) were from the Northern league, and the remaining four (3%) from the southern ($p<0.01$). Another 34 players (7%) reported to have exercise-induced asthma. Six players reported migraine and 3 players had diabetes (Table 5).

Table 5: Diseases among female football players (n=461).

Diseases	Second division (n=253)	Premiere league (n=208)	Total (n=461)
Allergy	45	49	94
Asthma	21	14	35
Exercised induced asthma	18	16	34
Migraine	3	3	6
Diabetes	1	2	3
Psoriasis		1	1
Hepatitis - B		1	1
Adrenogenital syndrom		1	1
"Cystic kidneys"		1	1
Atrial fibrillation		1	1
Thyroidea		1	1
Total:	88	90	178

One hundred and four players (23 %) were on medication prescribed by a physician (OC not included). In all, 39 different medications were prescribed and consisted mainly of bronchi dilatation and non-steroid anti-inflammatory drugs (NSAID).

Range of motion (ROM)

The mean ROM for the female football players is outlined in table 6. Players in the Northern league in the second division were found to be more flexible concerning dorsiflexion of the ankle with straight knee, external and internal hip rotation, hip extension ($p < 0.001$) and flexion of the hip ($p < 0.05$), than players in the Southern league (III).

Players in the second division had greater external and internal hip rotation and extension of the hip ($p < 0.001$) as well as knee flexion ($p < 0.05$) than players in the premiere league (III) (Table 6).

Table 6: Range of motion among female football players (n=455).

	North (n=125)		South (n=127)		p	Second division (n=252)	Premiere league (n=203)	p	Female football players (n=455)
	Mean \pm SD	Mean \pm SD	Mean \pm SD	Mean \pm SD		Mean \pm SD	Mean \pm SD		
Dorsiflexion (flexed knee)	33 \pm 5	33 \pm 7	ns	33 \pm 6	32 \pm 6	ns	33 \pm 6		
Dorsiflexion (straight knee)	33 \pm 6	29 \pm 6	***	31 \pm 6	32 \pm 6	ns	31 \pm 6		
Internal rotation of the hip	45 \pm 7	40 \pm 7	***	43 \pm 7	38 \pm 6	***	41 \pm 7		
External rotation of the hip	51 \pm 9	43 \pm 8	***	47 \pm 10	42 \pm 7	***	45 \pm 9		
Hip extension	22 \pm 6	20 \pm 6	***	21 \pm 6	18 \pm 5	***	20 \pm 6		
Hip flexion	104 \pm 15	100 \pm 13	*	102 \pm 14	103 \pm 13	ns	103 \pm 14		
Knee flexion	148 \pm 10	148 \pm 10	ns	148 \pm 10	146 \pm 11	*	147 \pm 11		
Hip abduction					42 \pm 6		42 \pm 6 ^{a)}		

* = $p < 0.05$

*** = $p < 0.001$

^{a)} n=203

Differences in ROM between age groups were seen. The youngest players (<20 years) had significantly higher ROM than the oldest players (> 23 years) concerning internal, external hip rotation and dorsiflexion of the foot with flexed knee ($p < 0.001$) (III). The total mean range of hip rotation (internal + external) was found to be decreased by almost 10% for the oldest age group compared to the youngest (III).

Exposure

In the second division the teams had 96 ± 17 (72-138) practice sessions and played 37 ± 11 (23-64) games during the season (I). The average individual participation in practice was 65% and in competitive games 63%. No regional differences were seen between the teams (I).

The average individual exposure during practice and games differed between the regions. Players in the north practiced more than players in the south ($p < 0.001$). Northern players had less game hours than those in the south ($p < 0.05$) resulting in more total hours of football ($p < 0.001$) than players in the south (Table 7). The practice to game ratio for both regions combined was 3 ± 4 (north 4 ± 3 ; south 3 ± 5 ; $p = 0.066$).

Table 7: Individual exposure (hours) during the pre-season (1 January - 17 April) and the competitive season (18 April - 4 October). Means with standard deviation (SD) and 95% confidence interval (95% CI).

	North (n=126) Mean \pm SD (95% CI)	South (n=127) Mean \pm SD (95% CI)	p	Total (n=253) Mean \pm SD (95% CI)
Practice				
pre-season	51 ± 20 (48, 55)	38 ± 16 (35, 40)	***	44 ± 19 (42, 47)
competitive season	59 ± 30 (54, 64)	44 ± 20 (41, 48)	***	52 ± 26 (48, 55)
total season	110 ± 46 (102, 118)	82 ± 33 (76, 87)	***	95 ± 42 (91, 101)
Games				
pre-season	8 ± 4 (8, 9)	10 ± 5 (9, 11)	*	9 ± 5 (9, 10)
competitive season	24 ± 12 (22, 26)	27 ± 13 (25, 29)	ns	25 ± 12 (24, 27)
total season	32 ± 14 (30, 35)	37 ± 17 (34, 40)	*	35 ± 15 (33, 36)
Total football				
pre-season	60 ± 22 (56, 63)	47 ± 19 (44, 51)	***	53 ± 22 (51, 56)
competitive season	83 ± 39 (76, 90)	71 ± 31 (66, 77)	**	77 ± 36 (73, 81)
total season	143 ± 56 (133, 152)	118 ± 46 (110, 126)	***	130 ± 52 (124, 137)

* = $p < 0.05$

** = $p < 0.01$

*** = $p < 0.001$

The individual football exposure for players in premiere league is outlined in table 8. In the premiere league, the players in the three highest ranked teams in the league at the end of the season had more practice hours during the preseason than the players in the three lowest ranked teams (111 ± 57 vs. 93 ± 30). The highest ranked teams also had more practice hours (163 ± 76 vs. 121 ± 46) during the competitive season as well as total football hours (321 ± 134 vs. 257 ± 78) during the whole season (II).

In the premiere league younger players in the lower age quartile (< 20 years), had more preseason practice hours (91 ± 39 vs. 86 ± 47), preseason game hours (11 ± 6 vs. 10 ± 7), total

preseason football hours (103 ± 43 vs. 96 ± 53), total practice hours (202 ± 92 vs. 191 ± 116) and total football hours (242 ± 109 vs. 227 ± 135) than players in the higher age quartile (>26 years) (II).

In summary, the studies showed that players in the north played fewer games but practiced more and in total were more exposed to football than players in the south (I). Players in the premiere league were found to be more exposed to football than players in the second division, and national team players were more exposed to football compared to non-national players.

Table 8: Exposure (hours), means and standard deviation (SD), during the pre-season (1 January - 23 April) and the competitive season (24 April - 29 October).

	National team players	Non national team players	Total
	Mean \pm SD	Mean \pm SD	Mean \pm SD
Practice			
pre-season	102 \pm 43	82 \pm 45	86 \pm 45
competitive season	151 \pm 60	96 \pm 69	108 \pm 71
total season	252 \pm 96	178 \pm 104	194 \pm 107
Games			
pre-season	14 \pm 7	9 \pm 7	10 \pm 7
competitive season	38 \pm 13	24 \pm 17	27 \pm 17
total season	52 \pm 16	33 \pm 21	37 \pm 22
Total football			
pre-season	115 \pm 47	91 \pm 50	96 \pm 50
competitive season	189 \pm 68	120 \pm 83	134 \pm 85
total season	304 \pm 107	211 \pm 122	231 \pm 125

Injuries

A total of 130/253 players in the second division (51%) sustained 229 injuries and 129/269 players in the premiere league (48%) sustained 237 injuries. Altogether a total of 466 injuries were studied.

The overall injury incidence was 9.6 injuries/1000 hours of football in the second division (I) and 4.6 injuries/1000 hours of football in premiere league (II).

Players in the north had a higher incidence of injury during game than those in the south (19.5 vs. 7.2/1000 hours, respectively, $p < 0.001$) (II).

No difference in injury incidence was found in the premiere league for players under/over the mean age (23 years). Players in the higher quartile (>26 years) had a higher incidence for ankle injuries during practice sessions (0.3 ± 1.2 vs. 0.0) as well as knee overuse injuries (0.6 ± 1.6 vs. 0.1 ± 0.8) compared to players in the lower quartile (<20 years) (II).

Traumatic and overuse injuries

Fifty-nine percent of all injuries in the second division and 69% in the premiere league were traumatic injuries (I, II). The incidence of traumatic injuries was 3.3 injuries (premiere league) and 5.9 injuries (second division)/1000 hours of football and for overuse injuries 1.3 injuries (premiere league) and 3.7 injuries (second division) /1000 hours (I, II). Both traumatic and overuse injuries occurred mainly during the early preseason and at the beginning of the competitive spring season in the second division (I). Overuse injuries mainly occurred during the preseason and at the beginning of the spring season in the premiere league (II). A total of 66/122 injuries (28-46%) were reoccurring injuries (re-injuries) (I, II).

Type of injury

In the second division the most common type of traumatic injury was sprain (28%) followed by contusion (18%). For players in the premiere league, the most common type of injury was sprains (29%) followed by strains (24%).

Location of injury

The majority of injuries (82-83%) were localized to the lower extremities (I, II). The most common location of injury was to the ankle (96/466), knee (94/466) and thigh (72/466) (I, II). The location for the highest injury incidence was to the knee (1.5 and 2.4 injuries/1000hours), the ankle (0.5 and 2.3 injuries/1000 hours) and to the thigh (0.9 injuries/1000 hours) (I, II).

Sporting time lost

In total, 13-17% of all injuries were classified as slight, 22-39% as minor, 37-39% as moderate and 11-22% as major injuries. Players in the Northern league of the second division had a higher injury incidence concerning moderate injuries than players in the Southern league ($p<0.01$) (I, II). The major injuries occurred often due to trauma and were mainly located to the knee (I, II).

Incidence during practice and games

In the second division the incidence of injury during practice was 8.4/1000 hours and during game was 13.3 /1000 hours. Players in the north had a higher incidence of injury during game than those in the south (19.5 vs. 7.2 /1000 hours, respectively, $p<0.001$) (I).

The injury incidence in the premiere league during practice was 2.7 /1000 hours and during game was 13.9 /1000 hours. The highest injury incidence during practice was to the knee (0.8 /1000 hours) and thigh (0.5 /1000 hours), and during game time was to the knee (4.4 /1000 hours) and head (2.2 /1000 hours) (II). The incidence of head injuries was almost 40 times, and ankle injuries almost 10 times higher during game compared to practice sessions (II).

Injuries in relation to range of motion

A total of 455 players (87%) were measured for passive ROM in the lower extremity. Of these, 48 players received a total of 83 strain injuries during the upcoming football season, mainly to the thigh (n=41) and hip/groin (n=10). Eighty-eight players received 110 sprain injuries during the upcoming football season mainly to the ankle (n=67) and to the knee (n=29). Players with decreased/increased ROM at the start of the season did not have a different injury incidence than players with “normal” ROM. Thus, this study did not show that preseason ROM measurements can identify players at risk for upcoming joint (sprain) or muscle-tendon (strain) injuries of the lower extremity. Differences in ROM were seen between the players in different league levels and between different age groups (III).

Menstruation cycle in relation to injuries

A total of 319 players registered menstrual periods during the entire or part of the year comprising 2 586 menstrual cycles (IV). The characteristics of the study group are outlined in table 9. Of all 319 players studied, 159 (50%) players received 297 injuries. When analyzing the entire population without regard to contraceptive pill usage, a tendency towards an increase in injury incidence was seen in the pre-menstrual and menstrual period but it was not of statistical significance. No difference in traumatic injury incidence was seen during the menstrual cycle (IV).

Oral contraceptive usage in relation to injuries

Physical characteristics of all players in study IV are outlined in table 9. An increased incidence of injuries was noted during the menstrual phase compared to the pre-ovulatory phase ($p < 0.01$) as well as during the post-ovulatory phase compared to the pre-ovulatory phase ($p < 0.01$) for non-OC users (IV). There were no differences between the OC/non-OC groups concerning injury incidence during practice, game or total football.

In relation to phases, an increased incidence of traumatic injuries was noted during the menstrual phase compared to the pre-ovulatory phase ($p < 0.05$) for non-OC users. There was no difference in total traumatic injury incidence between OC-users and non-OC-users (IV).

Table 9: Characteristics in the population studied (mean, SD, 95% CI).

	A) Menstrual registration (study group) (n= 317)				B) No menstrual registration (n=205)				Differences between group A and B. p	Total (n=522)			
	Total	OC-users	Non-OC- users	p	Total	OC- users	Non-OC- users	p		Total	OC-users	Non-OC- users	p
N (%)	317	162 (51%)	155 (49%)		205	88 (43%)	117 (57%)			522	250 (48%)	272 (52%)	
Age (year, mean, SD)	23 ± 4	24 ± 3	23 ± 5	ns	23 ± 4	22 ± 3	24 ± 4	**	ns	22 ± 4	23 ± 3	23 ± 5	ns
Height (cm, mean, SD)	168 ± 5	167 ± 4	169 ± 5	ns	168 ± 6	166 ± 5	169 ± 5	**	ns	167 ± 5	167 ± 5	169 ± 5	**
Weight (kg, mean, SD)	63 ± 7	62 ± 6	63 ± 7	ns	62 ± 7	60 ± 5	63 ± 8	*	ns	62 ± 7	62 ± 5	63 ± 8	ns
BMI (kg/m2, mean, SD)	22 ± 2	22 ± 2	22 ± 2	ns	22 ± 2	22 ± 2	22 ± 2	ns	ns	22 ± 2	22 ± 2	22 ± 2	ns
Number of injured players	169	89 (53%)	80 (47%)		89	45 (51%)	44 (49%)			258	134 (52%)	124 (48%)	
Number of injuries	311	181 (58%)	130 (42%)		155	65 (42%)	90 (58%)			466	246 (53%)	220 (47%)	
Number of football hours per player - practice (mean, SD, 95% CI)	155 ± 96 (117, 160)	155 ± 100 (133, 176)	154 ± 90 (132, 175)	ns	133 ± 94 (95, 138)				*	149 ± 98 (128, 161)	144 ± 93 (125, 156)	ns	
Number of football hours per player - game (mean, SD, 95% CI)	39 ± 17 (26, 45)	40 ± 17 (37, 44)	40 ± 16 (37, 44)	ns	30 ± 20 (17, 36)				***	37 ± 18 (32, 39)	35 ± 20 (30, 37)	ns	
Number of football hours per player - total (mean, SD, 95% CI)	194 ± 106 (144, 206)	194 ± 111 (170, 217)	195 ± 101 (171, 218)	ns	163 ± 110 (113, 175)				**	185 ± 110 (160, 197)	179 ± 108 (154, 191)	ns	
Practice game ratio (mean, SD, 95% CI)	4 ± 2 (4, 6)	4 ± 2 (4, 5)	4 ± 3 (4, 5)	ns	5 ± 5 (5, 7)				ns	4 ± 3 (3, 5)	4 ± 5 (3, 5)	ns	

* = p < 0.05

** = p < 0.01

*** = p < 0.001

Persisting symptoms

One hundred forty-five players in the *second division* (57%) reported 210 present physical complaints at the beginning of the football season. The most common location of present physical complaints was, in order of magnitude, the spine (17%), ankle (16%), knee (15%), and lower leg (12%) (Table 10).

One hundred thirty-one players (52%) reported 167 physical complaints as disturbing in practice or game. The most common location of disturbing physical complaints was the spine (15%), ankle (15%) and knee (13%). Players in the Northern league had a significantly higher total amount of present and disturbing physical complaints ($p<0.05$), which was mainly due to more complaints from the spine (Table 11).

Ninety-eight football players in the *premiere league* (47%) reported a total of 116 present physical complaints at the beginning of the football season. The most common locations of present physical complaints were the knee (15%), spine (12%), ankle (7%) and foot (7%) (Table 10).

Ninety-seven football players (47%) reported 109 physical complaints as disturbing in practice or game. The most common locations of disturbing physical complaints were the knee (17%), the spine (8%) and the ankle (7%) (Table 11).

Players in the second division had a significantly higher amount of present physical complaints ($p<0.05$), but no differences were found in the total amount of disturbing complaints between groups. Differences in location of both present and disturbing complaints were found (Table 10, 11).

Table 10: Present physical complaints among female football players at the beginning of the season (n=461).

	North (n=126)		P	Second division (n=253)		P	Premiere league (n=208)		P	Football (n=461)	
	n (%)	n (%)		n (%)	n (%)		n (%)	n (%)			
Foot	10 (8%)	3 (2%)	ns	13 (5%)	14 (7%)	ns			ns	27 (6%)	
Ankle	25 (20%)	16 (13%)	ns	41 (16%)	15 (7%)	**			**	56 (12%)	
Lower leg	18 (14%)	13 (10%)	ns	31 (12%)	10 (5%)	**			**	41 (9%)	
Knee	18 (14%)	19 (15%)	ns	37 (15%)	31 (15%)	ns			ns	68 (15%)	
Thigh	3 (2%)	4 (3%)	ns	7 (3%)	4 (2%)	ns			ns	11 (2%)	
Hip, groin	11 (9%)	6 (5%)	ns	17 (7%)	12 (6%)	ns			ns	29 (6%)	
Spine	32 (25%)	12 (9%)	***	44 (17%)	25 (12%)	ns			ns	69 (15%)	
Trunc	8 (6%)	3 (2%)	ns	11 (4%)	1 (1%)	*			*	12 (3%)	
Head	0	0	ns	0	1 (1%)	ns			ns	1 (0.5%)	
Upper extremities	7 (6%)	2 (2%)	ns	9 (4%)	3 (1%)	ns			ns	12 (3%)	
Total number of injuries	132	78	*	210	116	*			*	326	
Total number of injured players	83 (66%)	62 (49%)	*	145 (57%)	98 (47%)	*			*	243 (53%)	

* = p < 0.05

** = p < 0.01

*** = p < 0.001

Table 11: Disturbing physical complaints among female football players at the beginning of the season (n=461).

	North (n=126)		P	Second division (n=253)		P	Premiere league (n=208)		P	Football (n=461)	
	n (%)	n (%)		n (%)	n (%)		n (%)	n (%)			
Foot	7 (6%)	1 (0%)	ns	8 (3%)	11 (5%)	ns			ns	19 (4%)	
Ankle	21 (17%)	18 (14%)	ns	39 (15%)	15 (7%)	**			**	54 (12%)	
Lower leg	13 (10%)	9 (7%)	ns	22 (9%)	9 (4%)	ns			ns	31 (7%)	
Knee	17 (13%)	15 (12%)	ns	32 (13%)	36 (17%)	ns			ns	68 (15%)	
Thigh	1 (0%)	3 (2%)	ns	4 (2%)	4 (2%)	ns			ns	8 (2%)	
Hip, groin	8 (6%)	6 (5%)	ns	14 (5%)	13 (6%)	ns			ns	27 (6%)	
Spine	28 (22%)	11 (9%)	**	39 (15%)	16 (8%)	*			*	55 (12%)	
Trunc	3 (2%)	2 (2%)	ns	5 (2%)	1 (1%)	ns			ns	6 (1%)	
Head	0	0	ns	0	1 (1%)	ns			ns	1 (0.5%)	
Upper extremities	3 (2%)	1 (0%)	ns	4 (2%)	3 (1%)	ns			ns	7 (1.5%)	
Total number of injuries	101	66	*	167	109	ns			ns	276	
Total number of injured players	76 (60%)	55 (43%)	*	131 (52%)	97 (47%)	ns			ns	228 (49%)	

* = p < 0.05

** = p < 0.01

Team management

At the end of the season, all coaches were asked about the football team management the players had had access to during the season, i.e. medical personnel, football education level for the head coach/trainer as well as if the teams had any contracts and/or economical beneficial agreements with the players.

