Incidence of injury in adult elite women’s football: a systematic review and meta-analysis

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ABSTRACT

Aim To estimate the incidence of injury in adult elite women’s football and to characterise the nature and anatomical location of injuries.

Design Systematic review and meta-analysis.

Data sources Combinations of the key terms were entered into the following electronic databases (PubMed, SPORTDiscus, Science Direct and Discover) from inception to May 2021.

Eligibility criteria for selecting studies (1) Used a prospective cohort design; (2) captured data on elite women players; (3) reported injury incidence by anatomical site; (4) captured data of at least one season or national team tournament; (5) included a definition of injury; and (6) written in English.

Results The search identified 1378 records. Twelve studies published between 1991 and 2018 were included in our review and sampled 129 teams. In domestic club football, injury incidence rate was estimated to be 5.7/1000 hours (total), 19.5/1000 hours (match) and 3.1/1000 hours (training). In tournament, football match incidence was estimated to be 55.7/1000 hours. The knee (22.8%; 368/1822) was the most common site of injury in domestic club football. The ankle (23.7%; 105/443) was the most common site of injury in tournament football. Ligament sprains were the most common type of injury (27.8%), followed by muscle strains (19.1%). Seven studies (58%) had a high risk of bias associated with exposure definition and measurement and considerable heterogeneity exists between the included studies (I²=49.7%–95%).

Summary/conclusion Ligament sprains occur more frequently in adult elite women football players. We advise caution in interpreting point estimates of the incidence of injury due to high statistical heterogeneity. Standardising injury reporting and the accurate recording of match and training exposure will overcome such limitations.

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INTRODUCTION

Women’s football is played in more than 100 countries and the Fédération Internationale de Football Association 2019 Women’s Football Strategy aspires to double participation rates to 60 million by 2026. 1 A recent scoping review in 2021 revealed that sports medicine research including studies relating to injury (451 studies) and illness (29 studies) was the most common theme in women’s football research to date. 2 A recent meta-analysis including amateur and collegiate level female players estimated the injury incidence rate to be 6.1 injuries/1000 hours of exposure. 3

In 2017, it was estimated that there were 1790 professional and 1782 semiprofessional registered adult women players in Europe. 4 Up-to-date participation rates are difficult to obtain as they rely on retrospective survey data collated from participating football associations from the preceding season. A useful proxy measure of increased participation is the expansion of elite domestic leagues and international competitions which allows
players the opportunity to train and compete within an elite environment.5–6

An initial search of published literature did not find any systematic reviews with meta-analyses of pooled observational cohort data estimating the incidence of injury in adult elite women’s domestic league football and tournament football. The primary aim of our systematic review was to estimate the incidence of injury (overall, match and training) in elite adult women’s football. A secondary aim was to characterise the nature and anatomical location of injuries.

METHOD
This review was prepared and conducted according to the Preferred Reporting Items for Systematic Reviews and Meta-Analyses guidelines.7 The Condition, Context, Population framework8 for reviews addressing a question relevant to incidence or prevalence was considered when eligibility criteria was established and agreed on by authors.

Inclusion and exclusion criteria
Inclusion criteria were reports of studies that: (1) used a prospective cohort design; (2) captured data on elite level or national team female/women players; (3) reported injury incidence by anatomical site; (4) captured data of at least one season or team tournament; (5) included a definition of injury and (6) were written in English. Elite-level participation was considered as the two highest national football league divisions within the country of publication, providing the level of participation (of participants) included in the review.9

The following articles were excluded: (1) expert opinions, case reports/series, case–control studies, cross-sectional studies, self-report or retrospective studies; (2) studies conducted in male football only; (3) studies conducted on samples aged <18 years; (4) studies conducted on amateur players only and (5) studies conducted on alternative versions of football including; futsal, indoor football (six-a-side), Paralympic football, powerchair football, beach football, street football, three-sided football or walking football.

Literature search
Two authors (LM and AA) carried out a search of the electronic databases (from inception to May 2021 PubMed, SPORTDiscus, Science Direct and Discover). For full-text publications of cohort studies that reported incidence of injury in adult elite women’s football (online supplemental appendix S1: Search string). All citations were imported to EndNote X7 (Thomson Reuters, USA) and duplicates were removed by LM.

Literature screening
Two reviewers (LM and AA) independently screened title and abstracts of records and obtained full texts of potentially eligible studies. Full texts were screened independently (LM and AA) against the inclusion criteria and any disagreements were resolved via consensus with a third reviewer (GJ) acting as arbiter. Handsearching the reference list of a recent systematic review5 was conducted. No handsearch of specific sports medicine journals was performed.

Quality and risk of bias assessment
Two authors (LM and AA) independently assessed the methodological quality of included studies using a modified version of the Newcastle-Ottawa Scale (NOS). The version replicated the scale used in a previous systematic review and meta-analysis of injury in women’s football.5 The criteria descriptors were adjusted for the purpose of this review (online supplemental appendix S2). One star could be awarded for each criterion if methodological detail was clearly reported. Eight stars could be awarded for a given study and were categorised into low-quality ‘≤3 stars’, moderate-quality ‘≥4 to ≤6 stars’ and high-quality studies ‘≥7 stars’.10 Reporting quality was assessed using a tool adapted from Strengthening The Reporting Of Observational Studies in Epidemiology statement (STROBE)11 that had been used in a previous systematic review of injury epidemiology in football.12 The tool had five items: (1) study setting, location and study period; (2) eligibility criteria and sources and methods of participant selection; (3) exposure definition and measurement; (4) study outcome definition and measurement and (5) main result and precision. Summary of the quality of evidence were presented with items judged as low risk of bias were awarded 1 point, high-risk items were awarded 0 points, resulting in a possible range of 0–5 in total for every included study (online supplemental appendix S3, S6 and S7).

Data extraction
The following study information was extracted and recorded on a data extraction proforma by one reviewer (LM) and checked for accuracy by a second reviewer (GJ): study characteristics (authors, publication year, country of origin); characteristics of the study population; study design; injury definition and football exposure (study period, number of teams and seasons, total, match and training exposure), (1) incidence of injuries/1000 hours, (2) total, training and match exposure, (3) injury tally counts and percentages of injuries, (4) injury severity and (5) sites and types of injuries. Where it was not possible to extract elite player data from studies containing amateur data, contact with authors was made and the extracted data forwarded to LM.

Data management and analysis
Injury count data, exposure time and injury incidence rates per 1000 hours were extracted from the included studies with the reported 95% CI. Where an incidence rate was presented with a SD, it was transformed to a 95% CI using a standardised equation.13

No attempts were made to artificially generate an injury incidence rate by estimating team level exposure...
to avoid overestimating or underestimating exposure
time. Data were being extracted from a series of studies
that were conducted independently of each other, it is
unlikely that studies would be functionally equivalent
(eg, difference in exposure hours, number of matches
played and training sessions completed, total number
of injuries) and this could introduce unobserved hetero-
genety. Therefore, a random effects model was used to
provide a pooled estimate of the total incidence of injury
and for match and training incidence.

Visual inspection of results and forest plots was
performed and heterogeneity was quantified using the
I^2 statistic, which represents the percentage of total varia-
tion across all studies due to between-study heterogeneity.
Thresholds for heterogeneity (low, 0%–40%; moderate,
30%–60%; substantial, 50%–90%; considerable hetero-
genety, 75%–100%), recommended by Cochrane were
used. Data analysis was conducted using Comprehensive
Meta Analysis (V.3.0) software package.

