#ReadyToPlay: health problems in women’s football—a two-season prospective cohort study in the Norwegian premier league

Roar Amundsen, Solveig Thorarinsdottir, Benjamin Clarsen, Thor Einar Andersen, Merete Møller, and Roald Bahr

ABSTRACT

Objectives To describe the prevalence, incidence and burden of all health problems in the Norwegian women’s premier league.

Methods During the 2020 and 2021 seasons, players in the Norwegian women’s premier league reported all health problems (sudden-onset injuries, gradual-onset injuries and illnesses) weekly, using the Oslo Sports Trauma Research Centre Questionnaire on Health Problems. Team medical staff diagnosed reported problems using the Sport Medicine Diagnostic Coding System. We calculated average weekly prevalence, incidence and burden of all health problems reported.

Results We included 294 players (age: 22±4 years) from 11 teams. Response rate to the weekly questionnaire was 79%. On average, 32% (95% CI: 31% to 33%) of the players reported at least one health problem at any time and 22% (95% CI: 21% to 23%) reported a substantial health problem negatively affecting their training volume or performance. The overall incidence was 10.7 health problems per 1000 hours of football exposure. Sudden-onset injuries were most severe (68% of the total time loss), followed by gradual-onset injuries (25%) and illnesses (8%). Thigh was the most common injury location (26%), while knee injuries were most severe, causing 42% of the total injury time loss. Anterior cruciate ligament (ACL) injuries alone caused 30% of the total injury time loss.

Conclusion One in five players had a health problem negatively affecting their training volume or performance at any time. Sudden-onset injuries represented the most burdensome health problem. Thigh injuries were most frequent, while knee injuries, ACL injuries especially, were most severe.

INTRODUCTION

Women’s football is on the rise. The interest, available resources provided and number of professional players have increased rapidly in the last decade. The physical demands of the game have soared and may have changed the injury risk as well.

Most previous injury surveillance studies in top level women’s football have reported knee and ankle as the most commonly injured locations and mechanisms for these injuries and develop preventative measures targeted to the soaring demands of modern women’s football.

WHAT THIS STUDY ADDS

Gradual-onset injuries and illnesses are common in many sports but have not been studied with appropriate methods in women’s football.

Knee and ankle injuries have been the most commonly injured body areas in women’s football, and anterior cruciate ligament (ACL) injuries and concussions have received much attention. However, women’s football is developing rapidly, and it is questionable how accurately previous literature reflects the current injury risk.

WHAT IS ALREADY KNOWN ON THIS TOPIC

Gradual-onset injuries were more common than previously reported, but sudden-onset injuries still caused the highest burden. Illnesses caused a minor burden.

The most frequent diagnoses were muscle injuries to the thigh, suggesting that the injury risk might be changing. The most common mechanisms for thigh injuries were running and sprinting.

ACL injuries and concussion still represented major problems in women’s football. The majority of ACL injuries were non-contact, while concussions occurred mainly during collisions with another player.

HOW THIS STUDY MIGHT AFFECT RESEARCH, PRACTICE OR POLICY

ACL injuries, concussions and thigh muscle injuries should be targeted areas for injury prevention in women’s football. Future research should aim to study the risk factors and injury mechanisms for these injuries and develop preventative measures tailored to the soaring demands of modern women’s football.

Studies of gradual-onset injuries should still use a non-time-loss approach, but recording only time-loss injuries and expressing severity by number of days lost seem to give a reliable picture of the overall injury risk in football.

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recommended, and the Oslo Sports Trauma Research Centre Questionnaire on Health Problems (OSTRC-H) was developed, and later updated, to incorporate this broader definition. When compared with traditional injury registration using a time-loss definition only, the OSTRC-H identified 10 times more gradual-onset injuries in elite athletes from various sports and 3 times more groin problems in adult football players. Despite comprising a substantial part of the health problems in other cohorts, illnesses have not been addressed in previous epidemiological studies in women’s football.

To develop effective preventive measures tailored to the needs of modern female football players, we need reliable, up-to-date surveillance data. Therefore, we aimed to describe the prevalence, incidence and burden of all health problems in the Norwegian women’s premier league.