In *second division* all teams had a head coach and more than half of the teams also had an assistant trainer. A majority had a team organizer but only one out of three had access to a trainer for the goalkeeper. Two teams had access to a physician and 8 of 18 teams did not have access to any kind of medical trained personnel (physician, physiotherapist, masseur, etc.). Two head coaches were on the 4th education level and 6 coaches were on 3rd education level. Only 4 teams had any kind of contract with the players and no clubs had any kind of economical benefits (Table 12).

Table 12: Team management in second division.

Club	Trainer/coach	Ass. trainer	Trainer for goalkeeper	Team manager	Equipment manager	Mental coach/psychologist	Specific physical trainer	Physician	Physiotherapist	Naprapath	Chiropractor	Nurse	Masseur	Total no staff	Level of football education for head coach	Contract	Economical benefits
1	1	1	1	1	1	0	0	0	0	0	0	0	0	5	4	0	0
2	1	0	0	1	0	0	0	0	0	0	0	1	0	3	2	0	0
3	1	0	0	1	0	0	0	0	0	0	1	0	0	3	2	0	0
4	1	1	0	1	1	0	0	1	0	0	0	0	0	5	3	1	0
5	1	1	0	1	0	0	0	0	1	0	0	0	0	4	2	1	0
6	1	1	0	0	1	0	0	0	0	0	1	0	0	4	1	0	0
7	1	0	1	1	0	0	0	0	0	0	0	0	0	3	3	0	0
8	1	1	0	0	0	0	0	1	0	0	0	0	0	3	3	1	0
9	1	1	1	1	0	1	1	0	1	0	0	0	0	7	4	1	0
10	1	1	0	1	0	0	0	0	0	0	0	0	0	3	0	0	0
11	1	0	0	1	0	0	0	0	0	0	0	0	0	2	2	0	0
12	1	1	0	1	0	0	0	0	0	0	0	0	0	3	3	0	0
13	1	1	0	0	0	0	0	0	1	0	0	0	0	3	3	0	0
14	1	0	1	1	0	0	0	0	0	0	0	0	1	4	3	0	0
15	1	0	1	1	0	0	0	0	0	0	0	0	0	3	2	0	0
16	1	0	1	1	0	0	0	0	0	0	0	0	0	3	2	0	0
17	1	1	0	0	0	0	0	0	0	0	0	0	0	2	0	0	0
18	1	0	0	1	0	0	0	0	0	0	0	0	1	3	1	0	0
Total:	18	10	6	14	3	1	1	2	3	0	2	1	2			4	0
Mean/%:	100%	56%	33%	78%	17%	6%	6%	11%	17%	0%	11%	6%	11%	3,5	2,2	22%	0%

In the *premiere league* all teams had a head coach and an assistant trainer. Almost all teams had access to a special trainer for the goalkeeper as well as a team organizer. Almost all teams had access to any kind of therapist (physiotherapist, naprapath, masseur or chiropractor). The level of football education in the premiere league was high. Almost all head coaches were on the 3rd or 4th education level (out of 4 levels). Almost all clubs had contracts with the players as well as economical benefits (Table 13).

Table 13: Team management in premiere league.

Club	Trainer/coach	Ass. trainer	Trainer for goalkeeper	Team manager	Equipment manager	Mental coach/ psychologist	Specific physical trainer	Physician	Physiotherapist	Naprapath	Chiropractor	Nurse	Masseur	Total no staff	Level of football education for head coach	Contract	Economical benefits
1	1	1	0	1	0	0	0	0	1	0	0	0	0	4	0	1	1
2	1	1	1	1	1	0	0	0	0	1	0	0	0	6	3	1	1
3	1	1	0	1	0	0	0	0	0	0	1	0	0	4	3	1	1
4	1	1	1	1	1	0	0	0	1	1	0	0	0	7	4	1	1
5	1	1	1	1	0	0	0	0	0	1	0	0	1	6	3	1	0
6	1	1	1	1	1	1	0	0	1	0	0	0	1	8	3	1	1
7	1	1	1	1	1	0	0	0	0	1	1	0	1	8	4	0	1
8	1	1	1	0	0	0	1	1	1	1	0	0	0	6	3	1	1
9	1	1	1	1	1	0	1	1	1	1	0	0	0	9	4	1	1
10	1	1	1	1	0	0	0	1	1	0	1	0	0	7	3	1	1
Total:	10	10	8	9	5	1	2	3	6	5	3	0	3			9	9
Mean/%:	100%	100%	80%	90%	50%	10%	20%	30%	60%	50%	30%	0%	30%	6,5	3,0	90%	90%

DISCUSSION - RESULTS

Physical characteristics

The average age of elite female football players are reported to range from 20 to 24 years^{28,49,117}. The age of the players in our study was in the same range although players in the Northern league in the second division were significantly younger than players in the Southern league. The reason for this is unclear. It may be due to the urbanization process or different regional cultures.

Diseases and medication

A wide range of diseases is common among football players. This puts special medical demands among the personnel around a football team, especially concerning doping regulations.

One finding was geographical difference in asthma frequency. Lundbäck et al.⁹⁰ in a study of adults, found a prevalence of 7% asthma in northern Sweden (Norrbotten) and 5% in southern Sweden (Skåne). Another study of 20-29 years old non-smoking females showed a prevalence of 9% for asthma, and 23% for exercised-induced asthma¹⁰². Compared to these studies the frequency of asthma among our players was higher in the north, and lower in south. Although the reason for this is uncertain, one explanation could be the environment in connection to the football season. In the north blooming occurs after the season has started, but occurs during preseason training in the south. This could lead to a different selection of players with asthma.

Smokers

Seven of four hundred sixty-one players (2%) stated that they were smokers; one player in the premiere league (1/208) and none of the players in the national teams.

Injuries

The present thesis showed that the incidence of traumatic and overuse injuries varied over the football season (I, II). Traumatic injuries were more common during the early preseason and competitive spring season while overuse injuries were more common during preseason. These findings agree with Engström et al.⁴⁹. Of note in the present study is the different locations of injuries both between traumatic and overuse injuries as well as between regions (I, II).

An injury is often a result of both intrinsic as well as extrinsic factors. We found that regional factors play a role in the injury incidence especially during game.

One of the most common location of overuse injuries in our study was to the lower leg, which could be a result of the constant change of surfaces, especially during preseason. Wearing the appropriate shoes in regard to the surface, and with customized soles that reduces impact, might prevent this.

Another common location of overuse injury was to the spine (low back pain). Both changes of playing surface as well as weak trunk muscles in combination with hormonal fluctuations during the menstrual cycle have been topics of discussion^{21-23,99,100}. Proper prevention programs such as stabilizing trunk muscle training might prevent low back pain problems.

Of note is the high incidence of head injuries during game time. Barnes et al. reported that 43% of the women in their study had experienced some type of head injury during their football careers¹⁴. Special helmets that protect the head have now been introduced and are seen more frequently during international games but scientific evaluations of these helmets are still limited. Headgear is intended to reduce the force of impact so that the symptoms associated with mild head injuries are minimized, and ultimately some slight head injuries could be avoided^{68,82,105}. Headgears were not used by any of the players in the present study. Further studies concerning headgears are necessary before general medical recommendations can be made.

Sporting time lost

The injury severity was divided into four categories - slight, minor, moderate and major⁶¹. The reason for this was to classify the minor injuries into two groups, one likely not to miss a game (1- 3 days) and the other more likely to miss a game (4-7 days). Absence between one week and one month means that the player misses several games, and absence over one month is a sign of a serious injury. This classification does not conflict with other classifications, e.g. minor (1-7 days), moderate (8-28 days) and major (> 28 days)⁴⁶.

Risk factors

Age

In the studies players in the Northern league of the second division were younger than players in the Southern league and the injury incidence was found higher in the north than in the south (I).

As the girl develops into a woman, many physical as well as psychological and behavioural aspects are changing thereby influencing hormones, bone mineral density, coordination, muscular strength, cardiovascular factors, concentration, etc. One or several of these factors might increase the risk of injury. Further studies are needed to investigate age as a potential risk factor in female football.

Play-level

The studies show that play-level might be a risk factor. Players in the second division were found to have a higher injury incidence than players in the premiere league. The location of injuries also differed between play levels (I, II).

Östenberg & Roos¹¹² studied 123 players from five different league levels and Söderman et al.¹³¹ studied 175 players from the recreational level to the premiere league. Engström et al.⁴⁹ studied one team in the premiere league and one team in the third league level. No relations concerning differences in injury incidence due to play-level were presented in these studies.

Differences in injury incidence in female football players related to play-level need to be further investigated.

Range of motion (ROM)

The present study showed no relation between ROM and upcoming sprain and strain injuries (III). Furthermore, it was shown that female football players appear to have greater ROM in lower extremity than that reported for male players. In a recent study of 249 male football players, a significant association between pre-season hamstrings muscle tightness and subsequent development of a hamstrings muscle injury was found¹⁴⁸.

When using the term *ROM* the measured movement is often a result of the flexibility of joint structures (e.g. capsules, ligaments, cartilage and meniscus), the length and flexibility of the muscles surrounding the joint as well as hypertrophy antagonistic muscles blocking the movement (e.g. hamstrings when testing knee flexion)⁶⁹.

The term *joint laxity* is often used for measuring the movement that is increased by the passive joint structures such as capsules and ligaments. These tests are mainly performed with the surrounding muscles and/or passive structures at ease, also called loose packed position (e.g. when testing knee stability with the Lachman test). One method commonly used in studies, where a score indicates increased general joint laxity, is the Beighton method¹⁶.

The *muscle flexibility* term refers to the possibility to measure the flexibility of the muscle without the influence of passive structures such as capsules and ligaments.

Since different terms are used to describe movements of extremities, comparisons between studies are difficult to do^{35,40,41,47,101,135,148}. Therefore it is important to carefully describe the methods used in the study.

Exposure

The participation rate in football was lower than expected (66%), considering that these were premiere league as well as second division players. These results are, however, exactly in accordance with studies on male players on recreational level (66%)^{40,42}, but lower than a study of male elite football players (79%)⁴⁸.

Incidence during practice and games

Even though players in the north had a higher injury incidence per 1000 hours of football, especially during games, the present study found no difference in practice/game ratio between the players from the two regions. The practice/game ratio has been discussed in male football studies, and a high practice/game ratio appears to be beneficial to injury incidence^{42,61}. This was not shown in this thesis; the reason for this gender difference is unknown.

The incidence of injury was 2.7 to 8.4 injuries /1000 hours of practice and 13.3 to 13.9 injuries /1000 hours of game. This differs partly from Östenberg & Roos¹¹² (3.7 and 14.3/1000 hours for practice and game, respectively), Söderman et al.¹³¹ (1.5 and 9.1, respectively), Faude et al.⁵¹ (2.8 and 23.3, respectively) and Engström et al.⁴⁹ (7 and 24, respectively) (Table 14). These differences could be a result of differences in study design such as age groups, playing level as well as ways of calculating injury incidence.

The development within the sport over time could be another explanation. It should be noted that there are over 10 years between the Engström study⁴⁹ and the studies by Östenberg & Roos¹¹², Söderman et al.¹³¹, Faude et al.⁵¹ and the present studies.

Table 14: Injury incidence among female football players.

Authors	Play level	Study period	Injury definition	Number of players	Age of players	Injuries / 1000 hours			Injury severity (%)			
						Practice	Game	Total	Slight	Minor	Moderate	Major
Jacobson & Tegner	Premiere league	January - October (entire season)	All football related injuries causing absence from at least the following practice and/or game session.	269	16-36	3	14	5	17	22	39	22
Jacobson & Tegner, 2006	Second division	January - October (entire season)	As above	253	15-38	8	13	10	13	39	37	11
Faude et al., 2005	National league	August - June (outdoor season)	All football related injuries that limited athletic participation for at least the the day after the onset.	165	mean: 22 yrs	3	23	7	51		36	13
Söderman et al., 2001	Premiere league to recreational level	April - October (outdoor season)	All football related injuries causing absence from at least the following practice and/or game session.	175	14-19	1.5	9	7	34		52	14
Östenberg et al., 2000	Premiere leagu to sixth league level	April - October (outdoor season)	As above	123	14-39	4	14	?	31		51	18
Engström et al., 1991	First and second league level	January - December (entire season)	As above	41	16-28	7	24	12	49		36	15

Menstruation cycle

One of the findings was the apparent difference in injury incidence during the menstrual cycle in women not using OC (IV). During the menstrual phase both the estrogen and progesterone concentrations in serum are low and it might be speculated that this low-hormone state increases the susceptibility to traumatic injuries. Möller-Nielsen & Hammar, Myklebust et al. and Slauterbeck & Hardy found an increased injury incidence during the menstrual period, but also during the pre-menstrual phase. They suggested that the low estrogen concentrations, together with the occurrence of pre-menstrual symptoms, had negative cerebral effects on postural and neuromuscular control leading to an increased susceptibility to traumatic injuries^{99,103,127}.

Differences in postural control as a consequence of different hormonal concentrations may play a part in the panorama of female sports injuries. Also the mechanical properties of ligaments might be affected by different serum concentration in sex hormones⁵⁴.

The results of this study (IV) therefore support the theory of an increased risk of traumatic injury during low-hormone states.

Oral contraceptive usage

We were not able to demonstrate any significant difference in injury incidence between OC-users and non-users (IV). In a study by Möller-Nielsen & Hammar the authors found that athletes who were on OC had a lower injury incidence concerning traumatic injuries than non-OC users¹⁰⁰. They also discussed if this could be a result of decreased PMS or other factors that influence the physical performance such as joint laxity and neuromuscular control¹⁰⁰. This is an interesting hypothesis, but since we did not study PMS no comments can be made on that matter. PMS might be a risk factor that needs to be further investigated.

Persisting symptoms

Over half the players had at least one disturbing physical complaint which in most cases reduced their physical capacity when the preseason training started. Players in the north had more complaints at the beginning of season, especially foot and low-back complaints. The reasons for these regional differences need further investigations but it may be related to the constant change of surface for players in the north.

Regional aspects

A difference in injury incidence between the regions was found (I). Female football players in the northern region of Sweden had more practice hours, more total football hours and were more prone to injuries than players in the south. The number of total injuries as well as the total injury incidence was higher in the northern region. The northern players also had a significantly higher injury incidence per game and higher incidence of moderate injuries than those in the south. The distribution of injuries also varied between the regions (I).

Studies have tried to investigate extrinsic factors such as playing surface, weather and temperature^{6,17,44,49}. One study found significantly more injuries occurring on artificial turf than on grass or gravel in correlation to the number of hours in games and practice⁶. It has been found that surfaces with artificial turf seem to produce more abrasion injuries than surfaces with natural grass⁴⁴. Other studies did not show any influence of injury incidence due to extrinsic factors such as weather, playing surface or temperature^{17,49}. Since no meteorological data such as temperature, weather condition, etc., were registered in the present study, we do not know if these circumstances were the reason for the regional differences in injury incidence or if other factors such as age or play-level differences, culture, surface, shoes, etc. were involved.

Prevention of football injuries

Injuries seem to be more related to the *type of exposure* than to the amount of activity⁴⁸. Engström et al. suggest that the 2-3 month of decreased activity after the season and the sudden changes in training intensity are not favourable. They also suggest a more generous system of substituting exhausted players at the end of each game, especially at the end of the season, to prevent injuries⁴⁸.

The condition of the *playing surface* is probably an extrinsic factor that could influence the injury incidence. It is of concern that when changing the playing surface, e.g. from grass to artificial turf, studies are undertaken simultaneously.

The efficacy of *free substitution* on the incidence and duration of male football injuries was studied. Free substitution was defined as the possibility to substitute players any time during a match. The result shows no significant difference in injury incidence per 1000 match hours and in injury pattern with free substitution. However, in the substitution group, the duration of minor injuries was significantly lower than in the control group⁷².

Proprioceptive training has been shown to reduce the incidence of ankle sprains in different sports. It can also improve rehabilitation after ACL injuries whether treated operatively or conservatively. A prospective randomized intervention study of 221 female football players investigated whether training on a balance board could reduce the amount of traumatic injuries of the lower extremities¹³⁵. During the competition season, the intervention group performed a special training program consisting of 10-15 min of balance board training in addition to their football practices and games. The results showed no significant differences between the groups. Four of the five ACL injuries occurred in the intervention group, which the authors concluded that balance board training can not prevent ACL injuries. However, re-injuries were lower in the intervention group.

In a similar prospective controlled study of male football players (n=600) the possible preventive effect of a gradually increased proprioceptive training was studied. The proprioceptive training significantly ($p<0.001$) reduce the incidence of ACL injuries²⁴. Since ACL injuries leads to a long absence from sports, and are one of the main causes of permanent sports disability for female players, it is essential to try to prevent them.

Semi-rigid ankle orthosis and ankle disk training in reducing the incidence of ankle sprains in male football players have also shown to be effective. The players using the ankle orthosis had significantly ($p<0.05$) less ankle strains than the controls and the players following the ankle disk program had significantly ($p<0.01$) fewer ankle sprains than the controls¹⁴¹.

In a randomized study of male senior amateur players (n=180), the efficacy of an injury prevention program was studied⁴¹. It comprised (1) correction of training, (2) provision of optimum equipment, (3) prophylactic ankle taping, (4) controlled rehabilitation, (5) exclusion of players with grave knee instability, (6) information about the importance of disciplined play and the increased risk of injury at training camps, and (7) correction and supervision by doctor(s) and physiotherapist(s). The result showed a significant reduction of the total number of injuries ($p < 0.001$)⁴¹.

A *preseason strength training* programme for the hamstring muscle group for 30 elite male football players were studied⁷. The training was performed 1-2 times a week for 10 weeks by using a special device aimed at specific eccentric overloading of the hamstrings. Isokinetic hamstring strength and maximal running speed were measured in both groups before and after the training period and all hamstring injuries were registered during the total observational period of 10 months. The results showed that the occurrence of hamstring strain injuries was clearly lower in the training group (3/15) than in the control group (10/15). In addition, there were significant increases in strength and speed in the training group. These results indicate that addition of specific preseason strength training for the hamstrings, including eccentric overloading, would be beneficial for elite soccer players, both from an injury prevention and from performance enhancement point of view⁷.

Reduced range of motion has been claimed to be a factor for muscle injuries among male football players¹⁴⁸. In this study (III) no such relationship were found.

DISCUSSION – SUBJECTS AND METHODS

Subjects

In order to investigate if there were any *regional differences* concerning injuries and injury incidence, players were chosen from teams purposely from with distinct geographical regions, but on the national level. All teams from the most northern and southern leagues in the second division were therefore selected. The most northern and southern leagues are located in two different climatologically zones with a distance of more than 1700 km between the most northern and southern teams. One team in the study was even situated above the Arctic Circle.