RESULTS
The search identified 1378 records of which 690 records
were removed as duplicates and a further 645 records
were excluded for not meeting our eligibility criteria on
screening of title and abstract (figure 1). The reference
list of a recent systematic review was screened which
revealed four reports that required full text screening.
Thus, full-text reports were obtained for 47 records of
which 14 were excluded due to the population not being
described as adult elite women football players. Twenty-
one records were excluded because they did not meet
our criteria for either prospective medical reporting of
injuries, were review articles, where data were reported
via secondary analysis or was not available in English.
There were 12 studies included in our review and we were
able to extract and pool data from nine studies for meta-
analysis. A description of the excluded studies is available
in online supplemental appendix S4.

Characteristics of included studies
There were 12 studies included for review which were
published between 1991 and 2018 sampling a total of 129
teams. Ten studies sampled teams from domestic club
football (71 teams) which took place between 1988 to
2015 (table 1) and two studies sampled teams from
five national team tournaments (58 teams) taking place
between 1999 and 2005 (table 2).

Studies using samples from club football
Of the 10 studies that included participants sampled
from domestic football leagues, four were conducted
using multiple teams from Sweden, two from
Germany, and one from each of the following coun-
tries: Netherlands, Norway, Spain and USA. Eight
(80%) studies reported data from multiple teams over
one season.
### Table 1 Characteristics of included studies related to club football

<table>
<thead>
<tr>
<th>Publication</th>
<th>Country</th>
<th>Setting</th>
<th>Age (mean±SD)</th>
<th>Teams</th>
<th>Players</th>
<th>Injury recorder</th>
<th>Injury Severity Classifications</th>
<th>STROBE/5 (Reporting quality)</th>
<th>NOS/8 (Methodological quality)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Blokland et al†</td>
<td>The Netherlands</td>
<td>Club Football, Division I; one season, '2014/2015; August–June*</td>
<td>22.4±3.3</td>
<td>6</td>
<td>114</td>
<td>Physician or Physical Therapist</td>
<td>5</td>
<td>5</td>
<td>7</td>
</tr>
<tr>
<td>Engström et al†</td>
<td>Sweden</td>
<td>Club Football, Division I–II, 1 season, '1988/1999; November–October*</td>
<td>21†</td>
<td>2</td>
<td>41</td>
<td>Medical students</td>
<td>3ii</td>
<td>1</td>
<td>6</td>
</tr>
<tr>
<td>Faude et al‡</td>
<td>Germany</td>
<td>Club Football, Division I; one season, '2003/2004; August–June†</td>
<td>22.4±5.0</td>
<td>9</td>
<td>165</td>
<td>Physician or Physical Therapist</td>
<td>3i</td>
<td>2</td>
<td>7</td>
</tr>
<tr>
<td>Gaulrapp et al‡</td>
<td>Germany</td>
<td>Club Football, Division I; one season, '2004/2005; August–June†</td>
<td>22.8†</td>
<td>12</td>
<td>254</td>
<td>Team Physician</td>
<td>3i</td>
<td>3</td>
<td>7</td>
</tr>
<tr>
<td>Giza et al‡</td>
<td>USA</td>
<td>Club Football, Division I; two seasons, '2001 and '2002; February–August*</td>
<td>Not reported</td>
<td>8</td>
<td>202</td>
<td>Team trainer verified by Physician</td>
<td>Not reported</td>
<td>2</td>
<td>6</td>
</tr>
<tr>
<td>Hägglund et al‡</td>
<td>Sweden</td>
<td>Club Football, Division I; one season, '2005; January–October*</td>
<td>23±4</td>
<td>12</td>
<td>228</td>
<td>Team Physician</td>
<td>4</td>
<td>5</td>
<td>7</td>
</tr>
<tr>
<td>Jacobson and Tegner‡</td>
<td>Sweden</td>
<td>Club Football, Division I; one season, '00; January–October*</td>
<td>23±4</td>
<td>9</td>
<td>159</td>
<td>Team Physiotherapist</td>
<td>4</td>
<td>3</td>
<td>5</td>
</tr>
<tr>
<td>Laruskain et al‡</td>
<td>Spain</td>
<td>Club Football, Division I; five seasons, 2010–2015; July–June*</td>
<td>25±5</td>
<td>1</td>
<td>35</td>
<td>Multiple</td>
<td>4</td>
<td>5</td>
<td>6</td>
</tr>
<tr>
<td>Östenberg and Roos‡</td>
<td>Sweden</td>
<td>Club Football, Division I–II, 1 season, 96 season</td>
<td>24.1±6.1§</td>
<td>2§</td>
<td>32§</td>
<td>Physical Therapist</td>
<td>3ii</td>
<td>1</td>
<td>6</td>
</tr>
<tr>
<td>Tegnander et al‡</td>
<td>Norway</td>
<td>Club Football, Division I; one season, '01; April–October</td>
<td>23±4</td>
<td>10</td>
<td>181</td>
<td>Team Physiotherapist</td>
<td>3ii</td>
<td>4</td>
<td>8</td>
</tr>
</tbody>
</table>

Severity classification key:
- 3i—minor (0–7 days), moderate (8–30 days), major (+30 days).
- 3ii—minor (1–7 days), moderate (8–28 days), severe (+28 days).
- 3iii—minor (7 days or less), moderate (7 days to 1 month), major (more than 1 month).
- 4—minimal (1–3 days), mild (4–7 days), moderate (8–28 days), severe (+28 days).
- 5—minimal (0 days), slight (1–3 days), minor (4–7 days), moderate (8–28 days), major (+28 days).

*Including preseason.
†No SD reported.
‡Mid-season break December–January.
§Data from elite level players only provided by author.
NOS, Newcastle-Ottawa Scale; STROBE, Strengthening The Reporting of Observational Studies in Epidemiology statement.
multiple teams over two seasons and a further study captured data from one team over five seasons. The total number of participants from all study samples was 1411. The maximum number of participants in a study was 254 and the minimum number of participants in a study was 35. The maximum duration of data collection (including preseason) was 12 months, and the minimum duration was 7 months (table 1).

A time loss injury definition was used in all studies in domestic club football and more frequently used than a medical attention injury definition. Illnesses were not reported in any studies (online supplemental appendix table S5).

There was inconsistency in how studies classified injury severity. Five studies applied ‘minor, moderate, major’ time-loss (days lost) categories, three studies reported ‘minimal, mild, moderate and severe’ categories and one study applied ‘minimal, slight, mild, moderate and major’ time-loss injury categories. Only two studies reported a ‘career ending’ time-loss category. While all studies assigned a temporal measure of time (days lost) within each time-loss category, these were inconsistent across studies.

Studies using samples from tournament football
Two studies sampled five national team football tournaments; two Olympic Games, two World Cups and one European championship. There was a total of 58 national teams included in the two studies. The maximum number of national teams in a tournament was 16 and the minimum number of teams in a tournament was 8. A medical attention injury definition was applied in one study (Olympic Games and World Cups), with a further study (one European championship) applying a time-loss definition. These studies utilised similar injury severity categories (table 2).

Quality assessment and risk of bias
The average number of stars awarded for study quality (NOS) was 6 (range: 5–8 stars). All studies provided a definition of injury (criteria 2). All studies provided details on assessment outcome (criteria 6) where injuries were recorded via a Diagnostic Coding System (eg, Orchard Sports Injury Illness Classification System. All studies provided sufficient detail that met criteria 7 as the injury surveillance period lasted for at least one football season and/or complete football tournament.