METHODS

Study design and participants

We conducted a two-season prospective cohort study in Toppserien, the Norwegian premier league of women’s football (Union of European Football Associations (UEFA) club coefficients ranking: 12th), in the competitive season of 2020 and the preseason and competitive season of 2021. The league consisted of 10 teams, each playing 18 league matches and up to 5 national knock-out cup matches. Two teams per season also competed in the UEFA Women’s Champions League, playing two to three matches per team. Resources varied between teams, but most had a combination of professional and amateur players (as defined by Walden et al). Before the start of the 2020 season, players and physiotherapists from the 10 teams in the league were invited to participate. In the 2021 season, we added the one promoted team and continued monitoring the one relegated team. New players who signed a contract during or between the two seasons were invited to take part in the project, and players who left the league were followed until they transferred outside the Norwegian premier league or retired. To be included in the study, players had to be part of the first team squad, have a signed contract, be at least 16 years old and give their individual written informed consent to participate.

Definitions

We defined a health problem as any condition that reduced a player’s normal state of complete health, irrespective of its consequences on football participation or performance or whether she sought medical attention. Health problems were divided into injuries or illnesses. An injury was defined as a tissue damage or other derangements of normal physical function, with sudden-onset injuries caused by a single, clearly identifiable energy transfer, and gradual-onset injuries by multiple accumulative bouts of energy transfer without a single, clearly identifiable event responsible for the injury. Illness was defined as a relative bouts of energy transfer without a single, clearly identifiable event responsible for the injury. Definitions

Recording health problems and exposure

Players answered the updated version of the OSTRC-H (OSTRC-H) weekly through a mobile app (AthleteMonitoring, Fitstats, New Brunswick, Canada) for a total of 63 weeks (23 weeks from July to December 2020, 40 weeks from February to November 2021, separated by a 9-week recording break between seasons). We asked the players to respond to the following questions: (1) if the players had any health problems (regardless of time loss) during the previous week, and if so, (2) how it had affected their training volume and (3) performance, and (4) to what extent they had experienced symptoms. Based on the answers from these four questions, we calculated a severity score between 0 and 100 for each health problem. When players reported a new health problem, they also recorded the incident type (sudden-onset injury, gradual-onset injury or illness). For injuries, they recorded body area and type of activity (match play/football training/other training); for sudden-onset injuries, they also reported the injury mechanism chosen from a drop-down list (e.g., sprinting, landing or being tackled). For illnesses, they recorded which specific and general symptoms they had experienced. Players also recorded the date of the first symptom(s) and how many days of time loss the health problem had caused during the previous week. Health problems were classified as substantial if they lead to moderate or severe reductions in training volume or football performance, and as time-loss health problems if they caused absence from football training or match play. If players had several health problems in the same week, these steps were repeated for each problem, starting with the most severe. If players recorded the same problem multiple weeks, they had the option to choose the previously reported problem from a drop-down list and, hence, only had to report the number of days lost. Players also recorded hours of football-specific training, strength and conditioning training and match exposure in their weekly report. National team exposure was also included.

Before project start, the physiotherapists were educated on how to use the AthleteMonitoring software. Every Sunday, automatic SMS reminders were sent to the players to complete the questionnaire. If a player did not respond, automatic reminders were sent daily until the questionnaire was completed. After 3 days, we (RA or ST) sent an SMS reminder to non-respondents. We also asked team physiotherapists to encourage players to respond to the questionnaire.

The team physiotherapists (one to three per team) in each team had access to their players’ health reports. After examining the players, physiotherapists diagnosed the reported health problems using the Sports Medicine Diagnostic Coding System (SMDCS) and, when appropriate, they had the opportunity to reassign the onset and location of the injury reported by the players. If players were followed up by physiotherapists outside the team, we (RA or ST) contacted the physiotherapist to record the diagnosis, which then was registered into the application.

Equity, diversity and inclusion statement

All players in the Norwegian women’s premier league were invited to participate, but speaking Norwegian or English was necessary to be able to answer the OSTRC-H. The authors are all based in Nordic countries but consist of both women and men and include both junior and senior researchers. The authors have background as medical doctors, physiotherapists, football coaches and teachers.