To investigate *play-level differences* all premiere league teams were included. In order to get total football exposure for these players the national female and U21 teams were also included. In this way we were able to study international players (in the national teams) against the non-national team players in the premiere league. Furthermore comparisons of players in the teams in top of the premiere league versus players in teams at the bottom of the league as well as players in premiere league versus players in second division could also be made.

Dropout

Overall, two teams refused to take part in this study. This was mainly due to that they had not yet recruited the team and leaders at the beginning of the study period. In the premiere league all teams accepted but during the study period the leaders of two teams did not have the motivation to fulfil the request of reporting injuries, which resulted in a vast dropout (17%, 45/269).

Of note in our study was the high amount of individual dropouts during the season, i.e. 22% (55/253) in the second division and 11% (29/269) in the premiere league. This is more than reported in other studies^{112,131}. One explanation could be that the players were amateurs with no contracts and thus gave priority to other things.

Methods

When designing this study, reviews of football studies were performed and discussions with football scientists and coaches were conducted. Baseline information protocol, injury protocol from earlier football studies were collected and used, so that the data from the present study would be comparable to other studies.

In the study of menstruation and OC usage, the methodology of modelling the time dependency of injuries was based on four phases where the pre-ovulatory phase could vary in length. The rationale for this division is that the luteal phase is fairly constant (approximately 14 days), whereas the time between the menstrual bleeding and ovulation could vary significantly.

There is a fundamental problem associated with epidemiological studies concerning football injuries. The inconsistent way in which injury is defined and how data are collected and recorded makes conclusions concerning injuries and injury incidences in female, and male, footballers hard to be made, which expresses the need for a consensus⁴³. In 2005, an injury consensus group was established under the FIFA Medical Assessment and Research Centre (F-MARC). The aim was to make a consensus statement to establish definitions and methodology, implementation, and reporting standards that should be adopted for studies of injuries in football and to provide the basis for studies of injuries in other team sports. The work of this group produced a consensus that has now been publicized⁶⁰.

Injury incidence can be calculated on individual-, team or league level. The results of these calculations will differ, which is important to know when comparing data from different studies.

Exposure

In this prospective cohort study we registered all injuries during one entire football season. Similar designs were used by Engström et al.⁴⁹, Östenberg & Roos¹¹² and Söderman et al.¹³¹ registered injuries only during the competitive period (April-October), and not the preseason. Other prospective studies on female football players have mainly registered injuries during cups, tournaments or parts of the season^{3,9,76,91,108}.

To attain the total exposure and injury incidence for all players in the premiere league, we also included players' attendance in the two senior national teams, i.e. women's and U21. It is important when studying injuries in a sport, that the entire season is included as the injury pattern varies over the season.

The optimal study method would be to register the players' exact individual exposure time, which has been done in other studies^{46,61}. Since the team management for female players, on both the elite and the second division level, is far from the team management for male players, the effort of noting individual exposure was found to be over whelming for the coaches (who were usually the ones that in the end reported exposure/injuries every week). After long discussions, the team leaders and the author decided to approximate the exposure as described. Approximation of time could lead to over/underestimation of injuries. This is a weakness to account for.

Injury report

Since the distances between investigators and teams were far, and since female players /teams seldom have access to medical personnel, no clinical investigation of the injuries could be made. In order to minimize this collecting bias the telephone interview followed a standardized protocol and was performed by the author exclusively.

Another bias with the injury definition used in our study is that teams on this level (second division) practice 2-3 times per week and a minor injury causing interruption, medical care and absence for a couple of days but not from the following practice or game, would therefore not be recorded.

CONCLUSIONS

In the present thesis evidence is presented that *regional factors* are associated with injury incidence. Female football players in the northern region of Sweden were younger, had more practice hours, more total football hours and were more prone to injuries than players in the south. The number of total injuries as well as the total injury incidence was higher in the northern than in the southern region. The northern players also had a significantly higher injury incidence per game and higher incidence of moderate injuries than players in the south. The distribution of injuries also varied between regions. The thesis shows that it is of concern in epidemiological studies that age and regional aspects are taken into consideration.

Injury incidence and pattern differed between the two studied *play-levels*. Players in second division had higher total injury incidence mainly due to higher incidence during practice than players in premiere league. More than half of the injuries in second division were a minor injury (absence < 7 days) while almost every fourth injury in premiere league was a major injury (absence > 30 days).

Normal ROM for female football players is described. This study was not able to determine that preseason ROM measurements can identify players at risk for upcoming joint (sprain) or muscle-tendon (strain) injuries.

There are regional as well as play-level differences in ROM and physical complaints between female football players in Sweden. More than half the players begin their football season with physical complaints, which in most cases disturb her football activity. In other studies persistent injuries have been described as a risk factor for a new injury.

An increased injury incidence during the low-hormone menstrual phase was found. These results support the theory of an increased risk of traumatic injury during low-hormone states. No significant difference in injury incidence between OC-users and non-OC users were found but it appears to be a difference in injury incidence during the menstrual cycle in women not using OC.

PERSPECTIVES

“Physical activity is medicine, the injuries are the side effects”, is an old sports medicine saying. A physiotherapist’s profession is to assist the individual to a physically active life, regardless of age, sex, race, religion, diseases or physical handicap. It is well known that physical activities are important for individuals with high blood pressure, diabetes, overweight, stress related disorders, muscular-skeletal complaints or cardiovascular diseases. It is also well known about the importance of physical activities among young children, as we form our willingness to be active when we are young. The physical education pedagogues spend their entire professional lives trying to introduce children into different physical activities of which they might find one activity that interests the child.

Football is an uncomplicated sport, available for all and at a low financial cost. All you need is some space and a ball (or something that looks like it). As mentioned earlier, football is the largest team sport in Sweden with over 56 000 licensed female players over 15 years of age. The number of players under the age of 15 is estimated to be about the same. This means that around 100 000 girls/females in Sweden are physically active playing football.

“Football is not a sport, it’s a knee disease” and *“It is dangerous for females to play football”* are commonly heard expressions. But studies have shown that the injury incidence is similar for male and female football players, while female players seem to have more risk factors.

In addition there are the *gender aspects*. Most players in Sweden on the elite level practice 6-10 times and play 1-2 games per week; for players in the second division these are slightly less. To maintain a consistent balance between energy intake and expenditure, correct and sensitive nutritional counselling is essential for players and coaches. This is especially important for female football players who often have limited time available to prepare and consume meals, due to the constraints faced by having to combine football practices and games with full-time occupations, cleaning, doing the laundry and socializing with family and friends.

In case of an injury the female players have relatively seldom access to medical personnel within the team. Several players, especially in the second division, stated that they do not seek medical consultation at all in the case of a minor, moderate or even major sports injury due to

earlier bad experiences. This could be another risk factor for a new injury or a re-injury. If football clubs have access to sports medicine physicians and/or physiotherapists this might prevent or reduce the number of injuries.

Until we know more about the epidemiology of female football injuries, we have limited possibilities to prevent them. When the injury consensus group was established under the FIFA Medical Assessment and Research Centre the aim was to establish definitions and methodology, implementation, and reporting standards that should be adopted for studies of injuries in football and to provide the basis for studies of injuries in other team sports. The optimal methodologies require medical personnel (physicians) in the teams to examine and diagnose the injuries, which is far from reality for female players today. But this consensus can serve as a guideline for studies of female players. Studies concerning injuries among female football players are necessary to conduct to make football as joyful as possible, because having an injury is no fun!

The presented studies in this thesis have, as have other studies, confirmed that injuries in female football are complex. The risk of injury is often multi-factorial which makes prevention programs difficult to formulate and evaluate. The association between the menstruation cycle phases and injuries needs further investigation. During the days just before menstruation and during the first days of the menstruation phase, the player might have to be aware of the other injury risk factors.

As a sports medicine specialised physiotherapist it is my duty to make sure that all female individuals that are physically active in playing football can continue to play as safely as possible. Therefore, prevention programs must be formed and evaluated so that “*Physical activity is medicine*” will become a true picture of the reality.

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SVENSK SAMMANFATTNING

Bakgrund

Fotboll är en populär lagsport som utövas av cirka 40 miljoner kvinnor i mer än 100 länder. I Sverige är damfotboll den största lagsporten med fler än 56 000 utövare.

Syfte

Syftet med denna avhandling var att studera skador och skadeincidens bland svenska damfotbollspelare i division II och allsvenskan under en hel fotbollssäsong med speciell inriktning mot regionala och nivå skillnader; att undersöka rörlighet (ROM) i början av säsongen i förhållande till blivande led (stukningar) och muskel/ledbands (sträckningar) skador under säsongen; att studera om skadeincidensen varierar under menstruationscykelns olika faser samt om det förekommer någon skillnad i skadeincidens i förhållande till användandet av p-piller.

Material och metod

Trettio lag med totalt 522 spelare från två olika divisioner i Sverige, division II (18 lag) och allsvenskan (12 lag), studerades under en hel fotbollssäsong. Före säsongen inhämtades basdata och ROM mättes. Under säsongen registrerades menstruation, användande av p-piller, fotbollsexponering samt skador.

Resultat

Totalt inträffade 466 skador. Den totala skadeincidensen var 9,6 skador/1000 fotbollstimmar i division II och 4,6 skador/1000 fotbollstimmar i allsvenskan. Majoriteten av skador var orsakade av yttre våld (59-69 %) och den vanligaste skadan var stukning, huvudsakligen fotledsstukning. Fördelningen av skador varierade mellan regionerna och det totala antalet skador liksom skadeincidensen var högre för spelare i norra än i södra division II. Både olycksfalls- och överbelastningsskador förekom huvudsakligen tidigt på försäsongen samt i början av seriesäsongen.

Ökad/minskad ROM i nedre extremiteten föreföll inte vara en riskfaktor för blivande led (stukningar) och muskel/ledbands (sträckningar) skador i nedre extremitet.

En ökad skadeincidens noterades under menstruationsfasen i förhållande till faserna före och efter ägglossning för icke p-piller användare. Även en ökad skadeincidens av olycksfalls-skador noterades under menstruationsfasen i förhållande till fasen före ägglossning för icke p-piller användare. Ingen skillnad förelåg mellan p-piller användare och icke p-piller användare gällande skadeincidens vid träning, match eller totalt.

Konklusion

Dessa studier har kunnat visa på att regionala faktorer liksom spelnivå kan vara associerade med skadeincidens. Försäongs mätning av ROM kunde ej identifiera de spelare som under säsongen riskerar att ådra sig led (stukning) eller muskel/ledbands (sträckning) skador i nedre extremitet. Ökad skadeincidens konstaterades i menstruationsfasen hos icke p-piller användare men det förelåg ingen skillnad i skadeincidens mellan p-piller eller icke p-piller användare.

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Baseline questionnaire

Name:

Date of birth:

Address:

Phone number (home):

Phone number (work):

Phone number (mobile):

Fax number:

Club:

Height:

Weight:

Regular menstruations: Yes No

Oral contraceptive pill usage: Yes No

Smoker: Yes No

Snuff usage: Yes No

Medications:

Diseases/Allergies:

Present complaints:

Disturbing complaints:

Appendix 2: Participation in practice and game.

Name of player	Month and date													
	1-Jan	3-Jan	5-Jan	8-Jan	10-Jan	13-Jan								
AA	x	x	x	M	x	x								
BB	x	ST	ST	M	x	x								
CC	x	x	x	M	x	x								
DD	x	x	x	M	x	x								
EE	x	x	x	M	x	x								
FF	x	x	x	M	x	x								
GG	x	AO	x	M	x	x								
HH	x	x	x	SM	ST	x								
II	x	x	x	M	x	x								
JJ	x	x	x	M	x	x								
KK	x	x	x	M	x	x								
LL	x	x	x	M	x	x								
MM	x	x	x	M	x	x								
NN	x	x	x	M	x	x								
OO	x	x	x	M	x	x								

- x Present
- M Game
- ST Injured practice
- SM Injured game
- AO Other reason for absence

Injury card**Name:** _____ **Date of birth:** _____**Date of injury:** _____ **Club:** _____**Playing position:** 0 Keeper 0 Defender 0 Midfielder 0 Forward**Dominant foot:** 0 Right 0 Left 0 Right + left**Occasion of injury:** 0 Practice 0 Game**Trauma / overuse:** 0 Trauma 0 Overuse**Mechanisms of injury:** 0 Running 0 Shooting 0 Kicking 0 Heading, body contact
 0 Turning 0 Tackling 0 Heading, no body contact**Ball contact:** 0 Yes 0 No**Foul play:** 0 Yes 0 No**Surface:** 0 Grass 0 Artificial turf __ indoors __ outdoor
 0 Gravel 0 Snow/ice 0 Gymnasium 0 Other _____**Shoes:** 0 Skrew-in cleats 0 Rubber cleats 0 For artificial turf 0 Gravel
 0 Indoor 0 Jogging shoes 0 Other _____**Type of injury:** 0 Laceration 0 Concussion 0 Fracture
 0 Luxation 0 Contusion 0 Strain 0 Sprain
 0 Overuse**Location of injury:** 0 Foot 0 Ankle 0 Lower leg 0 Knee
 0 Thigh 0 Hip, groin 0 Spine 0 Trunc
 0 Head 0 Upper extremities**Side location:** 0 Right 0 Left 0 Bilat.**Re-injury (< 2 months):** 0 Yes 0 No**Re-injury same location:** 0 Yes 0 No**Categorisation of injury:** 0 Slight 0 Minor 0 Moderate 0 Major

Diagnosis: -----

Medical consultation: -----

Treatment: -----

Back in football activity: -----

Comments: -----

ORIGINAL ARTICLE

Injuries among female football players – With special emphasis on regional differences

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Abstract

In this 1-year prospective study, the aim was to investigate if there are any differences concerning injuries and injury incidence during an entire football season between Swedish female football players from different geographical regions. A total of 130 out of 253 players (51%) sustained 229 injuries. The overall injury incidence was 9.6/1000 h of football. The incidence of injury during practice was 8.4/1000 h and during game was 13.3/1000 h. Players in the north had a higher incidence of injury during game than those in the south (19.5 vs. 7.2/1000 h, respectively, $p < 0.001$). Fifty-nine per cent of all injuries were traumatic injuries. Both traumatic and overuse injuries occurred mainly during the early pre-season and at the beginning of the competitive spring season. Of all injuries, 13% were classified as slight, 39% as minor, 37% as moderate and 11% as major injuries. Players in the north had a higher injury incidence concerning moderate injuries than players in the south ($p < 0.01$). In the present study, evidence is presented that regional factors play a role in the injury incidence. Female football players in the north and south have different injury patterns. This could be a result of different conditions for football as a sport between the regions.

Key words: *Injury incidence, soccer, sport injuries, women*

Introduction

Football is one of the most popular team sports in the world. In over 100 countries, women are registered football players (www.fifa.com). In Sweden, football is the most popular female team sport. There are almost 50,000 licensed players (>15 years of age) registered in the Swedish football association that are playing in five different divisions (www.svenskfotboll.se).

Football is a physical game with body contact, which might lead to injuries. For males, football injuries have been analysed in several studies and the injury incidence is higher during game (7.4–37.2 injuries/1000 h) than during practice (1.5–7.6 injuries/1000 h) (1–11). Most prospective studies on female football players have registered injuries during cups, tournaments or a portion of the season (12–20). Injuries during an entire football season have also been studied (21–24). These studies showed the following: injuries are common in female football; injury rates nearly agree with that for male

football; the distribution of injuries disagree with male football; younger female players appear to have different injury rates and location of injuries than adult female players; overuse injuries appear to be more frequent during pre-season; and menstruation and contraceptive pills seem to have an influence on injuries and injury rate.

There is a fundamental problem associated with epidemiological studies concerning football injuries. The inconsistent way in which injury is defined and how data are collected and recorded makes conclusions concerning injuries and injury rates in female football hard to make (25).

Apart from methodological difficulties, there are many factors, both intrinsic and extrinsic, that could explain differences in injuries and injury rates. Regional differences such as climate, culture and/or playing turfs could be factors that influence this risk.

Sweden is a country of vast geographical differences. It is about 1800 km long from north to south, and 500 km wide from east to west. In the north, the

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western area has a mountain climate while the eastern area has a coastal climate. In the south, the climate is mainly maritime. Therefore regional differences concerning the possibility of playing football do exist.

In a previous study, significantly more injuries on artificial turf than on grass or gravel in correlation to the number of hours in games and practice were reported (26). Another study showed a difference between proportions of injuries, and that the distributions of several accident games were significantly higher in one district (Drôme-Ardèche) compared to another (Haute Savoie) in the same region in France (27). However, no relationship between bad or cold weather and risk of injury was found (27). It should be noted that these previously mentioned studies concerned male footballers and to our knowledge, no epidemiological study has addressed the regional aspects of injury for female football.

Aim

In this 1-year prospective study, the aim was to investigate if there are any differences concerning injuries and injury incidence during an entire football season between Swedish female football players from different geographical regions.

Materials and methods

Subjects

The Swedish Football Association (SvFF) classifies premiere league, first division and second division as national levels and administrates these levels. Third and fourth divisions as well as youth female teams are administrated by the district organizations of SvFF.

In order to investigate if there are any regional differences concerning injuries and injury incidence, we chose players from teams with wide range of regions within the league but on national level.

In the second division, there are nine leagues. We selected all teams from the most northern (Västerbotten, Norrbotten) and southern leagues (Skåne, Halland) in the second division, which is the third league level in Sweden. The most northern and southern leagues are located in two different climatologically zones with a distance of more than 1700 km between the most northern and southern teams. One team in the study was even situated above the Arctic Circle.

The annual mean temperature for the northern part of Sweden is 2°C and for the southern part is 7°C (www.smhi.se). In January, when the preseason practices and games begin, the mean temperature in

the northern region is -13°C and in the southern region +2°C. In April, when the league begins, the mean temperature in the north is 0°C, and in the south is +5°C. In July, during the summer break, the mean temperature for both the northern and southern regions is almost the same, +15-16°C. At the end of season, in October, the temperature in the northern region has fallen to +3°C and to +9°C in the southern region (www.smhi.se).

The cold and long winter, especially in the northern part of Sweden, makes it difficult to practise and play games on grass until late April or the beginning of May. The preseason period in the north therefore consists mainly of technique training indoors in gymnasiums or on artificial surfaces. When the season starts, the natural grass is seldom ready and the games are often played on a gravel surface or artificial turf. The summers are shorter in the north but temperatures do not differ more than a few degrees between the north and south. Therefore, games at the end of season, as in the beginning, are often played on a gravel surface or artificial turf. In the southern part of Sweden, the preseason training often takes place outdoors, on a gravel surface. The natural grass season usually starts in March and ends in November.

Of the 20 teams playing in the most northern and southern leagues, 18 teams, consisting of all nine teams from the northern league and nine from the southern, accepted to participate in this study. Two teams in the southern league did not accept the invitation because they were without a coach at the beginning of the study.