Three studies provided insufficient evidence that participants were representative of the average football player at the time the study was conducted (criteria 3). Nine studies provided insufficient evidence that participants were injury free at the start of the study (criteria 5) and two studies reported participant loss to follow-up of greater than 20% (criteria 8). The STROBE assessment revealed 11 studies were assessed as having a low risk of bias for study setting, location and study period (item 1) and 10 studies had low risk of bias for unclear or biased selection of participants (item 2). Four studies provided a low risk of bias across all five items and three studies provided a low risk of bias across four items (online supplemental appendix S7). It was noteworthy that seven studies had a high risk of bias associated with exposure definition and measurement (item 3) where exposure was not clearly reported or was approximated through a team-level estimate calculation (eg, number of players on the field, multiplied by the number of games and by the factor 1.5 (equivalent to a 90 min match)). There were seven studies that had a high risk of bias associated with imprecision of results (item 5) where incidence data were presented without an SD or 95% CI. Any discrepancies between the reviewers during the process of assessing risk of bias were resolved via
Incidence rate of injury in domestic Club football

The highest total injury incidence rate was 8.4 injuries/1000 hours, and the lowest rate was 1.93 injuries/1000 hours (table 3). Match injury incidence rate was 30.3/1000 hours (highest) and 12.6/1000 hours (lowest) of exposure. Training incidence rate was 5.2/1000 hours (highest) and 1.2/1000 hours (lowest) of exposure.

Incidence rate of injury in tournament football

The total injury incidence rate was 70.0/1000 hours (highest) and 39.0/1000 hours of exposure (lowest) when a medical attention injury definition was utilised. The total injury incidence rate was 11.6/1000 hours when a time-loss injury definition was used (table 4).

Site of injury

In domestic club football, lower limb injuries accounted for 85% of all injuries (1373/1615). The knee (23%; 368/1615) was the most common site of injury; the thigh region (21%, 333/1615) was the second most common site of injury; and the ankle (18%, 290/1615) was the third most common site of injury where discrete injury tallies (by injury site) in studies were available.18–26

In football tournaments,28 using a medical attention injury definition, lower limb injuries accounted for 66% (248/380) of all injuries. The ankle (18%, 50/380) was the third most common site of injury where discrete injury definitions were used (table 4).

Type of injury

Ligament sprains were the most common type of injury in elite adult women’s football (34%, 617/1810), followed by muscle strains (27%, 482/1810) and blunt soft tissue trauma (contusions & haematomas) (21%, 387/1810). In domestic club football, ligament sprains (37%, 517/1413) were the most common type of injury, followed by muscle strains (31%, 441/1413) and blunt soft tissue trauma (contusions and haematomas) (15%, 214/1413). (online supplemental appendix S9).

In football tournaments, using a medical attention injury definition,28 blunt soft tissue trauma (contusions and haematomas) was the most common type of injury (44%, 165/378) followed by ligament sprains (25%, 96/378) and muscle strains (10%, 38/378) (online supplemental appendix S9). Blunt soft tissue trauma (42%, 8/19), ligament sprains (21%, 4/19) and muscle strains (16%, 3/19) were the most common types of injury in tournament football utilising a time-loss injury definition.29

Ankle ligament sprains (43%, 131/308) was the most common injury diagnosis, followed by quadriceps muscle strains (16%, 48/308) and knee ligament sprains (12%, 38/308) when available injury diagnosis data was gleaned from the following studies.20 22 25 28

Severity of injury

In domestic club football,18–21 23–27 moderate time loss injuries were most common (8–28 days, 34%, 559/1645), followed by mild injuries (3–7 days, 35%, 544/1645); severe injuries (>28 days, 18%, 298/1645); minimal injuries (1–3 days, 12%, 204/1645); slight injuries (zero days, 2%, 28/1645) and career ending injuries (0.7%, 12/1645) (online supplemental appendix S9).

In tournament football using a medical attention injury definition,28 78% (116/149) of injuries prevented participation in match or training for up to 1 week, followed by moderate injuries (8–28 days; 10%, 15/149) and severe injuries (>28 days; 6%, 9/149). Tournament football utilising a time-loss injury definition,29 minimal injuries (1–3 days; 10/18, 56%) were most common, followed by moderate injuries (>7, <28 days, 4/18, 22%) and slight injuries (zero days, 3/18, 17%) and severe injuries (≥28 days; 3/18, 22%). (online supplemental appendix S9)

Incidence proportion (first injury)

Eight studies18–21 23 24 27 30 related to domestic club football reported the number of players sustaining at least one injury. The incidence proportion ranged between 0.32 and 0.81. Thus, the estimated risk of sustaining at least one injury in a season ranged from 32% to 81%. Incidence proportion data for repeat, multiple injuries or injuries sustained during tournament football were not available within studies.

Meta-analysis

Incidence of injury: total, match and training

In domestic club football, the total incidence was estimated to be 5.7 injuries/1000 hours of exposure (95% CI 4.3 to 7.2, I²=95%) (figure 2).18 20 21 23–25 match incidence was 19.5 injuries/1000 hours (95% CI 16.2 to 22.8, I²=72%) (figure 3)18 20 21 23–25 and training incidence was 3.2 injuries/1000 hours of exposure (95% CI 2.1 to 4.3, I²=95%) (figure 4).18 20 21 23–25

In football tournaments using a medical attention injury definition the match incidence was estimated to be 55.7 injuries/1000 hours of exposure (95% CI 42.8 to 68.6, I²=49.7%) (figure 5).28 There was insufficient data to provide a pooled estimate of match incidence from studies in tournament football utilising a time loss injury definition29 (table 5).

Incidence proportion (first injury)

The average probability of any player sustaining at least one injury in a domestic club football season (incidence proportion) was 55% (95% CI 47% to 63%, I²=89%).18–21 27
### Table 3 Injury incidence data: domestic club football