Data handling

The severity of a health problem was reported as (1) the total number of days lost and (2) the cumulative severity score for...
that problem. The severity was calculated from resolved health problems only. Health problems not resolved were assigned the median time loss of resolved problems with a similar diagnosis. None of the anterior cruciate ligament (ACL) injuries reported were fully resolved before the study ended. Therefore, we estimated their time loss and severity score based on data from four players who had sustained ACL injuries prior to inclusion and returned to play during the study period. For players reporting injuries causing 7 days lost in the last week of recording in 2020 and in the first week of recording in 2021, we imputed time loss (7 days per week) and severity score (100 per week) during the 9-week recording break between seasons. For incidents that involved multiple injuries, the severity of the primary injury was reported. After the data collection, injuries were reclassified to match the revised 2020 consensus version of the SMDCS. SMDCS codes that described similar injuries (eg, muscle spasm, strain and tear in the same muscle or 1°, 2° and 3° sprains in the same ligament) were combined and reported as follows: quadriceps, hamstring, adductor, gastrocnemius and soleus muscle injuries, ACL injuries, deltoid ligament sprains, lateral ankle ligament sprains and tibiofibular ligament syndesmosis injuries.

**Statistical analyses**

All statistical analyses were conducted using R statistical software (V.3.6.1). The response rate was calculated as the number of responses to the questionnaire divided by the number of distributed questionnaires. We calculated the weekly prevalence of all health problems as the number of players reporting one or more problems each week, divided by the number of players responding to the questionnaire. Only health problems that occurred after players’ inclusion were included in analyses of incidence, severity and burden. Overall incidence was reported as the number of health problems that occurred per 1000 hours of football exposure. Football training injury incidence was reported as the number of injuries that occurred per 1000 hours of football training, and match injury incidence was reported as the number of injuries occurring in matches per 1000 hours of match play. Severity was reported as the total number of days lost together with median days lost and quartiles, and in the following categories: 0 days, 1–3 days, 4–7 days, 8–28 days, 29–90 days, 91–180 days and >180 days. Injury burden was reported as days lost per 1000 hours of exposure and illustrated in risk matrices with incidence and mean severity. Illness incidence was reported as the number of illnesses per player per 365 days. We compared overall incidence between the preseason and competitive seasons, and the injury incidence in match play versus football training with the significance level set at p<0.05.

**RESULTS**

**Participants and response rate**

We included 294 players (age: 22±4 years) from 11 teams in our analyses, which was 93% of all invited players (figure 1). The players responded to 10 544 of the 13 420 questionnaires distributed, with a mean weekly response rate of 79% (range: 57–100%). Physiotherapists from 10 of the 11 teams diagnosed the reported health problems with SMDCS (injuries: 71%, illnesses: 38%, total: 63%).

![Figure 1](http://bjsm.bmj.com/) Flow chart of participants in the project. In 2021, we included the promoted team and continued to follow the relegated team. Players who transferred from the league or retired during the season were followed until drop-out (dotted boxes).
Table 1  The average weekly prevalence of health problems

<table>
<thead>
<tr>
<th>Health Problems</th>
<th>Mean (95% CI)</th>
</tr>
</thead>
<tbody>
<tr>
<td>All health problems</td>
<td>32% (31% to 33%)</td>
</tr>
<tr>
<td>Injuries</td>
<td>30% (29% to 31%)</td>
</tr>
<tr>
<td>Sudden-onset injuries</td>
<td>15% (15% to 16%)</td>
</tr>
<tr>
<td>Gradual-onset injuries</td>
<td>15% (15% to 16%)</td>
</tr>
<tr>
<td>Illness</td>
<td>2% (2% to 3%)</td>
</tr>
<tr>
<td>Substantial health problems</td>
<td>22% (21% to 23%)</td>
</tr>
<tr>
<td>Injuries</td>
<td>20% (19% to 21%)</td>
</tr>
<tr>
<td>Sudden-onset injuries</td>
<td>12% (11% to 12%)</td>
</tr>
<tr>
<td>Gradual-onset injuries</td>
<td>8% (8% to 9%)</td>
</tr>
<tr>
<td>Illness</td>
<td>2% (2% to 2%)</td>
</tr>
<tr>
<td>Time-loss health problems</td>
<td>23% (22% to 24%)</td>
</tr>
<tr>
<td>Injuries</td>
<td>21% (20% to 22%)</td>
</tr>
<tr>
<td>Sudden-onset injuries</td>
<td>12% (11% to 12%)</td>
</tr>
<tr>
<td>Gradual-onset injuries</td>
<td>9% (9% to 10%)</td>
</tr>
<tr>
<td>Illness</td>
<td>2% (2% to 2%)</td>
</tr>
</tbody>
</table>