The coaches for each team were instructed to select the 15 best, active and non-injured players in their teams to participate in the study (i.e. 18 teams × 15 players = 270 players). At the time of the study, not all teams had completed the recruiting procedure and therefore the 15 best, active, non-injured players were not yet available. One team could not distinguish the best 15 players and therefore selected 16 players for the study. Thus, a total of 253 players were included in the study comprising 11-16 players per team.

Method

The season for football differs around the world. In Sweden, football is mainly a summer sport. The build-up period starts in November and practice games and tournaments start in January. The competitive season starts in April and ends in October.

The investigated period in this study included both preseason (1 January-17 April) as well as the competitive season (18 April-4 October) in 1998.

Before the beginning of the investigation, the first author visited all of the teams to give a presentation and inform them about the study.

Individual participation in club/team scheduled practice and game sessions (presence/time loss) as well as injuries were registered by the respective trainer/coach, using standardized attendance protocols (1) and reported once a week. The duration of each practice and game session was approximated to 90 min (1). The approximation of time to 90 min for scheduled practice sessions was decided after discussions with the coaches and players. Only injuries occurring during football activities were recorded.

The reported injured players were interviewed by telephone shortly after the injury by the first author, a sports medicine specialist, using a standardized protocol that included location of injury, injury mechanism, type of injury, occasion of injury, playing position, dominant foot, ball contact, foul play, re-injury, medical consultation, treatment, etc. (1). No clinical examinations were made. Injuries occurring at the end of the investigation period were followed up according to their full duration or up to 18 months beyond the investigated period.

A problem with prospective studies is maintaining the motivation among the teams to complete the registration during the whole period. In order to minimize this bias during data collection, the first author kept weekly contact by telephone and fax with all teams throughout the entire season.

Definitions

An *injury* was defined as damage to the body sustained during practice or game session causing absence from at least the following practice and/or game session. An injury was defined as *traumatic* if it had a sudden onset associated with a trauma (18,24). An *overuse* injury was an injury where the symptoms had a gradually onset without any known trauma (18). *Sprain* was defined as a ligament injury (1) and *strain* as a distension injury to the muscle-tendon unit (1). *Re-injury* was defined as a new injury sustained within 2 months after an earlier injury at the same bodily location. The player was defined as *injured* until she considered herself able to participate fully in practice and/or game time.

Injuries were categorized as *slight* (absent from practice and/or game 1–3 days), *minor* (absent 4–7 days), *moderate* (absent 8–28 days) or *major* (absent more than 28 days) (28).

Foul play was defined as a situation during game time that was interrupted by the referee and that led to a free kick/penalty kick.

Statistical analysis

The statistical procedures were performed with SPSS (SPSS Inc., Chicago, USA, version 11.0) for personal computer. Standard statistical methods were used to calculate means and standard deviations. Differences between groups were calculated using Student's *t*-test, the chi-square test and Fisher's exact test. The *p*-value level for significance was set at 0.05.

Injury incidence rates (*I*) were calculated according to the formula $I=A/R$, where *A* was the number of injuries during the study period and *R* was the sum of exposure time expressed in 1000 h of football. *Body mass index* (BMI) was calculated as weight (kg)/height² (m).

Ethics

The Ethical Committee of the Medical Faculty at the University of Umeå approved the study. The medical committee of the Swedish football association (SvFF), the teams, the coaches and the players all received verbal and written information about the study and gave their informed consent prior to the investigation.

Results

During the investigating year, 55 players quit playing football related to varying circumstances such as moving (*n* = 20), loss of interest (*n* = 11), injury (*n* = 7), did not agree with the coach (*n* = 7), pregnancy (*n* = 3), work (*n* = 2), change of team (*n* = 2), studies (*n* = 1), travel (*n* = 1) and choice of other sport (*n* = 1). These 55 players were included in the study until their individual time of drop-out. No regional relationships were seen for the group of drop-outs. At the end of the study period 198 players (78%) remained.

For the whole group the mean height was 166 ± 5 (153–179) cm, mean weight was 61 ± 7 (47–90) kg and mean BMI was calculated to 22 ± 2 kg/m². No statistical significant regional differences were seen between the groups except for age. Players in the north were younger than players in the south, i.e. 20 ± 3 (16–31) vs. 22 ± 4 (15–38) years, *p* < 0.01.

For player field position, midfielder was the most common (42%) followed by defenders (34%), forwards (15%) and goalkeepers (9%). Most players were right footed (84%).

On the average, the teams had 96 ± 17 (72–138) practice sessions and played 37 ± 11 (23–64) games during the season. The average individual participation in practice was 65% and in competitive games 63%. No regional differences were seen between the groups.

The average individual exposure during practice and games differed between the regions. Players in the north practised more than players in the south ($p < 0.001$). Northern players had fewer game hours than those in the south ($p < 0.05$) resulting in more total hours of football ($p < 0.001$) than players in the south (Table I). The practice to game ratio for both regions combined was 3 ± 4 (north 4 ± 3 ; south 3 ± 5 ; $p = 0.066$).

Of the 253 players, 130 players (51%) sustained 229 injuries during the season. The total injury incidence was 9.6/1000 h of football. Players in the north had a higher total injury incidence than players in the south (13.0 vs. 6.3, respectively, $p < 0.05$; Table II). Eighty-three per cent of all injuries were localized to the lower extremity. The distribution of football injuries varied between the regions. Players in the north had the highest injury incidence for the knee and ankle, whereas players in the south had the highest injury incidence for the ankle and thigh injuries (Table II). There was equal distribution between the left and right side.

Fifty eight per cent of all injuries occurred during a game. The injury incidence for both leagues during practice was 8.4/1000 h and during game was 13.3/1000 h (Table III). Players in the north had a higher game injury incidence (19.5 vs. 7.2/1000 h, respectively, $p < 0.001$). No differences in injury incidence were seen in relation to playing position. Forty-six per cent of all injuries occurred during ball contact, and 15% of the game injuries were related to foul play.

The injury incidence for overuse injuries to the hip/groin was found to be higher in players from the southern region ($p < 0.05$; Table IV). Fifty-nine per cent (135/229) of all injuries were traumatic injuries. Both traumatic and overuse injuries occurred mainly during preseason and at the beginning of the

competitive spring period (Figures 1 and 2) but were not statistically significant between regions ($p = 0.059$). The most common type of traumatic injury was sprain (28%) followed by contusion (18%) (Table V).

Of 229 injuries, 122 (53%) occurred within the last 2 months of a previous injury in the same bodily location (head, upper, lower extremity and trunk). Almost half of all injuries (46%) were a re-injury at the same bodily location. No regional differences were found concerning playing position, ball contact, foul play or re-injuries.

Of all injuries, 13% were classified as slight, 39% as minor, 37% as moderate and 11% as major. Players in the north had a higher injury incidence of moderate injuries than those in the south ($p < 0.01$) but there were no differences in injury incidence or in different injury location between the two regions. At a follow-up 18 months after a major injury, 17 of 24 players had returned to full football activity.

Discussion

In the present study, evidence is presented that regional factors are associated with injury incidence. Female football players in the northern region of Sweden had more practice hours, more total football hours and were more prone to injuries than players in the south. The number of total injuries as well as the total injury incidence was higher in the northern region. The northern players also had a significantly higher injury incidence per game and higher incidence of moderate injuries than those in the south. The distribution of injuries also varied between geographical regions.

The assessment of data is a problem associated with epidemiological football injury studies. In this prospective cohort study, we registered all injuries

Table I. Exposure (hours) during the pre-season (1 January–17 April) and the competitive season (18 April–4 October).

	North ($n = 126$) Mean \pm SD (95% CI)	South ($n = 127$) Mean \pm SD (95% CI)	p	Total ($n = 253$) Mean \pm SD (95% CI)
Practice				
Pre-season	51 \pm 20 (48–55)	38 \pm 16 (35–40)	***	44 \pm 19 (42–47)
Competitive season	59 \pm 30 (54–64)	44 \pm 20 (41–48)	***	52 \pm 26 (48–55)
Total season	110 \pm 46 (102–118)	82 \pm 33 (76–87)	***	95 \pm 42 (91–101)
Games				
Pre-season	8 \pm 4 (8–9)	10 \pm 5 (9–11)	*	9 \pm 5 (9–10)
Competitive season	24 \pm 12 (22–26)	27 \pm 13 (25–29)	ns	25 \pm 12 (24–27)
Total season	32 \pm 14 (30–35)	37 \pm 17 (34–40)	*	35 \pm 15 (33–36)
Total football				
Pre-season	60 \pm 22 (56–63)	47 \pm 19 (44–51)	***	53 \pm 22 (51–56)
Competitive season	83 \pm 39 (76–90)	71 \pm 31 (66–77)	**	77 \pm 36 (73–81)
Total season	143 \pm 56 (133–152)	118 \pm 46 (110–126)	***	130 \pm 52 (124–137)

Means with standard deviation (SD) and 95% confidence interval (95% CI). * $p < 0.05$; ** $p < 0.01$; *** $p < 0.001$. ns, not significant.

Table II. Injury incidence/1000 h of football in relation to bodily location.

	North (n = 126)		South (n = 127)		p	Total (n = 253)	
	n (%)	Injuries/1000 h	n (%)	Injuries/1000 h		n (%)	Injuries/1000 h
Foot	13 (9)	1.5	11 (13)	0.6	ns	24 (10)	1.0
Ankle	45 (31)	3.0	20 (24)	1.6	ns	65 (28)	2.3
Lower leg	16 (11)	1.3	12 (14)	0.8	ns	28 (12)	1.1
Knee	25 (17)	4.2	10 (12)	0.6	ns	35 (15)	2.4
Thigh	15 (10)	1.0	11 (13)	0.9	ns	26 (11)	0.9
Hip, groin	3 (2)	0.2	8 (9)	0.8	ns	11 (5)	0.5
Spine	19 (13)	1.3	8 (9)	0.7	ns	27 (12)	1.0
Trunk	0	0.0	2 (2)	0.1	ns	2 (1)	0.1
Head	8 (6)	0.5	2 (2)	0.1	ns	10 (4)	0.3
Upper extremities	0	0.0	1 (1)	0.1	ns	1 (0)	0.0
Total	144 (100)	13.0	85 (100)	6.3	*	229 (100)	9.6

* $p < 0.05$. ns, not significant.

during one whole football season. A similar design was used by Engstrom et al. (22). Ostberg & Roos (24) and Soderman et al. (18) registered injuries only during the competitive period (April–October), and not the preseason. Most prospective studies on female football players have registered players during cups, tournaments or parts of the season (12,14–17). Varying study designs make comparisons between studies difficult to make, which could explain the differences in injury incidences reported in the literature (12,14–18,24). The inconsistent way in which injury is defined and how data are collected and recorded expresses the need for a consensus (25).

The mean time for practice sessions was reported to be 90 min. The optimal study method would be to register a player's exact individual exposure time, which has been done in some recent studies (20,28,29). Approximation of time could lead to over- or underestimation of injuries.

Since the distances between investigators and teams were far, and since female players/teams on

this level seldom have access to medical personnel, no clinical investigation of the injuries could be made. In order to minimize this collecting bias, the telephone interview followed a standardized protocol and was performed by the first author exclusively.

A bias with the injury definition used in our study is that teams on this level practice only two to three times per week and a minor injury, causing interruption, medical care and absence for a couple of days but not from the following practice or game, would therefore not be recorded.

Of note in our study was the high amount of drop-outs during the season, 22% (55/253). This is more than reported in other studies (18,24). Reasons for these drop-outs could be that the players were amateurs with no contracts and thus gave priority to other things.

An injury is often a result of both intrinsic as well as extrinsic factors. We found that regional factors, especially during game, play a role in the injury incidence. A few studies have tried to investigate some extrinsic factors such as playing surface, weather

Table III. Injury incidence/1000 h of football in relation to practice and game.

	Practice				Game			
	North (n = 126)	South (n = 127)	p	Total (n = 253)	North (n = 126)	South (n = 127)	p	Total (n = 253)
Foot	1.6	0.7	ns	1.1	1.1	0.5	ns	0.8
Ankle	2.0	1.4	ns	1.7	5.6	2.2	*	3.9
Lower leg	1.4	0.9	ns	1.1	1.1	0.8	ns	1.0
Knee	3.6	0.4	ns	2.0	5.9	1.1	ns	3.5
Thigh	0.6	0.6	ns	0.6	2.2	1.5	ns	1.9
Hip, groin	0.1	1.1	*	0.6	0.5	0.0	ns	0.2
Spine	1.2	1.0	ns	1.1	1.5	0.4	ns	0.9
Trunk	0.0	0.1	ns	0.1	0.0	0.3	ns	0.1
Head	0.0	0.1	ns	0.1	1.5	0.2	ns	0.9
Upper extremities	0.0	0.0	ns	0.0	0.0	0.2	ns	0.1
Total	10.5	6.3	ns	8.4	19.5	7.2	***	13.3

* $p < 0.05$; *** $p < 0.001$. ns, not significant.

Table IV. Injury incidence/1000 h of football in relation to trauma and overuse.

	Trauma				Overuse			
	North (n = 126)	South (n = 127)	p	Total (n = 253)	North (n = 126)	South (n = 127)	p	Total (n = 253)
Foot	0.4	0.2	ns	0.3	1.1	0.3	ns	0.7
Ankle	1.9	1.5	ns	1.7	1.1	0.1	ns	0.6
Lower leg	0.3	0.3	ns	0.3	1.1	0.5	ns	0.8
Knee	3.9	0.4	ns	2.2	0.3	0.2	ns	0.2
Thigh	0.8	0.6	ns	0.7	0.2	0.3	ns	0.2
Hip, groin	0.1	0.2	ns	0.1	0.1	0.6	*	0.4
Spine	0.3	0.2	ns	0.3	1.0	0.5	ns	0.7
Trunk	0.0	0.1	ns	0.1	0.0	0.0	ns	0.0
Head	0.5	0.1	ns	0.3	0.0	0.0	ns	0.0
Upper extremities	0.0	0.0	ns	0.0	0.0	0.1	ns	0.0
Total	8.2	3.7	ns	5.9	4.8	2.7	ns	3.7

*p < 0.05. ns, not significant.

and temperature (22,26,27,30). One study found significantly more injuries occurring on artificial turf than on grass or gravel in correlation to the number of hours in games and practice (26). It has been found that surfaces with artificial turf seem to produce more abrasion injuries than surfaces with natural grass (30). Other studies did not show any influence of injury rate related to extrinsic factors such as weather, playing surface or temperature (22,27).

Since no meteorological data such as temperature, weather condition, etc., were registered in our study, we do not know if these circumstances were the reason for these regional differences in injury rate or if other factors such as age or level differences, culture, surface, shoes, etc., were involved.

Injury incidence is defined as the number of injuries per hours of exposure occurring during a

study period. Numerous studies concerning football injuries for both females and males show that differences in injury incidence in different age groups are apparent (8–10,15,16,18,22,24,31). It could also be the result of other factors such as play-level and regions (18,22,24). The development within the sport over time could be another explanation of variances. The present study shows that it is of concern in epidemiological studies that regional aspects are taken into consideration.

Our study found that players in the north played fewer games but practised more and were in total more exposed to football than players in the south. Even though players in the north had a higher injury incidence per 1000 h of football, especially during games, our study found no difference in practice/game ratio between the players from the two regions.

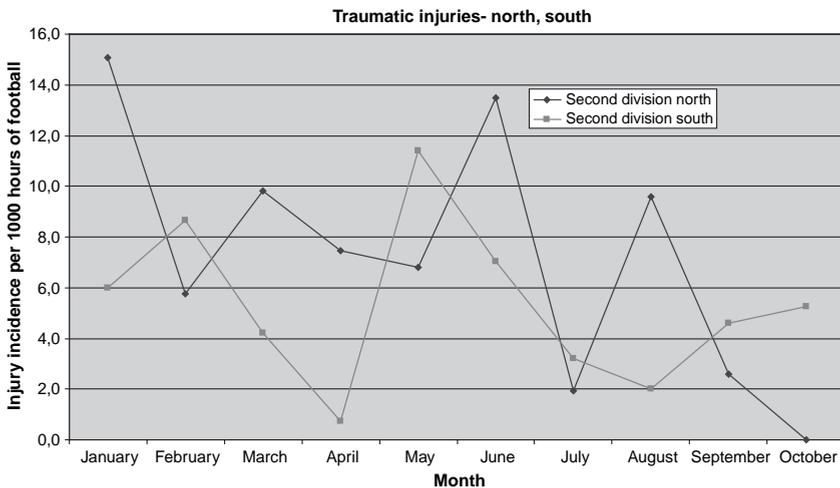


Figure 1. Injury incidence of traumatic injuries over the football season for players in the northern and southern second division. The preseason was from 1 January to 17 April and the competitive season was from 18 April to 4 October.

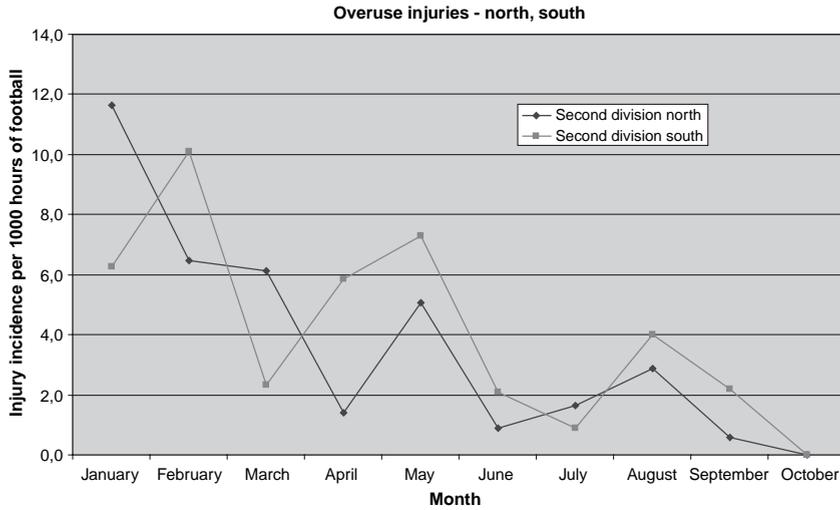


Figure 2. Injury incidence of overuse injuries over the football season for players in the northern and southern second division. The preseason was from 1 January to 17 April and the competitive season was from 18 April to 4 October.

The practice/game ratio has been discussed in male football studies and a high practice/game ratio seems to be beneficial to injury rate (28,32).

The present study showed that 59% (135/229) of the injuries were traumatic injuries. Other studies report slightly higher proportions, between 66% and 78% (18,22,24). The reason for this discrepancy could be the definition of injuries as well as the period studied. Our study showed that the incidence of traumatic and overuse injuries varied over the football season. Traumatic injuries were more common during the early preseason and competitive spring season, whereas overuse injuries were more common during preseason. These findings agree with Engstrom et al. (22). Notable in our study is the different locations of injuries both between traumatic and overuse injuries as well as between regions.

A common traumatic injury for the whole study group was head injury (7%). The most commonly

Table V. Injury incidence per 1000 h of football in relation to type of injury.