<table>
<thead>
<tr>
<th>Study</th>
<th>Country</th>
<th>Setting</th>
<th>Teams</th>
<th>Players</th>
<th>Injury tally n (%)</th>
<th>Players injured (%)</th>
<th>Total incidence/1000 hours (95% CI)</th>
<th>Match incidence/1000 hours (95% CI)</th>
<th>Training incidence/1000 hours (95% CI)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Blokland et al[^8]</td>
<td>Netherlands</td>
<td>Division I</td>
<td>6</td>
<td>114</td>
<td>179 (49)</td>
<td>92 (51)</td>
<td>8.4±9.2 (6.4 to 10.3)*</td>
<td>30.3±60.5 (19.3 to 41.2)*</td>
<td>5.2±7.3 (4.2 to 6.3)*</td>
</tr>
<tr>
<td>Engström et al[^9]</td>
<td>Sweden</td>
<td>Division I–II</td>
<td>2</td>
<td>41</td>
<td>78† (46)</td>
<td>23 (30)</td>
<td>33 (80)</td>
<td>12†</td>
<td>24†</td>
</tr>
<tr>
<td>Faude et al[^20]</td>
<td>Germany</td>
<td>Division I</td>
<td>9</td>
<td>165</td>
<td>241§</td>
<td>126 (52)</td>
<td>6.8 (5.9 to 7.7)</td>
<td>23.3 (19.1 to 27.5)</td>
<td>2.8 (2.2 to 3.4)</td>
</tr>
<tr>
<td>Gaurapp et al[^21]</td>
<td>Germany</td>
<td>Division I</td>
<td>12</td>
<td>254</td>
<td>246</td>
<td>91 (37)</td>
<td>3.3 (2.9 to 3.7)</td>
<td>18.5 (15.7 to 21.3)</td>
<td>1.4 (1.1 to 1.7)</td>
</tr>
<tr>
<td>Giza et al[^22]</td>
<td>USA</td>
<td>Division I</td>
<td>8</td>
<td>202</td>
<td>173</td>
<td>Not reported</td>
<td>Not reported</td>
<td>110 (55)</td>
<td>1.9†</td>
</tr>
<tr>
<td>Hägglund et al[^32]</td>
<td>Sweden</td>
<td>Division I</td>
<td>12</td>
<td>228</td>
<td>299</td>
<td>175 (59)</td>
<td>150 (66)</td>
<td>16.1 (13.5 to 19.2)</td>
<td>3.8 (3.2 to 4.4)</td>
</tr>
<tr>
<td>Jacobson and Tegner[^23]</td>
<td>Sweden</td>
<td>Division I</td>
<td>1</td>
<td>269</td>
<td>237</td>
<td>121 (51)</td>
<td>129 (48)</td>
<td>13.9 (8.2 to 18.5)</td>
<td>2.7 (1.8 to 3.6)</td>
</tr>
<tr>
<td>Laruskain et al[^26]</td>
<td>Spain</td>
<td>Division I</td>
<td>1</td>
<td>35</td>
<td>160†</td>
<td>80 (50)</td>
<td>75 (47)</td>
<td>Not reported</td>
<td>6.3 (5.4 to 7.4)</td>
</tr>
<tr>
<td>Östenberg and Roos[^26]</td>
<td>Sweden</td>
<td>Division I–II</td>
<td>2**</td>
<td>32**</td>
<td>20**</td>
<td>13 (65)**</td>
<td>7 (35)**</td>
<td>Not reported</td>
<td>4.9†</td>
</tr>
<tr>
<td>Tegnander et al[^27]</td>
<td>Norway</td>
<td>Division I</td>
<td>10</td>
<td>181</td>
<td>189</td>
<td>100 (53)</td>
<td>93 (52)</td>
<td>23.6††† and 0.8†††</td>
<td>3.1††† and 0.7†††</td>
</tr>
</tbody>
</table>

[^8]: 95% CI calculated by the authors of this review based on injury data and the SD presented in the study.  
[^9]: 95% CI calculated by the authors of this review based on injury data and the SD presented in the study.  
[^10]: Data from elite-level players provided by author.  
[^11]: Only acute injury incidence reported.  
[^12]: Only overuse injury incidence reported.  
[^13]: Authors state unclear circumstances for three injuries. Some injuries were multiple injuries and the total number of diagnoses n=276 exceeded the number of injuries.  
[^14]: Missing data on five injuries (training or match).  
[^15]: Authors state unclear circumstances for three injuries. Some injuries were multiple injuries and the total number of diagnoses n=276 exceeded the number of injuries.  
[^16]: Only acute injury incidence reported.  
[^17]: Only overuse injury incidence reported.  
[^18]: Only acute injury incidence reported.  
[^19]: Only overuse injury incidence reported.  
[^20]: Only acute injury incidence reported.  
[^21]: Only overuse injury incidence reported.  
[^22]: Only acute injury incidence reported.  
[^23]: Only overuse injury incidence reported.
There were insufficient data to provide incidence proportion estimates for repeat injuries, multiple injuries or injuries sustained during tournament football.

**DISCUSSION**

The aim of our review was to provide a pooled estimate of the incidence of injury (overall, match and training) across adult elite women's club football and tournament football and ascribe the nature and anatomical location of these injuries.

**Injury incidence rate**

In domestic club football, the total incidence rate found in our review (5.7/1000 hours, 95% CI 4.3 to 7.2, I²=95%) implies that elite adult women players have a rate of injury lower than that found in elite adult male football players (8.1/1000 hours, 95% CI 7.2 to 9.0, I²=99.1%). However, we remain cautious of point estimates presented due to high heterogeneity values found in both reviews. Furthermore, our review and a recent publication have not performed a direct comparison of pooled data extracted for men vs women, to prove the existence or otherwise, that any difference exists.

The injury incidence rate during tournament matches (55.7/1000 hours, 95% CI 42.8 to 68.6, I²=49.7%) was higher than that found in domestic club football matches (19.5/1000 hours, 95% CI 16.2 to 22.8, I²=72%). However, we remain cautious of point estimates presented due to high heterogeneity values found in both reviews. Furthermore, our review and a recent publication have not performed a direct comparison of pooled data extracted for men vs women, to prove the existence or otherwise, that any difference exists.

Our pooled incidence rate and 95% CI's overlap with estimated rates found in a recent systematic review of injury profiling in women's football (total, 6.1, 95% CI 4.6 to 7.7, I²=98.8%; training, 3.5, 95% CI 2.4 to 7.7, I²=97.7%; match, 19.2, 95% CI 16.0 to 22.4, I²=94.9%). This descending injury incidence order reflects the same trend found in male elite football and reaffirms that in line with team sports (football, basketball, male handball, rugby, male handball as rugby, match incident rate) match injury incidence rates are higher than training injury rates. Injury incidence rate during tournament matches (25.7/1000 hours, 95% CI 22.8 to 29.9, I²=95%) is higher than that found in domestic club football matches (19.5/1000 hours, 95% CI 16.2 to 22.8, I²=72%). However, we remain cautious of point estimates presented due to high heterogeneity values found in both reviews. Furthermore, our review and a recent publication have not performed a direct comparison of pooled data extracted for men vs women, to prove the existence or otherwise, that any difference exists.

**Table 4**  Injury incidence data: tournament football

<table>
<thead>
<tr>
<th>Study details</th>
<th>Medical attention (injury definition) data</th>
<th>Time-loss (injury definition) data</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Total injuries/1000 hours (95% CI)</td>
<td>Injuries/1000 hours (with expected time loss) (95% CI)</td>
</tr>
<tr>
<td></td>
<td>Total injuries 1000 hours (95% CI)</td>
<td>Match injuries 1000 hours (95% CI)</td>
</tr>
<tr>
<td>Junge and Dvorak</td>
<td>USA WC, 1999 16 176* 32 42 39 (15 to 53)</td>
<td>USA WC, 2003 16 176* 54 52 (38 to 66) 27 (17 to 37) 0.9 (0.6 to 1.2)</td>
</tr>
<tr>
<td>Australia OG, 2000 8 88* 16 34 65 (43 to 87) 24 (10 to 38) 0.8 (0.3 to 1.3)</td>
<td>Greece OG, 2004 10 110* 20 45 70 (50 to 90) 30 (16 to 43) 1.0 (0.5 to 1.4)</td>
<td>11.6±1.4 (9.8 to 13.4)† 36±39 (30 to 42)† 2.5±3.6 (1.9 to 3.1)†</td>
</tr>
</tbody>
</table>

*Sample based on authors incidence calculation; 11 players/team.
†95% CI calculated by the authors of this review based on injury data and the SD presented in individual studies.
EC, European Championship; OG, Olympic Games; WC, Women's World Cup.

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cited in the study referred to a non-footballing amateur cohort.

Recurrent injuries in sport are common and it is widely accepted that subsequent injury is strongly associated with previous injury occurrence. Our estimate of injury risk (incidence proportion) revealed that 55% of players sustained at least one injury in a season. However, it was unclear in studies whether injuries were specifically first injuries and how many were categorised as reinjuries or multiple reinjuries of the same or different anatomical site.