Prevalence

During the study period, 235 players (80%) reported at least one health problem affecting their participation or performance (median: 3, IQR: 2–4) and 215 players (73%) reported at least one substantial health problem (median: 2, IQR: 1–4). In total, 819 health problems were reported; 608 were considered substantial health problems and 652 caused time loss. The average weekly prevalence of health problems is shown in Table 1. The prevalence of health problems was higher during the pre-season of 2021 (37%, 95% CI: 36% to 39%) compared with the competitive seasons of 2020 (30%, 95% CI: 29% to 32%) and 2021 (32%, 95% CI: 30% to 33%).

Incidence and severity

All health problems

Of the 819 health problems reported, 110 occurred prior to inclusion. Thus, 709 new health problems (44% sudden-onset injuries, 35% gradual injuries and 21% illnesses) occurred during 66 234 hours of football exposure (7351 match hours and 58 884 training hours), resulting in an overall incidence of 10.7 health problems per 1000 hours of football exposure (95% CI: 9.9 to 11.5). Players also reported a total of 34 334 hours of strength and conditioning training (3.3 ±0.5 hours per player per week). The incidence did not differ between the 2020 and 2021 competitive seasons (9.7 vs 10.7 health problems per 1000 hours, p=0.25), but was higher in the pre-season of 2021 compared with the competitive seasons (12.4 vs 10.2 health problems per 1000 hours, p=0.03).

The new health problems caused a median of 3 days lost (IQR: 1–7 days, range: 0–354 days, total number of days lost: 9466 days). Twenty per cent caused no time loss, 38% caused 1–3 days, 17% caused 4–7 days, 17% caused 8–28 days, 5% caused 29–90 days, 2% caused 91–180 days and 1% caused >180 days. Sudden-onset injuries were most severe (68% of the total time loss, 62% of cumulative severity score), followed by gradual-onset injuries (25% of total time loss, 28% of cumulative severity score) and illnesses (8% of total time loss, 10% of cumulative severity score).

Injuries

The players sustained 558 new injuries (440 caused time loss) in 66 234 hours of football exposure, resulting in an overall injury incidence of 8.4 injuries (95% CI: 7.7 to 9.2) per 1000 hours (6.6 time-loss injuries per 1000 hours, 95% CI: 6.0 to 7.3). The injury incidence was greater during match play than in training (13.5 vs 3.6 injuries per 1000 hours, p<0.001). The most common injury locations were the thigh (26%), knee (15%) and ankle (14%), and the same body areas caused the largest proportion of total time loss (knee: 42%, ankle: 13% and thigh: 11%, total number of days lost to injury: 8749 days) and cumulative severity score (knee: 38%, thigh: 14%, ankle: 12%, total cumulative severity score: 155 361) caused by injuries. Muscle injuries were most common (26% of all injuries), while injuries to ligament/joint capsule were most severe (caused 39% of days lost to injuries). ACL injuries alone caused 30% of the total injury time loss. Table 2 displays the number, incidence, time loss and burden of the body areas and injury diagnoses with the highest burden (see online supplemental table 1 for a complete dataset). The most commonly reported mechanisms for thigh injuries were running/sprinting (39%) and kicking (21%); knee injuries mostly occurred during kicking (13%), tackling (13%), rotation about a planted foot (11%), landing (11%) or other unspecified mechanisms (15%), and ankle injuries during tackling or being tackled (28%), collision with other player (21%) or landing (16%). Most players who sustained ACL injuries (63%) reported injury mechanisms that were likely non-contact, while concussion mostly occurred during collision with other players (72%). Injury mechanisms for all sudden-onset injuries by body region and for the most burdensome diagnoses are displayed in online supplemental table 2.

Injury burden

Figure 2 illustrates the incidence and severity of injuries for the body regions with the highest injury burden. The diagnoses causing the highest injury burden were ACL injuries (39.3 days lost per 1000 hours), concussion (8.3 days lost per 1000 hours) and hamstring muscle injuries (7.9 days lost per 1000 hours).