	<i>n</i> (%)	Injuries/1000 h
Laceration	1 (0)	0.0
Concussion	7 (3)	0.2
Fracture	5 (2)	0.1
Dislocation	0 (0)	0.0
Contusion	42 (18)	1.3
Strain	15 (7)	0.7
Sprain	65 (28)	3.6
Overuse	94 (41)	3.7
Total	229 (100)	9.6

reported head injury situation is collision with another player or getting hit in the head by the ball (33). The plastic-coated football weighs 396–453 g and the speed of the ball for male football players can reach up to 130 km/h and hit the head with an impact of more than 2000 N (11). No studies on female football players recording head injuries have been found, but in one study, football was found to be the sport most commonly associated with serious head injuries (34). Disturbed neuropsychological function has been reported for male players (2,11,35,36). The long-term effect of these injuries for female players is unknown. Therefore, more studies concerning head injuries in female football, and its consequences, are needed. Special helmets that protect the head have now been introduced but knowledge about their protective effects is limited.

The most common overuse injury in our study was to the lower leg, which could be a result of the constant change of surfaces, especially during preseason. This is a location of an injury that might be prevented by wearing the appropriate shoes in regard to the surface and with customized soles that reduces impact. Another common location of overuse injury was to the spine (low back pain). Both changes of playing surface as well as weak trunk muscles in combination with hormonal fluctuations during the menstrual cycle have been topics of discussion (21,23,37–39). Proper prevention programs, such as stabilizing trunk muscle training, might prevent low back pain problems.

Almost half the injured players were re-injured at the same bodily location within 2 months. Lack of

primary medical consultations as well as poor rehabilitation could be a reason for this.

Most football injuries cause only short absence from football. Over half of the injured players (52%) were back in football activity within 1 week and 89% of the injured players returned to activity within a month. Players in the north had a higher injury incidence of moderate injuries. A reason for this could be the differences in location and types of injuries between the regions.

Our study has shown differences between two leagues situated in two different regions of Sweden. These regions differ in many aspects – climate, cultural, urban/rural population – and all these factors, alone or combined, can contribute to these differences in injury incidence. The reasons for these incidence differences are unclear and need further studies, preferably multidisciplinary.

Acknowledgements

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Injuries among Swedish female elite football players: a prospective population study

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Injury occurrence in all 12 female elite senior football teams in premiere league was registered during 1 year. Of 269 players, 129 (48%) sustained 237 injuries. The total injury incidence was 4.6/1000 h of football. The injury incidence during practice was 2.7 and during the game time was 13.9/1000 h. The highest injury incidence during practice was to the knee (0.8/1000 h) and thigh (0.5/1000 h), and during game time was to the knee (4.4/1000 h) and head (2.2/1000 h). In total, the location for the highest injury incidence was the knee with 1.5 injuries/1000 h of football.

The majority of injuries (82%) were localized to the lower

extremities. Sixty-six injuries (28%) were re-occurring injuries (re-injuries). The incidence of traumatic injuries was 3.3/1000 h of football and for overuse injuries 1.3/1000 h. Overuse injuries occurred mainly during the pre-season and at the beginning of the spring season.

Thirty-nine percent of the injuries were slight or minor causing absence from practice or game time of less than 1 week, 39% were moderate (absence 7–28 days) and 22% were major (absence more than 28 days). The major injuries occurred often owing to trauma and were mainly to the knee.

Football is a popular female team sport played by approximately 40 million women in over 100 countries the world over (www.fifa.com). In Sweden, football is the largest female team sport, with almost 40 000 players (www.svenskfotboll.se).

Several studies have been published during the recent decades regarding injury patterns in male football players (Ekstrand, 1982; Tysvaer & Lochen, 1991; Tysvaer, 1992; Inklaar, 1994a; Chomiak et al., 2000; Dvorak & Junge, 2000), including studies concerning skill-level differences (Poulsen et al., 1991; Junge et al., 2000; Peterson et al., 2000). Inklaar (1994a, b) and Dvorak and Junge (2000) concluded from their reviews of the literature that injury incidence is higher during game time (7.4–37.2 injuries/1000 h) than during practice (1.5–7.6 injuries/1000 h), that 60–90% of all injuries occur in the lower extremities and that incidence of injury increases with age. The causes of injury are believed to be multifactorial, such as intrinsic factors, e.g., joint instability, muscle strength, muscle tightness, body asymmetry, biomechanics, psychological factors, as well as extrinsic factors, e.g., level of play, position on the field, amount and standard of practice/game, equipment, pitch conditions, rules and fair play. Previous injuries and inadequate rehabilitation are also factors to account for (Inklaar, 1994b; Chomiak

et al., 2000; Dvorak & Junge, 2000; Dvorak et al., 2000).

Different injury rates and distribution of injuries have been shown for male and female football players (Nilsson & Roaas, 1978; Ekstrand, 1982; Engstrom et al., 1991; Tysvaer & Lochen, 1991; Tysvaer, 1992; Inklaar, 1994a; Chomiak et al., 2000; Dvorak & Junge, 2000; Ostenberg & Roos, 2000; Soderman et al., 2001).

The injury incidence for female players seems to be lower than for males (Dvorak & Junge, 2000). As for male players, the incidence is higher during game time (9.1–24 injuries/1000 h) than during practice (1.5–7 injuries/1000 h) (Engstrom et al., 1991; Ostenberg & Roos, 2000; Soderman et al., 2001).

Lately, attention has been focused on the higher risk of knee injuries among female football players (Engstrom et al., 1991; Arendt & Dick, 1995; Roos et al., 1995) and on the fact that they sustain their knee injuries at an earlier age (Ostenberg & Roos, 2000). The mean age for sustaining an anterior cruciate ligament injury in female football players is 19 years compared with 23 years among male players (Roos et al., 1995).

In male football players, head injuries account for 4–22% of all football injuries (Dvorak & Junge, 2000). Male players were found to have at least

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double the risk than female players of sustaining a concussion (Barnes et al., 1998).

Injuries among female football players have not been thoroughly investigated. More specifically, prospective studies of the injury incidence over an entire football season in a large group of elite female football players have not been conducted. Such studies are important to be carried out in order to avoid different biases such as recall bias in a retrospective study and bias owing to variation of injuries over the season.

Aim

The aim of this prospective population study was to investigate injuries and injury rates among all Swedish female elite football players in premiere league during an entire football season.

Materials and methods

Materials

All 12 female senior football teams from the premiere league in Sweden were invited to participate in this prospective cohort population study, and they all accepted the invitation. All active players in the teams at the beginning of the football season ($n = 269$) were included in the study and followed until their individual time of dropout. Players recruited to the teams during the study period were not included in the study.

In order to study total football exposure for these elite players, the women's national team and U-21 (under 21 years) the national team, were also studied. The players that, on any occasion, had played on the national women's or U-21 team during the investigated year are referred to as national team players. All other players are referred to as non-national team players.

The studied teams were also divided into two subgroups: the three highest ranked teams in the league at the end of the season compared with the three lowest ranked teams.

Method

In Sweden, football is mainly a summer sport. The training period begins in November and practice games and tournaments start in January. The competitive season starts in April and ends in October. The investigated period in this study included both preseason (January 1 to the April 23) and the competitive season (April 24 to October 29 2000).

Before the beginning of the investigation, the first author visited all the teams to give a presentation and inform them about the study.

Participation in club/team-scheduled practice and game sessions as well as injuries were registered by the respective trainer/coach, using standardized attendance protocols (Ekstrand, 1982). Individual participation and injuries in the national women's and U-21 teams were registered by the physiotherapist for each team.

The attendance protocol was reported once a week from the club teams, or after every national gathering, to the first author. The duration of each scheduled practice was approximated to 120 min and a scheduled game session was 90 min for both national and non-national teams.

The reported injured players were interviewed by telephone by the first author using a standardized protocol that included location of injury, injury mechanism, type of injury, occasion of injury, playing position, dominant foot, ball contact, foul play, re-injury, medical consultation, treatment, etc. (Ekstrand, 1982). Injuries occurring at the end of the investigational period were followed-up according to their full duration or up to 18 months beyond the investigational period.

Definitions

An *injury* was defined as damage to the body sustained during practice or game session causing absence from at least the following practice and/or game session. A *traumatic injury* was an injury with a known trauma.

An *overuse injury* was an injury without any known trauma. *Sprain* was defined as a ligament injury and *strain* as a distension injury to the muscle-tendon unit. *Re-injury* was defined as a new injury sustained within 2 months after an earlier injury at the same bodily location. The player was defined as *injured* until she considered herself able to participate fully in the practice and/or game time.

Injuries were categorized as *slight* (absent from practice and/or game 1–3 days), *minor* (absent 4–7 days), *moderate* (absent 8–28 days) or *major* (absent more than 28 days) (Hagglund et al., 2003).

Foul play was defined as a situation during game time that was interrupted by the referee and that led to a free kick/penalty kick.

Injury incidence was defined as the number of injuries/1000 h of football activity.

Statistical analysis

The statistical procedures were performed with SPSS (SPSS Inc., Chicago, USA, version 11.0) for personal computer. Standard statistical methods were used to calculate means, range and standard deviation. As this was a population study, no hypothesis testing procedure was used to compare groups.

Ethics

The study was approved by the Ethical Committee of the Medical Faculty at the University of Umeå. The medical committee of the Swedish Football Association (SvFF), the teams, the trainers/coaches and the players all received verbal and written information about the study and gave their informed consent before the investigation.

Results

After participating for 2 months of the investigational period, one team (27 players) chose to drop out. After 6 months, another team (18 players) did not want to continue to register and report injuries, thereby leaving 224 players.

During the season, another 29 players quit playing football in the premiere league owing to varying circumstances such as injury (6), moving to USA to play football (4), work (3), loss of interest (2), physical complaints (2), disagreements with the team/coach (2), not making the team (2), or

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unknown reasons (8). At the end of the season, 195 players of the original 269 (72%) remained.

The mean age for the players in this study was 23 ± 4 (16–36) years, height 168 ± 5 (155–184) cm, weight 62 ± 7 (48–98) kg and BMI 22 ± 2 (18–30). Twelve percent of the players were goalkeepers, 29% were defenders, 36% were midfielders and 23% were forwards. Most players were right footed (69%).

On the average, the teams had 140 ± 48 (24–238) practice sessions and played 35 ± 12 (2–48) games during the season. The main difference between the number of scheduled practice and game sessions was a result of dropouts. The average individual participation was 66% both in practice and competitive games.

During the investigated year, 51 players were selected to join the national women's team or the national U-21 team. The national women's team and the U-21 team had 52 scheduled practice sessions and played 23 games during the season. National team

players were taller (170 ± 5 vs 167 ± 5 cm) and had more total football exposure compared to non-national players (Table 1).

The players in the three highest ranked teams in the league at the end of the season had more practice hours during the preseason (111 ± 57 vs 93 ± 30 h) than the players in the three lowest ranked teams. The highest ranked teams also had more practice hours (163 ± 76 vs 121 ± 46 h) during the competitive season as well as total football hours (321 ± 134 vs 257 ± 78 h) during the whole season.

Younger players, in the lower age quartile (<20 years), had more preseason practice hours (91 ± 39 vs 86 ± 47 h), preseason game hours (11 ± 6 vs 10 ± 7 h), total preseason football hours (103 ± 43 vs 96 ± 53 h), total practice hours (202 ± 92 vs 191 ± 116 h), and total football hours (242 ± 109 vs 227 ± 135 h) than players in the higher age quartile (>26 years).

Of the 269 players, 129 (48%) sustained 237 injuries during the season. Sixty-four players received one injury, 44 two injuries, 10 three injuries and 11 players received four or more injuries. Eighty-two percent of all injuries were localized to the lower extremities and equally distributed between the left and right sides.

The incidence of injury during practice was 2.7/1000 h and during game time was 13.9/1000 h (Table 2).

The practice/game ratio was 5 ± 4 . No difference was found between national and non-national team players. Players in the three highest ranked teams had a higher practice/game ratio than players in the three lowest ranked teams (6 ± 5 vs 5 ± 1). Injured players had a higher practice/game ratio than non-injured players (6 ± 4 vs 5 ± 3).

During both practice and game sessions, the knee had the highest injury incidence in relation to location. The incidence of head injuries was almost 40 times and ankle injuries almost 10 times higher

Table 1. Exposure (hours), means and standard deviation (SD), during the pre-season (1 January–23 April) and the competitive season (24 April–29 October) for national team players ($n=51$) vs non-national team players ($n=218$)

	National team players	Non-national team players	Total
	Mean \pm SD	Mean \pm SD	Mean \pm SD
Practice			
Pre-season	102 \pm 43	82 \pm 45	86 \pm 45
Competitive season	151 \pm 60	96 \pm 69	108 \pm 71
Total season	252 \pm 96	178 \pm 104	194 \pm 107
Games			
Pre-season	14 \pm 7	9 \pm 7	10 \pm 7
Competitive season	38 \pm 13	24 \pm 17	27 \pm 17
Total season	52 \pm 16	33 \pm 21	37 \pm 22
Total football			
Pre-season	115 \pm 47	91 \pm 50	96 \pm 50
Competitive season	189 \pm 68	120 \pm 83	134 \pm 85
Total season	304 \pm 107	211 \pm 122	231 \pm 125

Table 2. Incidence of practice and game injuries (injuries/1000 h)

	Practice		Game		Total	
	n (%)	Injuries/1000 h	n (%)	Injuries/1000 h	n (%)	Injuries/1000 h
Foot	7 (6)	0.1	9 (8)	0.7	16 (7)	0.2
Ankle	12 (10)	0.2	19 (16)	2.0	31 (13)	0.5
Lower leg	16 (13)	0.4	9 (8)	1.5	25 (11)	0.5
Knee	29 (24)	0.8	30 (26)	4.4	59 (25)	1.5
Thigh	24 (20)	0.5	22 (19)	1.7	46 (19)	0.9
Hip, groin	12 (10)	0.2	5 (4)	0.4	17 (7)	0.3
Spine	14 (12)	0.3	5 (4)	0.5	19 (8)	0.3
Trunk	3 (2)	0.1	3 (3)	0.2	6 (3)	0.1
Head	2 (2)	0.1	12 (10)	2.2	14 (6)	0.3
Upper extremities	2 (2)	0.0	2 (2)	0.2	4 (2)	0.1
Total	121 (100)	2.7	116 (100)	13.9	237 (100)	4.6

Table 3. Incidence of traumatic and overuse injuries (injuries/1000 h)

	Trauma		Overuse		Total	
	n (%)	Injuries/1000 h	n (%)	Injuries/1000 h	n (%)	Injuries/1000 h
Foot	7 (4)	0.1	9 (12)	0.1	16 (7)	0.2
Ankle	25 (15)	0.4	6 (8)	0.1	31 (13)	0.5
Lower leg	12 (7)	0.2	13 (18)	0.3	25 (11)	0.5
Knee	30 (18)	0.9	29 (39)	0.6	59 (25)	1.5
Thigh	45 (28)	0.9	1 (1)	0.0	46 (19)	0.9
Hip, groin	14 (9)	0.2	3 (4)	0.0	17 (7)	0.3
Spine	7 (4)	0.1	12 (16)	0.2	19 (8)	0.3
Trunk	6 (4)	0.1	0	0.0	6 (3)	0.1
Head	14 (9)	0.3	0	0.0	14 (6)	0.3
Upper extremities	3 (2)	0.1	1 (1)	0.0	4 (2)	0.1
Total	163 (100)	3.3	74 (100)	1.3	237 (100)	4.6

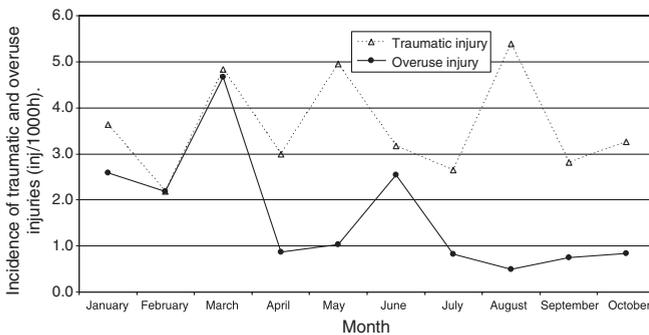


Fig. 1. Distribution of traumatic and overuse injury rate over one football season.

during game compared with practice sessions (Table 2).

No difference in injury incidence was found for players under/over the mean age (23 years). Players in the higher quartile (>26 years) had a higher incidence for ankle injuries during practice sessions (0.3 ± 1.2 vs 0.0) as well as knee overuse injuries (0.6 ± 1.6 vs 0.1 ± 0.8) compared with players in the lower quartile (<20 years).

Most of the injuries were traumatic (163/237, 69%). The incidence of traumatic injuries was 3.3/1000 h of football (Table 3). The highest incidence for traumatic injuries was to the knee and thigh, followed by the ankle and head. The distribution of traumatic injuries over the year is shown in Fig. 1.

The incidence of overuse injuries was 1.3/1000 h of football (Table 3). Overuse injuries were distributed with the highest incidence to the knee, the lower leg, and the spine. Overuse injuries occurred mainly during preseason and at the beginning of the spring season (Fig. 1).

Seventeen percent of all injuries were classified as slight, 22% as minor, 39% as moderate and 22% as major injuries. The major injuries occurred often owing to trauma (33/52) and were mainly to the

knee (30/52). The most common type of major injury was sprain (26/52) and overuse (16/52). The injury incidence in relation to location and severity of injury is outlined in Table 4. At follow-ups 18 months after major injuries, 49 of the 52 players were once again playing football. The three players that were not back within 18 months all had serious knee injuries.

The highest injury incidence in relation to type of injury was in strains, sprains and overuse (Table 5).

Forty-five percent (107/237) of all injuries occurred during ball contact. Forty-nine percent ($n = 116$) of all injuries occurred during game time. Of these 116 injuries, 19% were owing to foul play.

Forwards had the highest injury incidence during both practice and game (3.8 ± 6.8 vs 18.7 ± 38.9), followed by defenders (2.6 ± 6.0 vs 16.2 ± 24.6), midfielders (2.3 ± 7.9 vs 11.8 ± 36.6) and goalkeepers (2.1 ± 4.1 vs 5.2 ± 17.1).

Fifty-eight percent (137/237) of the injuries occurred to the same body part (e.g., same leg) as an earlier injury within the previous 2 months, and 28% (65/237) were re-injuries at the same location.

Seventy-four percent of all re-injuries (48/65) occurred during practice. The re-injuries were overuse injuries (30/65), sprains (15/65), strains (19/65) and a

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Table 4. Injury incidence/1000 h of football in relation to location and severity of injury

	Slight (<i>n</i> = 41, 17%)	Minor (<i>n</i> = 52, 22%)	Moderate (<i>n</i> = 92, 39%)	Major (<i>n</i> = 52, 22%)	Total (<i>n</i> = 237)
Foot	0.0	0.1	0.1	0.0	0.2
Ankle	0.0	0.2	0.1	0.1	0.5
Lower leg	0.1	0.2	0.1	0.1	0.5
Knee	0.1	0.2	0.2	1.0	1.5
Thigh	0.1	0.3	0.4	0.1	0.9
Hip, groin	0.0	0.1	0.1	0.0	0.3
Spine	0.1	0.1	0.1	0.1	0.3
Trunk	0.0	0.0	0.0	0.0	0.1
Head	0.0	0.1	0.1	0.0	0.3
Upper extremities	0.0	0.0	0.0	0.0	0.1
Total	0.6	1.3	1.2	1.5	4.6

Table 5. Injury incidence/1000 h of football in relation to type of injury

	<i>n</i> (%)	Injuries/1000 h
Laceration	3 (1)	0.1
Concussion	9 (4)	0.1
Fracture	3 (1)	0.0
Dislocation	2 (1)	0.0
Contusion	20 (8)	0.4
Sprain	58 (24)	1.3
Strain	68 (29)	1.3
Overuse	74 (31)	1.3
Total	237 (100)	4.6

concussion (1/65). Forty percent of the overuse injuries and 28% of the strain injuries were re-injuries.