In domestic club football, the majority of injuries were of moderate severity (34%) (8–28 days), followed by mild (33%) (3–7 days), whereas in a recent systematic review and meta-analysis in elite male football players, minimal injuries (1–3 days) were most frequent, followed by mild injuries (3–7 days). A recent single site cohort study found elite women players experienced a greater number of moderate and severe injuries than their male counterparts with 21% more days lost in women than men. However, reinjury and multiple reinjury data were either not clearly presented or not available from studies.

In domestic club football, the majority of injuries were of moderate severity (34%) (8–28 days), followed by mild (33%) (3–7 days), whereas in a recent systematic review and meta-analysis in elite male football players, minimal injuries (1–3 days) were most frequent, followed by mild injuries (3–7 days). A recent single site cohort study found elite women players experienced a greater number of moderate and severe injuries than their male counterparts with 21% more days lost in women than men. However, reinjury and multiple reinjury data were either not clearly presented or not available from studies.

Figure 2  Overall injury incidence rate: domestic club football.

Figure 3  Match injury incidence rate: domestic club football.
to extract which limits the extent to which injury burden and injury severity (including the specific types of injuries) can be currently presented in adult elite women’s football.

I² values exceeded 75% in our review and in a recent review of women’s football injury profiling and thus significant heterogeneity exists between the studies available. Consequently, in our review no further meta-analytical pooling of data was conducted. Climatic playing conditions (cooler and warmer climates), match fixture congestion, frequency of matches played, mid-season breaks and levels of professionalism are factors that have been reported as potential sources of methodological heterogeneity found in male elite football literature. Whether incidence rates are moderated by these factors through meta-analysis currently remains unknown as this data was not readily extractable from the studies available. We wish to be judicious in interpreting the results from this review and highlight areas of inconsistencies in injury terminology, data collection procedures and calculations of exposure which might explain the high heterogeneity found and furthermore, make recommendations for future work.

Evaluating injury terminology

In our review studies applied either a time loss definition, an ‘any physical complaint’ or medical attention injury definition (online supplemental table S5), where the choice of vocabulary used in these injury definition statements varied. Differences might stem from the specific context from which statements were developed or, is a result of the diverse vocabulary and/or grammatical variation that exists. Adopting illness and injury definitions that embrace a broad array of injury-related and...
### Table 5  Summary of findings table

<table>
<thead>
<tr>
<th>No of studies</th>
<th>Study design</th>
<th>STROBE Reporting quality</th>
<th>NOS Methodological quality</th>
<th>Inconsistency ($I^2$)</th>
<th>Summary effect</th>
</tr>
</thead>
<tbody>
<tr>
<td>Overall injury incidence rate for adult elite women in domestic club football</td>
<td>18 20 21 23–25</td>
<td>Observational cohort</td>
<td>Moderate</td>
<td>Moderate</td>
<td>Considerable (95%)</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>5.7 (4.3 to 7.2) injuries/1000 hours of exposure</td>
</tr>
<tr>
<td>Training injury incidence rate for adult elite women in domestic club football</td>
<td>18 20 21 23–25</td>
<td>Observational cohort</td>
<td>Moderate</td>
<td>Moderate</td>
<td>Considerable (95%)</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>3.2 (2.1 to 4.3) injuries/1000 hours of exposure</td>
</tr>
<tr>
<td>Match injury incidence rate for adult elite women in domestic club football</td>
<td>18 20 21 23–25</td>
<td>Observational cohort</td>
<td>Moderate</td>
<td>Moderate</td>
<td>Substantial (72%)</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>19.5 (16.2 to 22.8) injuries/1000 hours of exposure</td>
</tr>
<tr>
<td>Match injury incidence rate in tournament football utilising a medical attention injury definition</td>
<td>28</td>
<td>Observational cohort</td>
<td>Low</td>
<td>High</td>
<td>Moderate (49.7%)</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>55.7 (42.8 to 68.6) injuries/1000 hours of exposure</td>
</tr>
<tr>
<td>Match injury incidence rate in tournament football utilising a time loss injury definition</td>
<td>29</td>
<td>Observational cohort</td>
<td>Low</td>
<td>High</td>
<td>None*</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>36 (30 to 42) injuries/1000 hours of exposure</td>
</tr>
<tr>
<td>Training injury incidence rate in tournament football utilising a time loss injury definition</td>
<td>29</td>
<td>Observational cohort</td>
<td>Low</td>
<td>High</td>
<td>None*</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>2.5 (1.9 to 3.1) injuries/1000 hours of exposure</td>
</tr>
</tbody>
</table>

*Inconsistency described as per Cochrane guidance for a single cohort.

NOS, Newcastle Ottawa Scale; STROBE, Strengthening The Reporting of Observational Studies in Epidemiology statement.
illness related health problems\textsuperscript{45} that may affect a player is worthy of consideration in future epidemiological research in women’s football.

An update on the consensus statement of injury and illness definitions currently used in football\textsuperscript{47} is required so that it can acknowledge specific urogenital/gynaecological female/women injury and illness symptom clusters. Specifically, these might include; loss of normal menstruation, irregular or infrequent menstruation, menstrual cramps/pain and excessively long periods recently highlighted in the 2020 International Olympic Committee Consensus Statement\textsuperscript{43} as required women-specific medical issues for recording and reporting of epidemiological data on injury and illness in sport.

Previous meta-analyses\textsuperscript{34,48} have attributed heterogeneous estimates of injury incidence to the inconsistencies in injury definitions and severity descriptors applied within studies. Studies in this review used inconsistent injury severity classification descriptors. Some studies\textsuperscript{19-21,26-27} applied three severity categories (mild, moderate, severe) and others applied four\textsuperscript{25-26} (minimal, mild, moderate, severe) or five\textsuperscript{18} severity categories (minimal, slight, mild, moderate, major). Subgroup meta-analyses on injury site and injury type data was not possible in adult elite women cohorts (without threatening contaminating data) as the temporal measure assigned (time/days lost) within each descriptor was inconsistent across studies.

It is recommended that future studies adopt a consistent and clear categorisation of a first injury, reinjury and multiple reinjury of the same or different type, identify the underlying mechanisms as well as ensuring consistent terminology is used before subsequent estimates of injury burden can be made.

**Data collection and evaluating data processing**

To provide estimates of the extent of injury burden, capturing and evaluating training and match exposure consistently and accurately within sport is fundamental to quantifying injury risk. The athletes at risk (AAR) method\textsuperscript{14} has been recommended within injury consensus statements (football,\textsuperscript{47} rugby union\textsuperscript{49}) when individual level exposure is not possible or is deemed to be over cumbersome.\textsuperscript{14} The AAR method recommends the multiplication of the number of players on the field (football=11 players) by the number of games or game-hours the team has played (football=90 min=1.5 hours), divided by the number of injuries sustained in a given period (match / season).