DISCUSSION

This is the first study in women’s premier league football to record all health problems, including illnesses, irrespective of time loss and medical attention. The results document that, at any given time, one in five players (22%) reported a substantial health problem. Gradual-onset injuries were more common than previously reported, but sudden-onset injuries still caused the greatest burden. Muscle injury was the most common injury type, but ligament injuries caused the greatest burden, particularly ACL injuries, responsible for 30% of the total number of days lost to injuries.

Prevalence and player availability

Of the 22% of players reporting a substantial health problem at any given time, the majority (20%) were due to injury, and only 2% illnesses. While team sport athletes report a lower prevalence of illness compared with athletes from other sports, both seasons in this study included periods with COVID-19 restrictions that likely prevented transmission of infections. Although...
the prevalence of substantial health problems is comparable with studies using the same methodology in other sports, our data highlight that health problems, especially injuries, do represent a concern in women’s football. In a normal training week, for a typical Norwegian premier league team with a squad of 22 players, 7 players were experiencing a health problem and for 5 of these, their performance and participation were at least moderately reduced. Low player availability limits training content, reduces training quality and negatively affects player and team development and football performance.

Injury types, locations and diagnoses

Injury types
The incidence of 6.6 time-loss injuries per 1000 hours is comparable with recent studies from women’s premier league football. Seven (of eight) Irish teams (UEFA club coefficient ranking: 31st–33rd) had 7.9 injuries per 1000 hours during the 2018 and 2019 seasons, seven (of 13) teams in the Dutch/Belgian premier league (UEFA club coefficients ranking: 17th) had 8.4 injuries per 1000 hours in the 2014/2015 season, and one Spanish team followed from 2010 to 2015 (UEFA club coefficient ranking: 6th–11th) had 6.3 injuries per 1000 hours. However, our injury rate was higher than most of the early studies from women’s premier league football (conducted between 2000 and 2010, 3.3–5.5 injuries per 1000 hours), with a few exceptions (6.2–6.8 injuries per 1000 hours). A direct comparison between our results and previous studies should be made with care, as they have all used medical staff to report which has been found to capture fewer time-loss injuries compared with player registrations. Still, it seems clear that the injury rate in women’s football is going in the wrong direction. In contrast, the injury rate in men’s football has decreased during the same period. Increasing demands of the sport, combined with low availability of medical care, strength and conditioning support and facilities and the fact that many female players still have to combine their football career with their academic or working career, may contribute to the escalation in injury rate. With the resources in women’s football increasing, the current data emphasise that medical care, as they have all used medical staff to report which has been found to capture fewer time-loss injuries compared with player registrations. Still, it seems clear that the injury rate in women’s football is going in the wrong direction. In contrast, the injury rate in men’s football has decreased during the same period. Increasing demands of the sport, combined with low availability of medical care, strength and conditioning support and facilities and the fact that many female players still have to combine their football career with their academic or working career, may contribute to the escalation in injury rate.

Injury types, locations and diagnoses

Table 2  Number, incidence, time loss and injury burden of body areas and diagnoses for injury types with a burden of >2.5 days lost per 1000 hours