Discussion

The principal findings of this prospective population study were the high incidence of knee and head injuries during games, the high number of re-injuries, that the injury incidence for players in teams that had the highest exposure to football (national team players and players from the top three teams) was not different from the injury incidence of their counterparts and that injured players had higher practice/game ratio than non-injured players.

The first step in prevention of sport injuries is to identify and describe the injury incidence. Since the definition of a football injury and the study designs differ between studies (Junge & Dvorak, 2000; Ekstrand & Karlson, 2003), comparisons are difficult to make. The study design we chose has been used in several previous studies (Ekstrand, 1982; Engstrom et al., 1991; Ostenberg & Roos, 2000; Soderman et al., 2001).

Most prospective studies of female football players have registered players during cups, tournaments or parts of the season (Nilsson & Roaas, 1978; Maehlum et al., 1986; Backous et al., 1988; Andreassen et al., 1992; Kibler, 1993; Ostenberg & Roos, 2000;

Soderman et al., 2001). In this prospective population study, we chose to register all injuries during an entire football season in the premiere league. To attain the total exposure and injury rate for all players in the premiere league, we included players' attendance in the two senior national teams, women's, and U-21. Since 2000 was the year of the Olympic Games in Sidney (September 13–28), the national competitive football season took a short break during this time and was therefore prolonged until the end of October.

In order to minimize the collecting bias, a telephone interview followed a standardized protocol and was conducted by the first author.

All teams did not have physicians available to diagnose all injuries. As teams in the premiere league come from all over Sweden, the geographical distance made it impossible for clinical investigations of the injuries by the authors. Therefore, no diagnoses could be established. This is a bias that has to be taken into account.

One of the problems with prospective studies is in maintaining the motivation among the teams to complete the registration appropriately during the whole period. In order to minimize this bias during data collection the first author kept weekly contact with all teams throughout the season. In this study, leaders of two teams did not have the motivation to fulfil the request of reporting injuries. Another 29 players quit during the season, which caused the dropout to be 26% (71/269). This is more than the 13% (22/175) found by Soderman et al. (2001) and Ostenberg and Roos (2000) where no dropouts were reported.

The approximation of time to 120 min for scheduled practice sessions was decided after discussions with the coaches and players on both national and non-national levels. The mean time for practice sessions was reported to be 2 h. The optimal study method would be to register the player's exact individual exposure time, which has been done in some studies (Hagglund et al., 2003; Ekstrand et al.,

2004). Approximation of time could lead to over- or underestimation of injuries.

The participation rate was quite low (66%), considering that these were premiere league players. Our results are in exact accordance with studies on male players on recreational level, 66% (Ekstrand & Gillquist, 1983; Ekstrand et al., 1983), but lower than another study of male elite football players, 79% (Engstrom et al., 1990). The reason for this is unknown. One hypothesis could be that female players are amateurs while male players are professional.

The injury severity was divided into four categories – slight, minor, moderate and major (Hagglund et al., 2003). The reason for this was to classify the minor injuries into two groups, one likely not to miss a game (1–3 days) and the other more likely to miss a game (4–7 days). Absence between 1 week and 1 month means that the player misses several games, and absence over 1 month is a result of a serious injury. This classification does not stand in any contradiction with other classifications, such as minor (1–7 days), moderate (8–28 days) and major (>28 days) (e.g., Ekstrand et al., 2004).

Injury incidence is defined as the number of injuries per hours of exposure occurring during a study period. The incidence of injury in this study was 2.7 injuries/1000 h of practice and 13.9 injuries/1000 h of game. This differs partly from Ostenberg and Roos's (2000) (3.7 and 14.3/1000 h for practice and game, respectively) and Soderman et al.'s (2001) incidence of injury (1.5 and 9.1, respectively). However, the injury incidence in our study is lower than that reported by Engstrom et al. (1991) (7 and 24, respectively). These differences could be a result of differences in study design, such as different age groups and different playing levels. Ostenberg and Roos (2000) studied 123 players from five different league levels and Soderman et al. (2001) studied 175 players from the recreational level to premiere league. Engstrom et al. (1991) studied one team in the premiere league and one team in the third league level. Differences in injury incidence in female football players related to age and play level need to be investigated further.

The development within the sport over time could be another explanation. It should be noted that there are nearly 10 years between the Engstrom (1991) study and the studies by Ostenberg and Roos (2000), Soderman et al. (2001) and our study.

Different factors could influence the injury incidence. For male football players it has been shown that high practice to game ratio is beneficial concerning risk of injury (Ekstrand et al., 1983; Hagglund et al., 2003). This could not be shown in our study, and the reason for this gender difference is unknown.

Of note is the high incidence of head injuries during game time (2.2/1000 h). Barnes et al. (1998) reported that 43% of the women in their study had experienced some type of head injury during their football careers. The most common head injury situation is collision with another player or getting hit in the head by the ball (Dvorak & Junge, 2000). Traumas to the head can cause neuropsychological symptoms regarding attention, concentration, memory, judgment and thus is to be considered a concussion (Tysvaer & Lochen, 1991; Tysvaer, 1992; Matser et al., 1998; Matser et al., 1999; Aubry et al., 2002). Special helmets that protect the head have now been introduced and are seen more frequently during international games, but scientific evaluations of these helmets are still limited. Headgear is intended to reduce the force of impact, so that the symptoms associated with mild head injuries are minimized, and ultimately some slight head injuries could be avoided (Lewis et al., 2001; Janda et al., 2002; Naunheim et al., 2003). Headgears were not used by any of the players in our study. Further studies concerning headgears are necessary before general medical recommendations can be made.

The differences in skill levels between teams within the premiere league are high. In the top of the league, the teams consist of several national team players. Players of a lower skill level, who play against national and international top players, might have tempo difficulties during games. This could lead to fatigue and result in traumatic injuries and overuse injuries.

Several studies concerning football injuries in varying age groups, both female and male, show that differences in injury incidence in different age groups are apparent (Hoff & Martin, 1986; Backous et al., 1988; Schmidt-Olsen et al., 1991; Andreassen et al., 1992; Junge et al., 2000; Junge et al., 2002). We found no difference in injury incidence concerning players over or less than 23 years of age (mean age). The hypothesis that young (lower quartile) skilled players, who are recruited from smaller clubs and exposed to the higher level of practices and games, receive more overuse injuries after a period of time was not supported.

The high number of traumatic injuries reflects the characteristics of the sport. The most common type of traumatic injury in our study was strain. This agrees with studies by Engstrom et al. (1991), Ostenberg and Roos (2000) and Soderman et al. (2001). We also found that the distribution between traumatic and overuse injuries differs during the football season. In our study the distribution of traumatic injuries occurred evenly during the entire season, with no apparent peak, which differs from that of the study of Engstrom et al. (1991) who showed a peak at the beginning of the competitive spring

period. The reason for this could be that injury patterns might have changed over the years as a result of differences in exposure to practice and game. The players, trainers, and medical personnel might also be better educated in preventing and taking care of traumatic injuries.

Overuse injuries seem to be more common during pre-season and at the beginning of the spring season. These findings agree with Engstrom et al. (1991). The etiology of overuse injuries is more complicated as they depend on both intrinsic as well as extrinsic factors. These injuries might therefore need a more complex approach.

A high incidence of overuse injury to the spine was noted. Both changes of surface and weak trunk muscles in combination with hormonal fluctuations and premenstrual symptoms have been areas of discussion (Moller-Nielsen & Hammar, 1989, 1991; Brynhildsen et al., 1990, 1997a, b). Proper prevention programs such as special lower back and trunk stabilizing training programs might prevent these lower back pain problems. Prescription of contraceptive pills to reduce hormonal fluctuations and low back pain must take into account gynecological as well as ethical consideration.

Another of this study's findings was the high amount of re-injuries. Over half of the injured players reported an injury to the same body part occurring within 2 months of the initial injury. One out of four injuries was a re-injury at the same location, which is lower than that reported by Soderman et al. (2001). A re-injury could be a result of insufficient rehabilitation after an earlier injury. A hypothesis is that lack of knowledge about physical demands concerning female football games could be a reason for the high amount of re-injuries. Evidence-based physical tests to establish if the player is ready to go back into practice and game situations are needed. Even though most teams on this level have access to medical personnel, few of these personnel are present during all practices and games. A sports medicine trained physiotherapist, who is specialized in football medicine, could be valuable for the team during pre-season training, for individual prevention programs, management of acute injuries as well as sport-specific rehabilitation of the player.

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Conclusion

The present study shows that the knee is the most common location of injuries in elite female football players. One of five injuries is a major injury mainly owing to trauma, and localized to the knee. The high amount of head injuries during game time was notable. National team players, as well as players in the three highest ranked teams, were exposed to more playing hours during the year but did not differ in injury incidence from their counterparts. Injured players were found to have higher practice/game ratio than non-injured players.

Perspectives

Further studies concerning the demands of female football as well as valid tests to establish if the player is physically and medically ready to return to game situations are needed. The high amount of re-injuries in our study emphasises this need.

The amount of traumatic head injuries is noticeably high. Protective helmets have now been introduced internationally and their effects need to be evaluated further.

Recent studies have shown that injury rate and distribution of injuries differ between genders, but the numbers of studies on female football players are still limited. The effect of age and playing level on incidence of injury is still unclear. The numbers of studies using the same method are limited. As a result, comparisons are hard to make. More studies with emphasis on age and playing level are needed in order to attain wider knowledge concerning injuries among female football players.

Keywords: soccer, sport injuries, women, injury incidence.

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Range of motion in relation to upcoming sprain and strain injuries among female football players.

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Abstract

Objectives

The aim of this prospective cohort study was to investigate range of motion (ROM) in relation to upcoming injuries among female football players.

Background

Decreased ROM is a postulated risk factors for development of muscle injuries for male football players. ROM among female football players is poorly studied but could be a factor contributing to injuries.

Methods and measures

Thirty female senior football teams (n=522) were investigated at the beginning of a football season in regard to their ROM. Upcoming injuries were registered prospectively during the entire football season.

Results

A total of 455 players (87%) were measured for passive ROM in the lower extremity. Of the 455 players who had preseason testing, 48 players received a total of 83 strain injuries during the upcoming football season, mainly to the thigh (n=41) and hip/groin (n=10); 88 players received 110 sprain injuries during the upcoming football season mainly to the ankle (n=67) and to the knee (n=29).

Players with a decreased/increased ROM at the start of the season did not have a different injury incidence than players with a normal ROM. Differences in ROM were seen between the players in different league levels and between different age groups.

Conclusions

Increased/decreased ROM in the lower extremity does not appear to be a predisposing risk factor for muscle-tendon (strain) or joint (sprain) injuries of the lower extremity of female soccer players. We were not able to determine that preseason ROM measurements could identify players at risk for upcoming sprain or strain injuries.

Key words: women, football, injuries

Introduction

Football has been played for centuries and is currently one of the most popular sports in the world. It is played by approximately 40 million women in over 100 countries the world over (www.fifa.com). In Sweden, football is the largest female team sport with more than 56,000 registered female football players (www.svenskfotboll.se).

Football is a complex high intensity physical sport with body contact, and therefore it is associated with an injury risk. Studies concerning female football injuries have shown that the injury incidence almost agrees with the injury incidence for male football players (1.5-7 injuries /1000 (female) vs. 1.5-7.6 injuries /1000 (male) practice hours and 9.1-24 injuries /1000 (female) vs. 7.4-37.2 injuries /1000 (male) game hours)^{4, 5, 8, 9, 17, 18, 22, 23, 25, 26, 40, 45, 47, 52, 53} but that the distribution of injuries appear to differ between the sexes^{5, 7, 9, 17, 22, 38, 40, 47, 52, 53}. Most prospective studies on female football players have registered injuries during cups, tournaments or a portion of the season^{1, 2, 27, 30, 38, 47-49, 51}. Injuries during an entire football season have also been studied^{3, 17, 18, 32, 40}. These studies show also that younger female players appear to have different injury rates and location of injuries than do adult female players, overuse injuries appear to be more frequent during the preseason, and menstruation and contraceptive pills seem to have an influence on injuries and injury rate.

Inklaar²² and Dvorak & Junge⁷ concluded from their reviews of the literature that 60-90% of all injuries occur in the lower extremities. The causes of injury are believed to be multi-factorial such as intrinsic factors, e.g. joint instability, muscle strength, muscle tightness, as well as extrinsic factors, e.g. level of play, position on the field, amount and standard of practice/game, equipment, rules and fair play. Previous injuries and inadequate rehabilitation are also factors to account for^{5, 7, 8, 23}.

In 1983, Ekstrand and Gillquist showed that decreased range of motion (ROM) is a postulated risk factors for development of muscle injuries for male football players^{9, 10}. Other studies have confirmed their findings^{19, 20, 54, 57}. To our knowledge no study regarding ROM as a risk factor for injuries for female football players exist.

Aims

The aim of this study was to describe normal ROM among a large group of female football players and to determine whether increased/decreased ROM in the lower extremity is a predisposing risk factor for muscle-tendon (strain) or joint (sprain) injuries of the lower extremity for female football players. The main hypotheses in this study were a) decreased/increased ROM during preseason might lead to injuries during the upcoming season; b) decreased ROM might increase the risk of strain injury and; c) increased ROM might increase sprain injuries.

Material and methods

Subjects

Twenty senior female football teams in the second division (the third highest league level) and all 12 teams in premiere league were invited to participate in the study. Thirty teams, 18 teams from second division (1998) and all 12 teams from premiere league (2000) accepted the invitation, thereby comprising 522 players.

Before the beginning of the investigation, the first author visited all of the teams to give a presentation and inform about the study. The players answered a baseline questionnaire concerning physical parameters. At that time the player had the opportunity to discuss the answers of the questionnaire.

The mean age for the players in this study (n=455) was 22 ± 4 (15-38) years, height 167 ± 5 (153-183) cm, weight 62 ± 7 (47-98) kg and BMI 22 ± 2 (18-35). Ten percent of the players were goalkeepers, 32% were defenders, 41% midfielders and 17% were forwards. Most players were right-footed (86%).

ROM measurements

Of all 522 players invited to the study, 455 players (87%) were measured for passive ROM in the lower extremity. The players were all examined within a 6-week period before the start of their football season.

ROM was measured by using a flexometer¹⁵ and a double armed goniometer (hip abduction)⁵⁷. Measurements were conducted bilaterally. The ranges investigated were dorsiflexion of the foot

with straight and flexed knee, hip extension, hip flexion, knee flexion, abduction^{11, 15} and hip rotation⁶. The first author (a sports medicine specialized, well experienced physiotherapist) conducted all the measurements.

Injury registration

The players were studied over a period of 10 months that included both the preseason (January - April) as well as the competitive season (April- October) in 1998 (second division) and 2000 (premiere league). In order to study total football exposure for the premiere league players, the women's national team as well as the national team U21 (under 21 years), were also studied.

Participation in club/team scheduled practice and game sessions as well as injuries were registered by the respective trainer/coach using standardized attendance protocols⁹. Individual participation and injuries in the national women's and U21 teams were registered by the physiotherapist for each team.

The attendance protocol was reported once a week from the club teams or after every national gathering, to the first author. The duration of each scheduled practice was approximated to 90 minutes (second division) or 120 minutes (premiere league) and a scheduled game session was 90 minutes.

The reported injured players were interviewed by telephone by the first author using a standardized protocol that included location of injury, injury mechanism, type of injury, occasion of injury, playing position, dominant foot, ball contact, foul play, re-injury, medical consultation, treatment, etc.⁹ Injuries occurring at the end of the investigational period were followed up according to their full duration or up to 18 months beyond the investigational period.

An *injury* was defined as damage to the body sustained during practice or game session causing absence from at least the following practice and/or game session. *Sprain* was defined as a ligament injury and *strain* as a distension injury to the muscle-tendon unit. The player was defined as injured until she considered herself able to participate fully in practice and/or game time. Injury incidence was defined as the number of injuries / 1000 hours of football activity.

Statistical analysis

The statistical procedures were performed with SPSS (SPSS Inc., Chicago, USA, version 11.0) for personal computer. Standard statistical methods were used to calculate means and standard deviations. Among the players who sustained an injury, chi-square test were used to examine whether differences in injury incidence could be detected between dominant/non-dominant leg and affected/non-affected body side. Differences in ROM between strain/sprain injured and non-injured groups were calculated using Student's t-test. Pearson bivariate correlation was used to identify relations between ROM and injuries. In order to analyse the relationship between decreased/increased ROM and strain/sprain injuries, 1 standard deviation and 10/90 percentiles were calculated and analyzed using One-Way ANOVA test. The p-value level for significance was set at 0.05.

Ethics

The study was approved by the Ethical Committee of the Medical Faculty at the University of Umeå. The medical committee of the Swedish football association (SFF), the teams, the trainers/coaches and the players all received verbal and written information about the study and gave their informed consent prior to the investigation.

Results

Injuries

Of all 455 players, 257 players received 466 injuries. The location and type of all injuries are outlined in table 1 and 2. The injury incidence was 5.9/1000 practice hours, 13.5/1000 game hours and 7.3/1000 of football hours.

Range of motion

The results of ROM measurements among the players are outlined in table 3. No significant difference in ROM was found between right and left leg, therefore the mean value was used in general comparisons. Thus, when relating ROM to unilateral lower extremity injuries, the measurements for left and right leg was used.

When dividing the players into groups with increased ROM (> 1 SD) and decreased ROM (< 1 SD), as well as highest and lowest percentiles, no relation between ROM and injury incidence was found.

Differences in ROM between injured and non-injured players were only found concerning dorsiflexion of the foot with flexed knee ($p<0.05$) (Table 4). No relation was found between injuries and ROM in the affected body side.

Differences in ROM were seen between the players in different league levels concerning internal and external hip rotation, hip extension ($p<0.001$) and knee flexion ($p<0.05$) (Table 5).

When dividing the groups into age categories, differences in ROM were seen. The youngest players (<20 years) had significantly higher ROM than the oldest players (> 23 years) concerning internal, external hip rotation and dorsiflexion of the foot with flexed knee ($p<0.001$) (Table 6). The total mean range of hip rotation (internal + external) was found to decrease with almost 10% between the youngest age group to the oldest age group (Table 6).