Recent systematic reviews and meta-analyses\textsuperscript{3,31,34,48,50} have employed this method to provide estimates of injury incidence (prior to meta-analysis) when rates and precision estimates are not reported within individual studies. It is recommended that when estimating injury incidence using this method, events which reduce the number of players on a team (eg, red card) for part of a game (this would over-estimate exposure time), and, events which would underestimate exposure time if games exceeded 90 min (eg, injury time, extratime, penalty kicks) are taken into account.\textsuperscript{14}

While the findings of these reviews\textsuperscript{3,31,34,48,50} provide current estimates of injury burden, they do not provide an explanation or the methodological steps taken to mitigate against errors in reporting of exposure using this approach. This method only replicates results of individual-level exposure time calculations when training and games are played with a consistent number of players under consistent exposure conditions.\textsuperscript{14} Injury rate estimates that have been calculated in this way, without due consideration or notification of such exposure-time reporting errors lead to bias in incidence reporting.\textsuperscript{31}

The International Olympic Committee consensus statement on reporting epidemiological data on injury and illness in sport currently recommend injury rates to be calculated by using individual level data for injuries and exposure rather than team-level estimates.\textsuperscript{45}

**Limitations**

The full extent of injury burden could not be obtained from our meta-analysis which we feel was due to several methodological inconsistencies of available studies. We chose not to undertake subgroup meta-analyses of incidence of injury by anatomical site or tissue and so the findings (to this degree) cannot be compared with findings from a meta-analysis in male elite football.\textsuperscript{31} Some studies reported multiple seasons or tournaments and while we were prudent in removing duplicate data sets to avoid double counts, we could only extract the incidence data that was available. If studies have not reported or accounted for all individual injury counts, double counting of injuries may have occurred. Our aim was to retrieve data from adult elite players aged eighteen years and older and while we were diligent in data extraction, there is a small risk that players under eighteen may have been sampled. We amended our PROSPERO registration to include a definition of ‘elite’ football, replacing the term ‘soccer’ with ‘football’ and the addition of the NOS for risk of bias assessment.

We chose not to employ ARR methods to estimate injury incidence at a team level. This may have resulted in us not capturing all available data sets and studies. This limits the ability for us to provide full evaluations of injury burden. However, we feel this decision was justifiable as we wanted to remain cautious of limiting the ecological fallacy that arises when aggregate or team-level data fails to properly reflect individual level exposure data.\textsuperscript{32} Furthermore, due to the considerable heterogeneity, recommendations are that further pooling of data should be avoided and definitive conclusions drawn when more studies become available.\textsuperscript{39}

**Conclusions**

This meta-analysis found that the rate of injury in adult elite women’s football is lower to that found in elite male football. Caution is needed when interpreting these estimates due to the high heterogeneity values. We have...
greater confidence in the findings relating to injury site and type, where the lower extremities including the knee, thigh and ankle were commonly injured. Our injury tallies identify ligament injuries occur more frequently in adult elite women football players, followed by muscle injuries. Future studies must make a concerted effort to standardise injury and illness definitions, medical reporting and clear and accurate recording of match and training exposure in women’s football is needed.

Twitter Lawrence Mayhew @mayhewlawrence

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Competing interests In the previous 5 years MU’s institution has received research and consultancy funding for work that he has undertaken for GlaxoSmithKline, Medi-International and TENSquare.

Patient consent for publication Not required.

Ethics approval Research Ethics Committee of Leeds Beckett University.

Provenance and peer review Not commissioned; externally peer reviewed.

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REFERENCES


Supplementary appendix S1: Search string

Search strategy in PubMed - 794 results

((("soccer"[Title/Abstract] OR "football"[Title/Abstract] OR "football"[MeSH Terms])
AND ("injury"[Title/Abstract] OR "injuries"[Title/Abstract] OR
"incidence"[Title/Abstract] OR "incidence"[MeSH Terms] OR
"prevalence"[Title/Abstract] OR "prevalence"[MeSH Terms] OR
"epidemiology"[Title/Abstract] OR "epidemiology"[MeSH Terms]) AND
("adult"[Title/Abstract] OR "adult"[MeSH Terms]) AND ("female"[Title/Abstract] OR
"female"[MeSH Terms] OR "women"[Title/Abstract] OR "women"[MeSH Terms])) NOT
"male"[Title/Abstract]) AND ("loattrfull text"[Filter] AND "humans"[MeSH Terms] AND
"female"[MeSH Terms] AND "english"[Language]) AND ("loattrfull text"[Filter] AND
"humans"[MeSH Terms] AND "female"[MeSH Terms] AND "english"[Language]) AND
((fft[Filter]) AND (humans[Filter] AND (female[Filter])) AND (female[Filter]))
fft[Filter]: loattrfull text[subset];  humans[Filter]: humans[MH];  female[Filter]: female
[MH];  english[Filter]: english [LA]

Search strategy in Discover - 17 results

S1. TI (football or soccer ) AND TI injury AND AB (incidence or prevalence or
epidemiology) AND AB (adult) AND AB (women or Female ) NOT TI (male or man or
boy) NOT TI (male or man or boy)

Limiters /Expanders: Full Text (including printed resources): Expanders - Also search
within the full text of the articles; Apply equivalent subjects: Narrow by Language: -
English: Search modes - Find all my search terms

Search Strategy in SPORTDiscus – 541 results

S1. - TX (football or soccer) AND AB Injury AND AB (incidence or prevalence or
epidemiology) AND AB (women or female or woman or females)

Limiters /Expanders: Limiters - Full Text; English Abstract Available: Expanders - Apply
equivalent subjects: Narrow by Language: - English
Search Strategy in Science Direct – 26 results

S1. – (‘Football’) OR (‘Soccer’–‘Women’) AND (‘Adult’) (‘Injury-Incidence’) OR (‘Epidemiology’)
Appendix S2 Description of the 8 criteria designed to assess risk of bias of external validity quality in the studies. This instrument is an adapted version of the Newcastle Ottawa Scale (NOS) for cohort studies.

<table>
<thead>
<tr>
<th>Criterion</th>
<th>Description of criteria</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Description or type of football players.</td>
<td>Studies that reported participation in the two highest club football league divisions receive a star for this criterion. Studies conducted in football tournaments or national team football (e.g. World Cup, European championships) were considered elite receive a star for this criterion. Studies describing participants as professional were considered elite and receive a star for this criterion. Studies that did not describe the level of football or described the level of play as amateur did not receive a star for this criterion.</td>
</tr>
<tr>
<td>2. Definition of football-related injury.</td>
<td>Studies reporting the incidence of injury in women’s football should state the definition of injury used in the study receive a star for this criterion. Studies that did not state a definition of injury did not receive a start for this criterion.</td>
</tr>
<tr>
<td>3. Representativeness of the exposed cohort.</td>
<td>Studies truly representative of the average football players in the community*; (b) studies somewhat representative of the average football players in the community*; (c) selected participants, group of users; (d) no description of the derivation of the cohort did not receive a start for this criterion.</td>
</tr>
<tr>
<td>4. Ascertainment of exposure.</td>
<td>(a) Secure record*; (b) structured interview*; (c) written self-report or; (d) no description did not receive a start for this criterion.</td>
</tr>
<tr>
<td>5. Demonstration that outcome of interest was not present at start of study.</td>
<td><em>(a) Yes</em>; Studies that described that football players included were injury-free at baseline received a star for this criterion. <em>(b) No.</em> Studies that did not describe that football players included were injury-free at baseline did not receive a star for this criterion</td>
</tr>
<tr>
<td>---</td>
<td>---</td>
</tr>
<tr>
<td>6. Assessment of outcome.</td>
<td><em>(a) Independent blind assessment</em>; <em>(b) record linkage</em> *(e.g International Classification of Diseases (ICD) codes, Sport Medicine Diagnostic Coding System (SMDCS), Orchard Sports Injury Illness Classification System (OSIICS)) *(c) self-report or *(d) no description did not receive a star for this criterion</td>
</tr>
<tr>
<td>7. Was follow-up long enough for outcomes to occur risk factors.</td>
<td><em>(a) Yes</em> Studies conducted over at least one football season and / or a football tournament received a star for this criterion; *(b) No.</td>
</tr>
</tbody>
</table>