<table>
<thead>
<tr>
<th>Region, type, diagnosis</th>
<th>Injuries</th>
<th>Incidence</th>
<th>Median time loss</th>
<th>Burden</th>
</tr>
</thead>
<tbody>
<tr>
<td>n (%)</td>
<td>Injuries per 1000 hours (95% CI)</td>
<td>Days (IQR)</td>
<td>Days lost per 1000 hours (95% CI)</td>
<td></td>
</tr>
<tr>
<td>Head</td>
<td>16 (3)</td>
<td>0.2 (0.1 to 0.4)</td>
<td>10.5 (3.5–22.3)</td>
<td>9.2 (8.5 to 9.9)</td>
</tr>
<tr>
<td>Nervous</td>
<td>12 (2)</td>
<td>0.2 (0.1 to 0.3)</td>
<td>11.5 (6.5–22.8)</td>
<td>8.6 (7.9 to 9.32)</td>
</tr>
<tr>
<td>Concussion</td>
<td>11 (2)</td>
<td>0.2 (0.1 to 0.3)</td>
<td>11.0 (5.0–24.5)</td>
<td>8.3 (7.7 to 9.1)</td>
</tr>
<tr>
<td>Lumbar/low back</td>
<td>33 (6)</td>
<td>0.5 (0.4 to 0.7)</td>
<td>1.0 (0.0–5.0)</td>
<td>3.7 (3.3 to 4.2)</td>
</tr>
<tr>
<td>Hip/groin</td>
<td>62 (11)</td>
<td>0.9 (0.7 to 1.2)</td>
<td>2.0 (1.0–6.0)</td>
<td>10.0 (9.2 to 10.8)</td>
</tr>
<tr>
<td>Bone</td>
<td>6 (1)</td>
<td>0.1 (0.0 to 0.2)</td>
<td>13.5 (4.5–78.8)</td>
<td>4.3 (3.8 to 4.8)</td>
</tr>
<tr>
<td>Pubic-related groin injury</td>
<td>5 (1)</td>
<td>0.1 (0.0 to 0.2)</td>
<td>6.0 (4.0–21.0)</td>
<td>2.8 (2.4 to 3.2)</td>
</tr>
<tr>
<td>Thigh</td>
<td>143 (26)</td>
<td>2.2 (1.8 to 2.5)</td>
<td>3.0 (1.0–7.5)</td>
<td>14.7 (13.8 to 15.7)</td>
</tr>
<tr>
<td>Muscle/tendon</td>
<td>112 (20)</td>
<td>1.7 (1.4 to 2.0)</td>
<td>4.0 (1.0–9.0)</td>
<td>13.8 (12.9 to 14.7)</td>
</tr>
<tr>
<td>Quadriceps muscle injury</td>
<td>34 (6)</td>
<td>0.5 (0.4 to 0.7)</td>
<td>2.5 (1.5–7.0)</td>
<td>2.7 (2.3 to 3.1)</td>
</tr>
<tr>
<td>Hamstring muscle injury</td>
<td>38 (7)</td>
<td>0.6 (0.4 to 0.8)</td>
<td>7.0 (3.0–13.0)</td>
<td>7.9 (7.3 to 8.6)</td>
</tr>
<tr>
<td>Adductor muscle injury</td>
<td>33 (6)</td>
<td>0.5 (0.4 to 0.7)</td>
<td>4.0 (0.0–9.0)</td>
<td>3.1 (2.7 to 3.5)</td>
</tr>
<tr>
<td>Knee</td>
<td>86 (15)</td>
<td>1.3 (1.1 to 1.6)</td>
<td>3.0 (1.0–13.0)</td>
<td>55.4 (53.7 to 57.2)</td>
</tr>
<tr>
<td>Cartilage/synovium/bursa</td>
<td>13 (2)</td>
<td>0.2 (0.1 to 0.3)</td>
<td>3.0 (1.0–12.0)</td>
<td>6.9 (6.3 to 7.5)</td>
</tr>
<tr>
<td>Meniscal tear</td>
<td>2 (0)</td>
<td>0.0 (0.0 to 0.1)</td>
<td>182.5 (95.5–268.8)</td>
<td>5.5 (5.0 to 6.1)</td>
</tr>
<tr>
<td>Ligament/joint capsule</td>
<td>18 (3)</td>
<td>0.3 (0.2 to 0.4)</td>
<td>415.0 (325.0–525.0)</td>
<td>41.4 (39.9 to 43.0)</td>
</tr>
<tr>
<td>Anterior cruciate ligament injury</td>
<td>8 (1)</td>
<td>0.1 (0.0 to 0.2)</td>
<td>325.0 (325.0–325.0)</td>