Strain injuries

Of the 455 players who had preseason testing, 48 players received a total of 83 strain injuries during the upcoming football season, mainly to the thigh ($n=57$) and hip/groin ($n=13$). The injury incidence for strain injuries was 0.78 injuries/1000 hours of football. No difference was found between left and right side (Table 7) or according to dominant leg. Players with upcoming strain injuries were not found to have any differences in ROM at the beginning of the football season compared to players with no upcoming strain injury.

Sprain injuries

A total of 88 players received 123 sprain injuries during the upcoming football season mainly to the ankle ($n=69$) and to the knee ($n=39$). The injury incidence for sprain injuries was 2.6 injuries/1000 hours of football. The right leg was more exposed to ankle and knee sprain injuries than the left leg ($p<0.05$) (Table 8). Players with upcoming sprain injuries were not found to have any differences in ROM at the beginning of the football season compared to players with no upcoming sprain injury.

Discussion

This study describes normal ROM for female football players. While female football players seemed to have higher ROM than male football players, we did not determine that preseason ROM measurements can identify players at risk for upcoming sprain or strain injuries.

Methods

Prevention of injuries in football can be enhanced by determining the risk factors for injuries. Since the definition of a football injury and the study designs differ between studies comparisons are difficult to make^{12, 24}. The study design we chose has been used in previous studies for both male and female football players^{10, 14, 35, 36, 48, 50, 55}.

Most studies use the term range of motion (ROM)^{10, 14, 35, 36, 55}, whereas others use the term muscle flexibility⁵⁷, while some use both⁴⁸. In this study we chose to use the term ROM. Since it is the range of the motion for, e.g. a knee flexion, that is measured, it includes the length of m. quadriceps as well as the movement of the knee joint, the volume of the hamstrings that might decrease the knee flexion, etc. When comparing injuries to the quadriceps muscle, the ROM of knee flexion could therefore be depended on several points that include more than just the muscle flexibility of the quadriceps muscle.

When discussing the results of ROM between studies, the methods of measuring and recording the ROM are important to consider. Since different studies measure angles in the same joint but in different ways, the results between studies can easily be confusing. Therefore, it is essential to use valid and reliable methods and to clearly describe the measurement methods.

Range of motion

Differences in ROM between injured and non-injured players were only found concerning dorsiflexion of the foot with flexed knee ($p < 0.05$). No other relations between ROM and upcoming injuries were found. In a study of male football players, Ekstrand & Gillquist showed that male players in general were less flexible than male non-football players¹⁰. Therefore, the authors introduced a prevention program for a male football player where stretching of muscles in the lower extremities was one of several recommendations to prevent injuries¹¹. Female football players in the present study had a ROM in the lower extremity that appears to be greater than that reported for male players^{9, 34, 55, 57}. This could be a result of earlier studies of male football players showing the importance of warming up and stretching before practice and game, as well as cooling down and stretching after the activity. The players in the present study might already have optimised their range of motion to the extent that the risk of injury has been decreased.

Our study also showed a difference in ROM in relation to league level. Increased ROM does not necessarily mean an increase in performance. Decreased ROM could be a result of hard training, inadequate rehabilitated injury, it could also be a selection in sport. Players in the premiere league had decreased ROM concerning hip rotation, hip extension as well as knee flexion. Increased ROM could have a negative effect on the biomechanical possibility to increase muscle force. The players in the premiere league might have more optimised relation between ROM and muscle force. Premiere league teams also practice more than teams in second division (*Jacobson & Tegner 2006 x 2, in press*) and might also put more effort in preventive training programs.

Several authors have shown that age might be a risk factor for injury. Younger female players were shown to have a greater risk of injury in some studies^{29, 42}, while other studies show that age might be correlated to injuries^{16, 17, 29, 30, 39, 44, 46}. Our study found that players in the oldest age group (>23 years) had decreased ROM in hip rotation and dorsiflexion of the foot with flexed knee, compared to the youngest age group (<20 years). These older players mainly started to play football at the age of 7-10 years, so they have been physical active in the sport for 15-20 years. This compares to 5-10 years for the youngest age group. The decreased dorsiflexion of the foot with flexed knee might be a result of ankle sprains during ones career. The ankle is the most frequent site of football injuries for both sexes^{3, 9, 13, 17, 21, 27, 31, 33, 37, 38, 41, 43, 45, 54} as twenty to twenty-five percent of all football injuries are ankle sprains¹⁷. The decreased hip rotation might be a sign for the beginning of a hip osteoarthritis. Soccer as a possible cause of hip osteoarthritis was described by Klünder et al. in 1980²⁸. In a Swedish study high exposure to all kinds of sport was shown to increase the risk of hip osteoarthritis in women⁵⁶. It is of importance that long-time follow up studies are conducted to investigate the frequency of early onset of hip osteoarthritis among female football players.

The lower part of the lumbar spine is the site of many physical complaints. Clinically it can be quite difficult to determine if the exact localization of the problem is in the lower lumbar spine, the sacrum, the pelvis or the hip (differential diagnosis). The amount of low back pain is a problem in female football. The biomechanical forces in football are considerably high and the importance of strong trunk muscles is vital. We had suspected to find a relation between increased ROM in hip flexion, hip extension and abduction and high incidence of low back pain. Surprisingly, no such relation was found.

Strain injuries

In the present study, there were no association between preseason ROM and upcoming strain injuries. Many authors have suggested that muscle flexibility plays a significant role in the development of injuries^{9,19}. In a recent study of male football players, a significant association between preseason hamstrings muscle tightness and subsequent development of hamstrings muscle injury was found⁵⁷. A similar, but less strong, relationship also existed for quadriceps muscle tightness and the development of quadriceps muscle injuries⁵⁷. This previous study also suggested that hamstrings muscle flexibility of less than 90° could be considered as “tight”⁵⁷. Since female football players seem to be more flexible in hip flexion than males, this might be the reason for the discrepancy in results between genders.

Sprain injuries

In the present study, no association between preseason ROM and upcoming sprain injuries was found. Thus, measuring ROM during the preseason might be of little importance when identifying pre season risk factors for football injuries among female players. Previous injuries and inadequate rehabilitation are factors that could influence injury risk^{5,7,8,23}. Therefore, investigating previous and persistent complaints might be more important in the search for preventive factors.

Conclusion

The main findings in this study were that; a) players with increased/decreased ROM at the start of the season did not have a different injury incidence than players with “normal” ROM; b) there were no relations between muscle flexibility and strain/sprain injuries in female football players.

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We affirm that we have no financial affiliation (including research funding) or involvement with any commercial organization that has a direct financial interest in any matter included in this manuscript, except as disclosed in an attachment and cited in the manuscript. Any other conflict of interest (i.e., personal associations or involvement as a director, officer, or expert witness) is also disclosed in an attachment.

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Table 1: Localisation of all injuries.

	n	%
Foot	40	9%
Ankle	96	21%
Lower leg	53	11%
Knee	94	20%
Thigh	72	15%
Hip, groin	28	6%
Spine	46	10%
Trunk	8	2%
Head	24	5%
Upper extremities	5	1%
Total:	466	100%

Table 2: Type of all injuries.

	n	%
Laceration	4	1%
Concussion	16	3%
Fracture	8	2%
Dislocation	2	0%
Contusion	62	13%
Strain	83	18%
Sprain	123	26%
Overuse	168	36%
Total:	466	100%

Table 3: Passive range of motion among female football players (n=455).

	Total (n=455) Mean ± SD
Dorsiflexion (flexed knee)	33 ± 6
Dorsiflexion (straight knee)	31 ± 6
Internal rotation of hip	41 ± 7
External rotation of hip	45 ± 9
Hip extension	20 ± 6
Hip flexion	103 ± 14
Knee flexion	147 ± 11
Abduction a)	42 ± 6

* = p < 0.05

a) n=203

Table 4: Differences between passive range of motion in relation to strain injuries.

	Not strain injured players (n=407)	Strain injured players (n=48)	
	Mean ± SD	Mean ± SD	p
Dorsiflexion (flexed knee)	33 ± 6	31 ± 5	*
Dorsiflexion (straight knee)	31 ± 6	30 ± 5	ns
Internal rotation of hip	41 ± 7	41 ± 8	ns
External rotation of hip	45 ± 9	46 ± 10	ns
Hip extension	20 ± 6	19 ± 5	ns
Hip flexion	103 ± 14	102 ± 15	ns
Knee flexion	147 ± 11	145 ± 10	ns
Abduction ^{a)}	43 ± 6	41 ± 6	ns

* = p < 0.05

^{a)} n=203

Table 5: Differences between passive range of motion in relation to play league level.

	Second division (n=252)	Premiere league (n=203)		Total (n=455)
	Mean ± SD	Mean ± SD	p	Mean ± SD
Dorsiflexion (flexed knee)	33 ± 6	32 ± 6	ns	33 ± 6
Dorsiflexion (straight knee)	31 ± 6	32 ± 6	ns	31 ± 6
Internal rotation of hip	43 ± 7	38 ± 6	***	41 ± 7
External rotation of hip	47 ± 10	42 ± 7	***	45 ± 9
Hip extension	21 ± 6	18 ± 5	***	20 ± 6
Hip flexion	102 ± 14	103 ± 13	ns	103 ± 14
Knee flexion	148 ± 10	146 ± 11	*	147 ± 11
Abduction ^{a)}		42 ± 6		42 ± 6

* = p < 0.05

*** = p < 0.001

^{a)} n=203

Table 6: Differences between passive range of motion in relation to age groups.

	< 20 years (n=151)		p	20-23 years (n=159)		p	< 20 years (n=151)		> 23 years (n=145)		p
	Mean ± SD	Mean ± SD		Mean ± SD	Mean ± SD		Mean ± SD	Mean ± SD			
Dorsiflexion (flexed knee)	34 ± 6	33 ± 6	ns	33 ± 6	31 ± 6	**	34 ± 6	31 ± 6	***		
Dorsiflexion (straight knee)	31 ± 6	32 ± 6	ns	32 ± 6	31 ± 6	*	31 ± 6	31 ± 6	ns		
Internal rotation of hip	43 ± 7	40 ± 7	***	40 ± 7	39 ± 7	ns	43 ± 7	39 ± 7	***		
External rotation of hip	47 ± 10	45 ± 9	ns	45 ± 9	43 ± 8	ns	47 ± 10	43 ± 8	***		
Hip extension	20 ± 6	20 ± 6	ns	20 ± 6	20 ± 5	ns	20 ± 6	20 ± 5	ns		
Hip flexion	102 ± 14	103 ± 14	ns	103 ± 14	104 ± 13	ns	102 ± 14	104 ± 13	ns		
Knee flexion	147 ± 10	147 ± 12	ns	147 ± 12	147 ± 11	ns	147 ± 10	147 ± 11	ns		
Abduction ^{a)}	42 ± 5	43 ± 6	ns	43 ± 6	42 ± 6	ns	42 ± 5	42 ± 6	ns		

* = p < 0.05

** = p < 0.01

*** = p < 0.001

Table 7: Number of strain injuries in relation to right and left body side in lower extremity.

	Right	Left	Total
M. triceps surae	2	2	4
M. quadriceps	16	14	30
M. hamstrings	15	12	27
Hip adductor muscles	7	6	13
	40	34	74

Table 8: Number of ankle and knee sprain injuries in relation to right and left body side.

	Right	Left	p	Total
Ankle	42	27	ns	69
Knee	23	16	ns	39
	65	43	*	108

* = p < 0.05

Paper IV

Injuries among female football players in relation to the menstrual cycle and oral contraceptive use.

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Key words: athletic injuries, women, soccer, sports medicine

ABSTRACT

Background

Studies have shown a theoretical evidence for a role of female sex hormones as a risk factor for injuries.

Objective

To investigate if the injury incidence in a group of female football player varies during the different phases of the menstrual cycle, and if there is a difference in injury incidence according to contraceptive pill usage.

Methods

Injuries occurrence for 30 female senior football teams were analyzed in relation to menstrual cycle and oral contraceptive usage during an entire football season.

Results

A total of 319 players registered menstrual periods during the entire or part of the year comprising 2586 menstrual cycles. Of all 319 players studied, 159 (50%) players received 297 injuries. When analyzing the entire population without regard to contraceptive pill usage, an increase in injury incidence, albeit not significant, was seen in the premenstrual and menstrual period. An increased incidence of injuries was noted during the menstrual phase compared to the pre-ovulatory phase ($p=0.006$) as well as during the post-ovulatory phase compared to the pre-ovulatory phase ($p=0.003$) for non-OC users. There were no differences between the OC and non-OC groups concerning injury incidence during practice, game or total football.

In relation to phases, an increased incidence of traumatic injuries was noted during the menstrual phase compared to the pre-ovulatory phase ($p=0.042$) for non-OC users.

When analyzing the entire population without regard to contraceptive pill usage, no

difference in traumatic injury incidence was seen during the menstrual cycle. There was no difference in total traumatic injury incidence between OC-users and non-OC-users.

Conclusion

We found an increased injury incidence during the low-hormone menstrual phase. We were not able to demonstrate any significant difference in injury incidence between OC-users and non-users.

Football is one of the most popular team sports in the world and is played by approximately 40 million women in over 100 countries (www.fifa.com). It is a physical sport with body contact that might lead to injuries.

Studies concerning female football injuries have shown that while the injury incidence nearly agrees with that for male football players, the distribution of injuries appear to differ between the sexes ¹⁻¹⁰.

Younger female players appear to have different injury incidence and location of injuries than adult female players ^{3 11-16}. Lately, focuses have been on the higher risk of knee injuries among female football players, ^{1 17 18} and on the fact that they sustain their knee injuries at an earlier age ². The causes of injury are believed to be multi-factorial but different factors could influence the risk of injury.

Hormonal fluctuations during the different phases of the menstrual cycle have been discussed as one risk factor for injuries ¹⁹⁻²⁴. Women have fluctuating levels of hormones throughout their lives from puberty to menopause ²⁵. Several studies have confirmed the increased risk of injury in physically active women during the menstrual phase ^{19 21 24 26} as well as during the pre-menstrual phase ^{19 21 23 24 26}. An impaired postural control during the premenstrual phase was suggested as one explanation for the increased risk of injury ²⁷. Players with pre-menstrual symptoms were found to more likely suffer a traumatic injury during the menstrual phase than during the other phases of the menstrual cycle ²⁶.

Usage of oral contraceptives seems to be associated with fewer injuries²⁶. Oral contraceptive pills contain synthetic estrogen and progestin steroids. As the concentrations of female sex hormones vary in a cyclic pattern during the normal menstrual cycle, but are more stable during oral contraceptive use, it has been postulated that variations in the exposure to female sex hormones may affect the risk of injury²⁷.

Studies have shown theoretical evidence for a role of female sex hormones as a risk factor for injuries^{19-24 26-29}. These studies have failed to reach consensus concerning the effects on injury pattern of the different hormonal concentrations during the menstrual cycle, as well as during oral contraceptive use. Thus, it is of great interest to study hormonal effects on musculoskeletal injury as well as effects of oral contraceptive pills on injury patterns.

Therefore, the aim of this study was to investigate if there was a difference in injury incidence in regard to contraceptive pill usage, and if the injury incidence in a group of female football player varied during the different phases of the menstrual cycle.

METHODS

Subjects

Thirty-two teams from two different league levels, the second division (20 teams) and the premiere league (12 teams) in Sweden were invited to participate in this prospective cohort study. Thirty teams accepted the invitation. At the start of the investigation 522 players, comprising 269 players from the premiere league and 253 players from the second division were included.

Of all 522 players initially invited to the study, 319 players (61%) registered menstruation data during the entire, or part of, the investigated year i.e. study group. The characteristics of the study group and the non study group are outlined in figure 1 and table 1. There were no differences between the group with (n=319) or without (n=203) menstrual registration concerning age, height, weight, BMI, practice to game ratio or oral contraceptive usage. Players with menstrual registration had more practice ($p<0.05$), game ($p<0.001$) as well as total football hours ($p<0.01$) compared to players without menstrual cycle registration.

Of all 522 players initially invited to the study, 258 players (49%) received 466 injuries. There were no differences between the group of injured players with or without menstrual registration concerning age, height, weight, BMI, injury incidence, location of injury or oral contraceptive usage.

Methods

The players were studied over a period of 10 months that included both the preseason (January -April) as well as the competitive season (April- October) in 1998 (second division) and in 2000 (premiere league).

Before the beginning of the investigation, the first author (a sports medicine specialized physiotherapist) visited all of the teams to give a presentation and inform about the study. The players answered a questionnaire with open questions concerning age, height, weight and oral contraceptive usage. Body mass index (BMI) was calculated as weight (kg)/height² (m). At that time the player had the opportunity to discuss the answers of the questionnaire with the first author.

Individual participation in training and game sessions as well as injuries were registered by the trainer or coach using standardized protocols and reported once a week to the first author. The injured player was interviewed by telephone by the first author using a standardized protocol regarding localization of injury, type of injury, etc. Injury incidence was defined as the number of injuries / 1000 hours of football activity. Injuries occurring at the end of the investigation period were followed up according to their full duration or up to 18 months beyond the investigated period. An *injury* was defined as damage to the body sustained during practice or game session that caused absence from at least the following practice and/or game session. An injury was defined as *traumatic* if it had a sudden onset associated with a trauma²³.

The players noted their menstrual periods and any alteration in contraceptive status over a 12-month period. The players sent these diaries to the first author at the end of June

and at the end of season. During the telephone interview due to an injury, the player was also reminded about the diary.

An average menstrual cycle lasts 28 days but may range from 20-45 days for women between the ages 20 to 40 years^{25 30}. The menstrual cycle in this study was divided into four phases as used previously^{26 29}; the *menstrual phase*, from the beginning of the menstrual bleeding and 7 days on; the *pre-ovulatory phase* which has a variable length from end of menstrual phase until beginning of the post-ovulatory phase; the *post-ovulatory phase*, 14 days before next menstrual bleeding and 7 days forward; and the *pre-menstruation phase*, the phase 7 days before menstruation^{31 32}. The reason for dividing the menstrual cycle in this way due to the fact that the length of the luteal phase is usually fairly constant, whereas the pre-ovulatory phase can vary³¹.

Female athletes who use oral contraceptives (OC) do not have the same hormonal fluctuations as those who do not use OC. In OC users, the cycle is known to have a fixed length of 28 days and ovulation does not occur³³.

Statistical analysis

The statistical procedures were performed with SPSS (SPSS Inc., Chicago, USA, version 11.0) for personal computer. Standard statistical methods were used to calculate mean, range and standard deviations concerning age, height, weight, BMI and number of football hours per player as well as practice to game ratio. Differences between groups were calculated using t-test, chi square test and Fisher's exact test. Wilcoxon

signed ranks test was used when calculating differences between the menstruation phases within groups. The p-value level for significance was set at 0.05.

The Ethical Committee of the Medical Faculty at the University of Umeå approved the study. The medical committee of the Swedish football association (SvFF), the teams, the coaches and the players all received verbal and written information about the study and gave their informed consent prior to the investigation.

RESULTS

A total of 319 players (319/522, 61%) registered menstrual periods during the entire or part of the year comprising 2.586 menstrual cycles. Forty-two players (42/319, 13 %) registered menstruation period's only part of the year. These 42 players were included in the study until individual time of dropout.