(b) Adequacy of follow-up of cohorts

A loss to follow-up greater than 20 % may increase the risk of bias in prospective studies *(Fewtrell et al., 2008)*. *(a) Complete follow-up of all subjects accounted for*; *(b) ≤ 20% of participants lost to follow-up unlikely to introduce bias or description provided of those lost* *(c) ≥ 20% follow-up rate and no description of those lost or *(d) no statement did not receive a star for this criterion |

Studies could be awarded a maximum of one star for each item. Eight stars could be awarded for a given study and were categorized into low quality “≤ 3 stars”, moderate quality “≥ 4 - ≤ 6 stars”, and high quality studies “≥ 7 stars

* A study with this alternative received a star for this criterion.
Supplementary appendix S3: Risk of Bias: Five-item study checklist adopted from von Elm et al (2007) used to assess risk of bias in the included studies

<table>
<thead>
<tr>
<th>Study</th>
<th>(1) study setting, location and study period</th>
<th>(2) eligibility criteria and sources and methods of participant selection</th>
<th>(3) exposure definition and measurement</th>
<th>(4) study outcome definition and measurement</th>
<th>(5) main result and precision (e.g. 95% confidence interval)</th>
<th>No. of items with low risk of bias</th>
</tr>
</thead>
</table>

The five items were based on the “Strengthening the reporting of observational studies in epidemiology” (STROBE) statement (von Elm et al., 2007), and have been used previously (Walden et al 2015). For each item the studies were assessed as having a low risk (1) or high risk (0) of bias. For all items, studies were assessed as having a high risk of bias if reporting was lacking or unclear.

1. Unclear reporting on the level of play for included teams and/or players
2. Unclear eligibility criteria, unclear selection or biased selection of teams/players for inclusion (e.g. the best 15 players in a team), large dropout (≥25%) of teams or players during study
3. Unclear football exposure registration, or approximated exposure to football
4. Unclear injury definition, or uncertainty regarding accuracy of measurement of injuries
5. Unclear regarding number and/or rates of injury per 1000 hours, and precision estimate lacking
Supplementary appendix S4: Description of studies excluded at full text screening

Description of excluded studies

Thirty-four studies were excluded at full text screening. Of these, 14 studies were excluded due to study population (amateur; 6 studies, collegiate/university; 3 studies, male; 3 studies, aged <18 years; 2 studies). Twenty-one studies were excluded for methodological reasons (retrospective reports; 3 studies, self-reporting of injury by participants; 3 studies, review articles; 3 studies, did not report an incidence rate; 2 studies, reporting of incidence from select body sites only i.e. lower limb and not upper limb; 2 studies, duplicate data; 2 studies did not report number of seasons; 1 study, secondary analysis of injury data; 1 study, grey literature; 1 study, audit via accident and emergency department; 1 study, data not available in English; 1 study; data not related to football; 1 study

<table>
<thead>
<tr>
<th>Reason for exclusion [Study Population]</th>
<th>Study details</th>
</tr>
</thead>
<tbody>
<tr>
<td>* states cohort is amateur on page 4 of discussion section</td>
<td></td>
</tr>
<tr>
<td>Study Design</td>
<td>Study details</td>
</tr>
<tr>
<td>-------------</td>
<td>--------------</td>
</tr>
</tbody>
</table>
### Review


### No incidence rate


### Incidence of select body sites


### Did not state one full season


### Secondary analysis of data


### Duplicate


### Reference list of Lopez-Valenciano 2021 studies screened out

Grey literature

Not available in English

Injury audit via Accident & Emergency department

Data not related to football
### Supplementary appendix table S5: Study Injury definitions used in studies

<table>
<thead>
<tr>
<th>Study</th>
<th>Injury Definition</th>
<th>Reference (if one cited)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Blockland et al, 2016</td>
<td>Any physical complaint sustained by a player that results from a football match or football training, irrespective of the need for medical attention or time loss from football activities. An injury that results in a player receiving medical attention is referred to as a “medical attention” injury, and an injury that results in a player being unable to take a full part in future football training or match play as a “time loss” injury.</td>
<td>Fuller CW, Ekstrand J, Junge A, et al Consensus statement on injury definitions and data collection procedures in studies of football (soccer) injuries British Journal of Sports Medicine 2006;40:193-201.</td>
</tr>
<tr>
<td>Engström et al., 1991</td>
<td>An injury was defined as occurring during training or a game and resulting in absence from scheduled activities for at least one training session or game.</td>
<td>van Mechelem W, Hlobil H, Kemper HC. Incidence, severity, aetiology and prevention of sports injuries: a review of concepts. Sports Med. 1992;14:82-99.</td>
</tr>
<tr>
<td>Faude et al., 2005</td>
<td>According to the definition of the National Athletic Injury Registration System of the United States, any physical complaint associated with soccer (received during training or a match) that limits athletic participation for at least the day after the day of the onset was defined as a soccer injury.</td>
<td></td>
</tr>
<tr>
<td>Gaulrapp et al., 2010</td>
<td>Following the definition of injury used by the US National Athletic Injury Registration System (NAIRS), an injury was defined as a specific identifiable event in playing soccer that forced the player to miss the rest of at least 1 practice or game or sit out at least 1 practice or game.</td>
<td></td>
</tr>
<tr>
<td>Giza et al., 2005</td>
<td>Injuries in this study were defined as those conditions which were reported to and evaluated by the team physician or athletic trainer. Each injury was subsequently reported to the league insurance company via a standardised “first report of injury” form which is completed by the team trainer.</td>
<td>Ekstrand J. Soccer injuries and their prevention. Thesis. Linköping: Department of Orthopaedics, Linköping University, 1983</td>
</tr>
<tr>
<td>Östenberg &amp; Roos, 2000</td>
<td>An injury was registered if it resulted in an absence from scheduled activities for at least one practice or game.</td>
<td></td>
</tr>
<tr>
<td>Hägglund et al., 2009</td>
<td>Injury was defined as a physical complaint resulting from football training or match play leading to the player being unable to participate fully in at least one training session or match.</td>
<td>Hägglund M, Walde´n M, Bahr R, Ekstrand J. Methods for epidemiological study of injuries to professional football players: developing the UEFA model. British Journal of Sports Medicine 2005a: 39: 340–346.</td>
</tr>
<tr>
<td>Jacobson &amp; Tegner, 2007</td>
<td>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.</td>
<td></td>
</tr>
<tr>
<td>Larruskain et al., 2017</td>
<td>Injuries were recorded in the club’s online database when a player was unable to participate in a future training session or match due to a physical complaint resulting from football training or match play and was considered injured until the medical staff cleared the player for full participation in training and match play.</td>
<td>Fuller CW, Ekstrand J, Junge A, et al Consensus statement on injury definitions and data collection procedures in studies of football (soccer) injuries British Journal of Sports Medicine 2006;40:193-201.</td>
</tr>
<tr>
<td>Tegnander et al., 2008</td>
<td>Any physical complaint sustained by a player that results from a football match or football training, irrespective of the need for medical attention or time loss from football activities.</td>
<td>Fuller CW, Ekstrand J, Junge A, et al Consensus statement on injury definitions and data</td>
</tr>
<tr>
<td></td>
<td>An injury that results in a player receiving medical attention is referred to as a “medical attention” injury, and an injury that results in a player being unable to take a full part in future football training or match play as a “time loss” injury.</td>
<td>collection procedures in studies of football (soccer) injuries British Journal of Sports Medicine 2006;40:193-201.</td>
</tr>
<tr>
<td>--------------------------</td>
<td>-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------</td>
<td>-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------</td>
</tr>
<tr>
<td>Junge &amp; Dvorak., 2007</td>
<td>An injury was defined as any physical complaint during a match which received medical attention from the team doctor, regardless of the consequences with respect to absence from the rest of the match or training.</td>
<td>Fuller CW, Ekstrand J, Junge A, et al Consensus statement on injury definitions and data collection procedures in studies of football (soccer) injuries British Journal of Sports Medicine 2006;40:193-201.</td>
</tr>
<tr>
<td>Waldén et al., 2007</td>
<td>Time loss injury was defined as an incident occurring during scheduled training sessions or matches causing the player to miss the next training session or match.</td>
<td>Hägglund M, Waldén M, Bahr R, Ekstrand J (2005) Methods for epidemiological studies of injuries to professional football players - developing the UEFA model. British Journal of Sports Medicine 39:340–346</td>
</tr>
</tbody>
</table>
## Supplementary Appendix S6. Newcastle Ottawa Scale Quality assessment of included studies