<td>39.3 (37.8 to 40.8)</td>
</tr>
<tr>
<td>Lower leg</td>
<td>38 (7)</td>
<td>0.6 (0.4 to 0.8)</td>
<td>2.0 (0.0–6.8)</td>
<td>8.2 (7.5 to 8.9)</td>
</tr>
<tr>
<td>Muscle/tendon</td>
<td>20 (4)</td>
<td>0.3 (0.2 to 0.5)</td>
<td>2.5 (1.0–8.0)</td>
<td>7.4 (6.7 to 8.0)</td>
</tr>
<tr>
<td>Gastrocnemius muscle injury</td>
<td>9 (2)</td>
<td>0.1 (0.0 to 0.3)</td>
<td>1.0 (1.0–3.0)</td>
<td>2.8 (2.4 to 3.2)</td>
</tr>
<tr>
<td>Achilles tendon rupture</td>
<td>1 (0)</td>
<td>0.0 (0.0 to 0.1)</td>
<td>213.0 (213.0–213.0)</td>
<td>3.2 (2.8 to 3.7)</td>
</tr>
<tr>
<td>Ankle</td>
<td>79 (14)</td>
<td>1.2 (1.0 to 1.5)</td>
<td>2.0 (1.0–7.0)</td>
<td>16.7 (15.8 to 17.7)</td>
</tr>
<tr>
<td>Bone</td>
<td>2 (0)</td>
<td>0.0 (0.0 to 0.1)</td>
<td>108.0 (55.5–160.5)</td>
<td>3.3 (2.9 to 3.7)</td>
</tr>
<tr>
<td>Talus stress fracture</td>
<td>1 (0)</td>
<td>0.0 (0.0 to 0.1)</td>
<td>213.0 (213.0–213.0)</td>
<td>3.2 (2.8 to 3.7)</td>
</tr>
<tr>
<td>Ligament/joint capsule</td>
<td>34 (6)</td>
<td>0.5 (0.4 to 0.7)</td>
<td>2.5 (1.3–11.3)</td>
<td>9.3 (8.6 to 10.0)</td>
</tr>
<tr>
<td>Lateral ligament sprain</td>
<td>33 (6)</td>
<td>0.5 (0.4 to 0.7)</td>
<td>1.0 (0.0–5.0)</td>
<td>3.7 (3.3 to 4.2)</td>
</tr>
<tr>
<td>Tibiofibular ligament syndesmosis injury</td>
<td>3 (1)</td>
<td>0.1 (0.0 to 0.1)</td>
<td>127.5 (80.5–174.3)</td>
<td>5.8 (5.2 to 6.4)</td>
</tr>
<tr>
<td>Foot</td>
<td>66 (12)</td>
<td>1.0 (0.8 to 1.3)</td>
<td>3.0 (1.0–14.0)</td>
<td>11.8 (11.0 to 12.7)</td>
</tr>
<tr>
<td>Bone</td>
<td>10 (2)</td>
<td>0.2 (0.1 to 0.3)</td>
<td>16.0 (7.8–63.3)</td>
<td>5.2 (4.6 to 5.7)</td>
</tr>
</tbody>
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Online supplemental table 1 displays all injuries.
that the risk of ACL injury is two to three times higher for female compared with male football players, and their mechanisms are mostly non-contact in nature. We also know that effective preventive programmes, although not necessarily targeted or adapted to the elite player, do exist but we do not know whether or how these are being implemented. It should also be noted that although the incidence of concussions was low and the median severity was 11 days, it was the second most burdensome injury diagnosis. This was due to some concussions causing major time loss, from 3 weeks to almost a year. Women can have more prolonged symptoms after concussion compared with men, and therefore should be carefully monitored after sustaining concussion to avoid long-term consequences.