Fifty-one percent (163/319) of the players with menstrual registration were oral contraceptive (OC) users at the beginning of the season. During the investigated year 18 players started to use oral contraceptives, 10 players stopped using oral contraceptives and 4 players became pregnant. There were no differences in characteristics between injured and non-injured players or between OC users and non-OC users. The characteristics of the study group are outlined in table 1. There were no differences in football exposure between the menstrual phases within the study group.

Of all 319 players studied, 159 (50%) players received 297 injuries. The most common injuries were to the ankle (n=66), knee (n=52) and thigh (n=43). The incidence of injury during practice was 6.4/1000 hours, during game time was 9.8/1000 hours and during total football was 8.2/1000 hours (Table 2). An increase in injury incidence, albeit not significant, was seen in the premenstrual and menstrual period when analyzing the entire population without regard to contraceptive pill usage. Concerning injury incidence during the different phases of the menstrual cycle for non-OC users, an increased incidence of injuries was noted during the menstrual phase compared to the pre-ovulatory phase ($p=0.006$) as well as during the post-ovulatory phase compared to the pre-ovulatory phase ($p=0.003$) (Table 3). The injury incidence in relation to menstruation day is outlined in figure 2. There were no differences between the

OC/non-OC groups concerning injury incidence during practice, game or total football (Table 2).

Ninety-six players received 183 traumatic injuries. The most common traumatic injuries were to the ankle, thigh and knee (Table 4). The incidence of traumatic injuries during practice was 5.3/1000 hours, during game time was 8.1/1000 hours and during total football was 5.0/1000 hours (Table 5). An increased incidence of traumatic injuries was noted during the menstrual phase compared to the pre-ovulatory phase ($p=0.042$) in non-OC users (Table 6). When analyzing the entire population without regard to contraceptive pill usage, no difference in traumatic injury incidence was seen during the cycle (Figure 3). The distribution of traumatic injuries in relation to type is outlined in table 7. There was no difference in total traumatic injury incidence (Table 5) or difference in relation to severity (time lost) of injury (Table 8) between OC-users and non-OC-users.

DISCUSSION

The principle finding in this study was the apparent difference in injury incidence during the menstrual cycle in women not using OC. We do not consider this as an effect of multiple comparisons due to the methods used. Women using OC by definition only have two phases, i.e. the OC-phase where the exogenous hormones make the serum concentrations rather stable, and the menstrual phase. During the menstrual phase both the estrogen and progesterone concentrations in serum are low and it might be speculated that this low-hormone state increases the susceptibility to traumatic injuries. Möller-Nielsen & Hammar²⁶, Myklebust et al.¹⁹ and Slauterbeck & Hardy³⁴ also found an increased incidence during this period, but also during the premenstrual phase. They suggested that the low estrogen concentrations, together with the occurrence of premenstrual symptoms, had negative cerebral effects on postural and neuromuscular control leading to an increased susceptibility to traumatic injuries.

Friden found enhanced neuromuscular control during the high-estrogen ovulatory phase compared with other phases in the menstrual cycle indicating that low estrogen concentrations might lead to impaired neuromuscular control and consequently increasing the risk of injury³⁵. In postmenopausal women, low estrogen serum-concentrations were proposed to be associated with impaired postural control, which might be one explanation to that the increased incidence of postmenopausal fractures is shown before osteoporosis has been developed^{36 37}. These women also demonstrated no variation in muscular strength or muscle endurance between different menstrual cycle phases³⁸. A significantly greater postural sway and decreased knee-joint kinesthesia among women with pre-menstrual symptoms³⁹ as well as impaired detection ability of

the movement in the knee joint and impaired postural control in the premenstrual phase was found^{35 40}. These factors may contribute to the reported higher injury incidence during the premenstrual phase and during the first day of the menses. In the young female athlete, an impaired postural control during the low-estrogen, pre-menstrual/menstrual phase might instead be reflected as an increased susceptibility to traumatic injuries. This suggests a central effect of the female sex hormones on postural control, possibly via neuro steroids³⁵.

No difference was found in injury incidence between OC-users and non-OC-users. More non-OC-users than OC-users (58% vs. 42%) did not register menstruation and we could not exclude the possibility of an effect on the interpretation of the results. Moreover, the players in the study group also had more practice and games sessions and thus had a higher exposure. We could not exclude that this skew distribution may have biased the generalization of our results.

Our methodology of modelling the time dependency of injuries was based on 4 phases where the pre-ovulatory phase could vary in length. The rationale for this division is that the luteal phase is fairly constant (approximately 14 days) whereas the time between the menstrual bleeding and ovulation could vary significantly.

However, differences in postural control as a consequence of different hormonal concentrations may not exclusively explain the panorama of female sports injuries. The mechanical properties of ligaments might also be affected by different serum concentration in sex hormones.

The incidence of anterior cruciate ligament (ACL) injuries is higher among female than among male athletes^{1 17 18}. In the end of the 1990s it was demonstrated that sex steroid receptors are present in the ACL,^{22 34 41} and as a consequence many studies have paid attention to possible hormonal effects on ACL injuries. Wojtys et al.²⁰ initially reported more ACL injuries during the ovulatory (high estrogen) phase of the menstrual cycle, and they confirmed the results in a subsequent larger study⁴². On the other hand, Myklebust et al.¹⁹ as well as Slauterbeck and Hardy³⁴ found a higher incidence of ACL injuries during the low-estrogen phase (just before and during the menstrual period). Karageanes et al.⁴³ studied knee laxity during three different phases of the menstrual cycle but was not able to conclude any significant differences between the different phases of the menstrual cycle.

Estrogen is also known to affect pain modulation on a spinal level⁴⁴ as well as the general well-being⁴⁵. As a consequence, the player might be more likely to report injuries during low-estrogen states, i.e. the pre-menstrual/menstrual period of the menstrual cycle.

The relationship between relaxin and injuries has been a topic of discussion. Arnold et al.⁴⁶ concluded in their study that there is a weekly fluctuation in serum relaxin in females, that there are similarities in relaxin levels across the genders, that there is a trend towards more translation in females with prior injuries, that there was no significant change in knee joint laxity over the course of menstruation, and that there was no relationship between laxity and relaxin levels⁴⁶.

Fluctuation in muscle strength has been noted across the normal menstrual cycle and these changes seem to be related to changes in oestradiol levels. Increases in muscle strength have also been reported late in the follicular phase corresponding to increases in oestradiol before ovulation^{47 48}.

In conclusion we found an increased injury incidence during the low-hormone menstrual phase. These results support the theory of an increased risk of traumatic injury during low-hormone states.

We were not able to demonstrate any significant difference in injury incidence between OC-users and non-users.

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All injuries

Table 1: Basic characteristics of all female football players (n=319).

	OC users	Non-OC users	p	Total
N (%)	163 (51%)	156 (49%)		319
Age (year, mean, SD)	24 ± 3	23 ± 5	ns	23 ± 4
Height (cm, mean, SD)	167 ± 4	169 ± 5	ns	168 ± 5
Weight (kg, mean, SD)	62 ± 6	63 ± 7	ns	63 ± 7
BMI (kg/m ² , mean, SD)	22 ± 2	22 ± 2	ns	22 ± 2
Number of injured players				159
Number of injuries	167 (56%)	130 (44%)		297
Number of football hours per player - practice (mean, SD, 95% CI)	155 ± 100 (133, 176)	154 ± 90 (132, 175)	ns	155 ± 96 (117, 160)
Number of football hours per player - game (mean, SD, 95% CI)	40 ± 17 (37, 44)	40 ± 16 (37, 44)	ns	39 ± 17 (26, 45)
Number of football hours per player - total (mean, SD, 95% CI)	194 ± 111 (170, 217)	195 ± 101 (171, 218)	ns	194 ± 106 (144, 206)
Practice game ratio (mean, SD, 95% CI)	4 ± 2 (4, 5)	4 ± 3 (4, 5)	ns	4 ± 2 (4, 6)

Table 2: Injury incidence (injuries/1000h) during practice and game in relation to OC (n=163) and non-OC (n=156) users (mean± SD).

	OC users	Non-OC users	p	Total
Practice	7.0 ± 15.2	5.7 ± 13.8	ns	6.4 ± 14.5
Game	11.4 ± 25.3	8.1 ± 18.2	ns	9.8 ± 22.1
Total	8.9 ± 15.6	7.5 ± 13.9	ns	8.2 ± 14.8

Table 3: Injury incidence (injuries/ 1000 h) for non-OC users (n=156) in relation to cycle phase (mean± SD).

With Wilcoxon signed rank test the menstrual phase was found to have significantly higher injury incidence than the pre-ovulatory phase (p=0.006) and the pre-ovulatory phase had a significantly lower injury incidence than post-ovulatory phase (p=0.003).

	Practice Non-OC	Game Non-OC	p	Total Non-OC
Phase 1 (Menstrual phase)	6.6 ± 25.2	8.2 ± 37.8	ns	10.0 ± 28.0 ¹
Phase 2 (Pre-ovulatory phase)	3.8 ± 27.8	7.8 ± 27.8	ns	4.1 ± 18.1 ²
Phase 3 (Post-ovulatory phase)	7.3 ± 23.3	9.5 ± 40.3	ns	8.7 ± 21.6
Phase 4 (Pre-menstrual phase)	5.1 ± 30.8	7.1 ± 29.1	ns	7.0 ± 29.9
Total:	5.7 ± 13.8	8.1 ± 18.2	ns	7.5 ± 13.9

¹ = Menstrual phase vs. pre-ovulatory phase (p=0.006).

² = Pre-ovulatory phase vs. post-ovulatory phase (p=0.003).

Traumatic injuries

Table 4: Bodily localisation of traumatic injuries (n=183).

	OC	Non-OC	Total
Foot	5	7	12
Ankle	30	22	52
Lower leg	6	4	10
Knee	16	17	33
Thigh	20	18	38
Hip, groin	3	3	6
Spine	6	1	7
Trunk	3	4	7
Head	7	8	15
Upper extremities	1	2	3
Total:	97	86	183

Table 5: Traumatic injury incidence during practice and game (injuries/1000h) in relation to OC (n=163) and non-OC (n=156) users.

	OC users	Non-OC users	p	Total
Traumatic injury incidence (injury/1000 hours football) during practice	4.5 ± 11.0	6.1 ± 21.3	ns	5.3 ± 16.8
Traumatic injury incidence (injury/1000 hours football) during game	9.8 ± 24.0	6.3 ± 15.8	ns	8.1 ± 20.5
Total traumatic injury incidence (injury/1000 hours football)	5.0 ± 8.8	5.0 ± 11.8	ns	5.0 ± 10.4

Table 6: Injury incidence of traumatic injuries / 1000 hours of football for non-OC users in relation to cycle phase (n=156) (mean ± SD).

With Wilcoxon signed rank test the menstrual phase was found to have significantly higher injury incidence than pre-ovulatory phase (p=0.42).

	Practice Non-OC	Game Non-OC	p	Total Non-OC
Phase 1 (Menstrual phase)	4.8 ± 21.6	7.5 ± 36.8	ns	7.1 ± 23.3 ¹
Phase 2 (Pre-ovulatory phase)	14.6 ± 63.6	5.1 ± 21.7	ns	3.2 ± 17.4
Phase 3 (Post-ovulatory phase)	2.0 ± 12.1	6.7 ± 34.4	ns	4.7 ± 15.5
Phase 4 (Pre-menstrual phase)	3.1 ± 16.4	6.0 ± 26.2	ns	5.3 ± 24.4
Total:	6.1 ± 21.3	6.3 ± 15.8	ns	5.0 ± 11.8

¹ = Menstrual phase vs. pre-ovulatory phase (p=0.42).

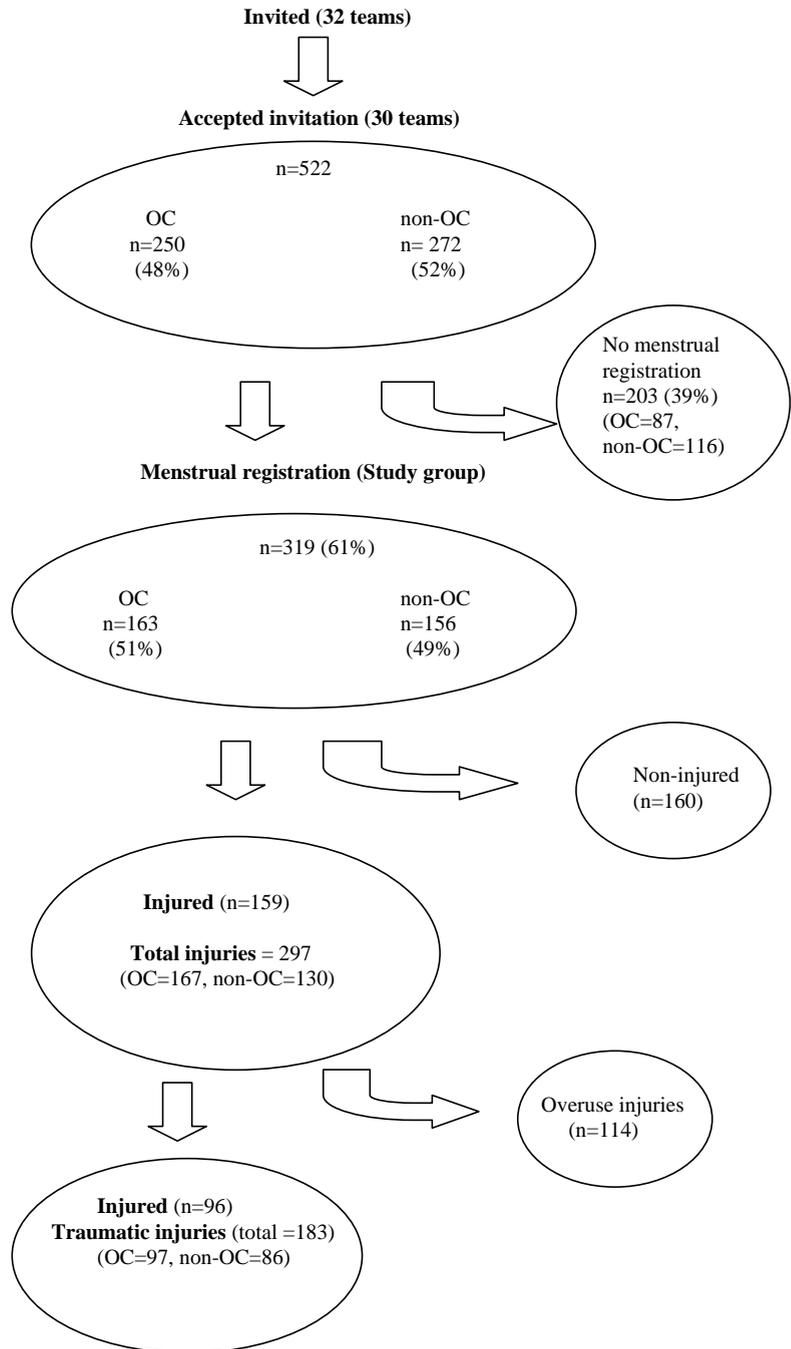
Table 7: Distribution of traumatic injuries (total=183) in relation to type of injury and oral contraceptive usage.

	OC	Non-OC	Total
Laceration	0	3	3
Concussion	4	4	8
Fracture	2	3	5
Dislocation	1	0	1
Contusion	28	11	39
Sprain	25	22	47
Strain	37	43	80
Total:	97	86	183

Table 8: Number of traumatic injuries (total=183) in relation to grade of severity and oral contraceptive usage.

	OC	Non-OC	Total
Slight (1-3 days)	13	10	23
Minor (4-7 days)	30	21	51
Moderate (8-30 days)	36	42	78
Major (>30 days)	18	13	31
Total:	97	86	183

Figure 1: Study group analysis.



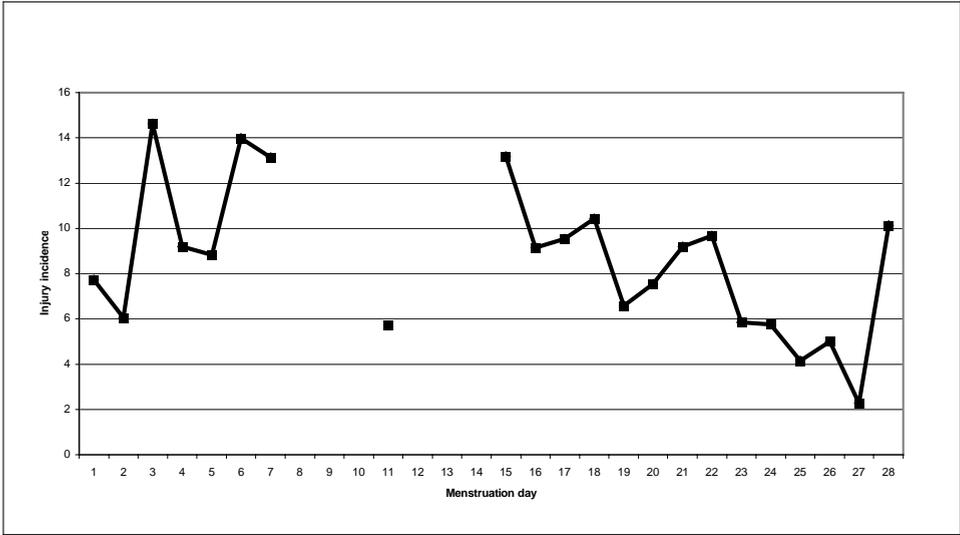


Figure 2: Injury incidence in relation to menstruation day

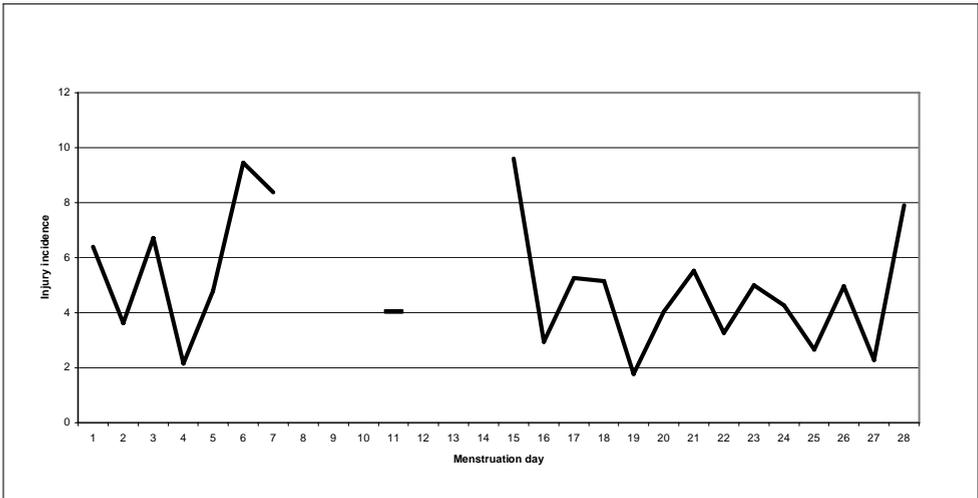


Figure 3: Traumatic injury incidence in relation to menstruation day