**Gradual-onset injuries more common than previously reported**

We observed a greater proportion of gradual-onset injuries than previously reported in women’s premier league football. This was expected, as previous studies have recorded time-loss injuries only. Players often continue training and playing through pain; many gradual-onset injuries are therefore not captured when a time-loss definition is used. Injuries to the thigh, hip/groin, ankle and foot were most burdensome among gradual-onset injuries (figure 2). Carefully developed training plans and good load management could help mitigate the burden of gradual-onset injuries. For this to work, good internal communication between the medical staff and the head coach is crucial. The OSTRC-H severity score was designed to better reflect the consequences of gradual-onset injuries. However, sudden-onset injuries were still the most burdensome both measured by days lost and severity score. Although the total number of injuries recorded and the proportion of gradual-onset versus sudden-onset injuries depend on the injury definition, the distribution of the incidence and severity of body regions was nearly the same whether all injuries or only time-loss injuries were included (figure 2).

Studies of gradual-onset injuries should still use a non-time-loss approach, but recording only time-loss injuries and expressing severity by number of days lost seem to give a reliable picture of the overall injury risk in football. Implementing a surveillance system where players report all health problems weekly (or even daily) may yield significant clinical benefit by helping medical staff identify health problems and intervene early.

**Figure 2** Risk matrices illustrating the incidence of all injuries with (A) sudden and (B) gradual onset and their mean cumulative severity score, and the incidence of time-loss injuries with (C) sudden and (D) gradual onset with mean days lost. Only the body regions with the highest injury burden are presented. Darker yellow represents greater injury burden and the curved lines indicate equal injury burden. Error bars display 95% CIs.
Methodological considerations

The main strengths of this project include the prospective design, the high number of players from all the teams in the league and the two-season duration. This should ensure good external validity for women’s premier league football, although injury rates and patterns may differ between regions. The combined use of players’ self-reporting and team physiotherapists providing the diagnoses grants the benefits of both methods: self-reporting identifies more health problems than injury recording by medical staff, while team medical staff provides detailed information that cannot reliably be recorded by players. Medical staff diagnosed 71% of the injuries, and the undiagnosed injuries were of minor severity, causing 7% of the total injury time loss. The diagnosis rate of illnesses (38%) was low, so our data do not provide much detail about these.

The OSTRC-H2 is dependent on players providing honest information. As team physiotherapists had access to the player reports, it is possible that some players were reluctant to report problems if they were concerned it could reduce their chances of being selected for matches. While the OSTRC-H2 allows players to report problems such as mental illness and eating disorders, no such problems were reported. This was probably because players were hesitant to report these, not that they do not exist in this cohort. The injury mechanisms were self-reported and not validated with video recordings or motion analyses. Mechanisms were chosen from a predetermined drop-down list adapted to the context of football, but it is possible that some players did not find a mechanism describing their injury on the list. To provide valid data, a high response rate is required. The overall response rate in the current study was 79%, similar to what was reported in a study of Norwegian Olympic and Paralympic athletes over a 40-week period, but lower than what has been reported in some shorter-duration studies. The response rate to the questionnaire fell over the course of both seasons, most likely due to reporting fatigue. We observed a relatively constant prevalence throughout the competitive seasons, but it is possible that reporting fatigue has increased the threshold for reporting minor problems towards the end of the seasons. Because injured players also responded to the weekly questionnaire, a considerable part of our strength and conditioning exposure were rehabilitation sessions, and therefore should not be included in the training exposure calculations. As we have calculated incidence from football exposure only, we may have overestimated the incidence compared with studies which have included physical activities aiming to improve or maintain physical condition in their exposure. As players did not respond to the questionnaire for 9 weeks between seasons, we do not have data on health problems sustained in this period and may have underestimated the severity of some problems that occurred toward the end of the 2020 season. We wanted team medical staff to use the surveillance system as a practical tool, which may have allowed them to detect problems and intervene early and may have reduced the severity of some health problems.

Clinical implications

The fact that one in five players had a substantial health problem at any given time, the high rate of muscle injuries and substantial injury burden caused by ACL injuries and concussions calls for action. The rapid and encouraging developments taking place in women’s football must be accompanied with greater medical and strength and conditioning support to ensure player well-being. The majority of the ACL injuries had non-contact mechanisms and we know that preventative measures can mitigate the risk of these. Future research should aim to understand how these measures best can be implemented in professional women’s football and identify potential barriers in this setting. Concussions mainly occurred in collision with another player. Future research should investigate if this is associated with foul play. If so, it could be considered if intentional elbowing to the head should receive an extra focus in the women’s game, as women can suffer more severely from concussions than men. The most common mechanism of thigh injuries was running or sprinting, so implementing measures to properly prepare the players for the increased running velocities required in the women’s game likely is a good investment to mitigate thigh injury risk. How to do this most safely and effectively, however, remains to be researched. Currently, we are far from having enough research to support the decision-making for coaching and medical staff in women’s football. Injury risk factors and mechanisms need to be identified and better understood. Exercises like the Nordic Hamstrings and the Copenhagen Adduction exercises have been found to be effective in reducing the risk of hamstrings and adductor injuries in male football players, but their preventative effect on female players remains to be studied. Preventative measures tailored to the needs of the modern female footballer must be developed, tested and constantly re-evaluated to keep pace with the accelerated development of women’s football.
REFERENCES

1. UEFA. Women’s football across the national associations 2017-2018.