<table>
<thead>
<tr>
<th>Study</th>
<th>Criteria for assessing risk of bias</th>
<th>Total</th>
<th>Quality</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>1</td>
<td>2</td>
<td>3</td>
</tr>
<tr>
<td>Blokland et al., 2016[18]</td>
<td>*</td>
<td>*</td>
<td>*</td>
</tr>
<tr>
<td>Engström et al., 1991[19]</td>
<td>*</td>
<td>*</td>
<td>*</td>
</tr>
<tr>
<td>Faude et al., 2005[20]</td>
<td>*</td>
<td>*</td>
<td>*</td>
</tr>
<tr>
<td>Gaulrapp et al., 2010[21]</td>
<td>*</td>
<td>*</td>
<td>*</td>
</tr>
<tr>
<td>Giza et al., 2005[22]</td>
<td>*</td>
<td>*</td>
<td>*</td>
</tr>
<tr>
<td>Hagglund et al., 2009[23]</td>
<td>*</td>
<td>*</td>
<td>*</td>
</tr>
<tr>
<td>Jacobson &amp; Tegner, 2007[24]</td>
<td>*</td>
<td>*</td>
<td>*</td>
</tr>
<tr>
<td>Junge &amp; Dvorak, 2007[28]</td>
<td>*</td>
<td>*</td>
<td>*</td>
</tr>
<tr>
<td>Larruskain et al.,2017[25]</td>
<td>*</td>
<td>*</td>
<td>*</td>
</tr>
<tr>
<td>Östenberg &amp; Roos, 2000[26]</td>
<td>*</td>
<td>*</td>
<td>*</td>
</tr>
<tr>
<td>Tegnander et al., 2008[27]</td>
<td>*</td>
<td>*</td>
<td>*</td>
</tr>
<tr>
<td>Waldén et al., 2007[23]</td>
<td>*</td>
<td>*</td>
<td>*</td>
</tr>
</tbody>
</table>

Criteria for assessing risk of bias: (1) description or type of football players; (2) definition of injury; (3) representativeness of the exposed cohort; (4) ascertainment of exposure; (5) demonstration that outcome of interest was not present at start of study; (6) assessment of outcome; (7) was follow-up long enough for outcomes to occur (e.g. minimum of one complete season); (8) adequacy of follow-up of cohorts / loss of participants to follow-up

Eight stars could be awarded for a given study and were categorized into low quality “≤ 3 stars”, moderate quality “≥4 - ≤ 6 stars”, and high quality studies “≥7 stars”[10]

*Star(s) awarded for each criterion.
Supplementary appendix S7: Five-item study checklist to assess risk of bias in the included studies

<table>
<thead>
<tr>
<th>Study</th>
<th>(1) study setting, location and study period</th>
<th>(2) eligibility criteria and sources and methods of participant selection</th>
<th>(3) exposure definition and measurement</th>
<th>(4) study outcome definition and measurement</th>
<th>(5) main result and precision (e.g. 95% confidence interval)</th>
<th>No. of items with low risk of bias</th>
</tr>
</thead>
<tbody>
<tr>
<td>Study</td>
<td>Item 1</td>
<td>Item 2</td>
<td>Item 3</td>
<td>Item 4</td>
<td>Item 5</td>
<td>Total</td>
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<tr>
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<td>--------</td>
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</tr>
<tr>
<td>Blokland et al., 2016 [18]</td>
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<td>1</td>
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<td>Engström et al., 1991 [19]</td>
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<td>0</td>
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<tr>
<td>Faude et al., 2005 [20]</td>
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<td>1</td>
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<tr>
<td>Gaulrapp et al., 2010 [21]</td>
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<tr>
<td>Giza et al., 2005 [22]</td>
<td>1</td>
<td>1</td>
<td>0</td>
<td>0</td>
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<tr>
<td>Haggland et al., 2009 [23]</td>
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<tr>
<td>Jacobson &amp; Tegner, 2007 [24]</td>
<td>1</td>
<td>1</td>
<td>0</td>
<td>1</td>
<td>0</td>
<td>3</td>
</tr>
<tr>
<td>Junge &amp; Dvorak, 2007 [28]</td>
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<td>1</td>
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<td>Larruskain et al., 2017 [25]</td>
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<td>1</td>
<td>1</td>
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<tr>
<td>Östenberg &amp; Roos, 2000 [26]</td>
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<td>0</td>
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<td>Tegnander et al., 2008 [27]</td>
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<td>Waldén et al., 2007 [23]</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>5</td>
</tr>
</tbody>
</table>

The five items were based on the “Strengthening the reporting of observational studies in epidemiology” (STROBE) statement (von Elm et al., 2007), and have been used previously (Walden et al. 2015). For each item the studies were assessed as having a low risk (1) or high risk (0) of bias. For all items, studies were assessed as having a high risk of bias if reporting was lacking or unclear.

1. Unclear reporting on the level of play for included teams and/or players
2. Unclear eligibility criteria, unclear selection or biased selection of teams/players for inclusion (e.g. the best 15 players in a team), large dropout (≥25%) of teams or players during study
3. Unclear football exposure registration, or approximated exposure to football
4. Unclear injury definition, or uncertainty regarding accuracy of measurement of injuries
5. Unclear regarding number and/or rates of injury per 1000 hours, and precision estimate lacking

No of items with low risk of bias: 1-2 items = high risk of bias, 3 items = moderate risk of bias, 4-5 items = low risk of bias.
Supplementary appendix S8: Risk of bias requiring intermediary attention

Please review the following two papers where disagreements were identified (Asterix *) by the first (LM) and second reviewer (AA). First and second reviewer comments are highlighted for the intermediary (GJ). Please score the sections as 1 = low risk of bias, or 0 = high risk of bias. Intermediary (GJ) report in italics

<table>
<thead>
<tr>
<th>Reviewer</th>
<th>Study</th>
<th>(1) study setting, location and study period</th>
<th>(2) eligibility criteria and sources and methods of participant selection</th>
<th>(3) exposure definition and measurement</th>
<th>(4) study outcome definition and measurement</th>
<th>(5) main result and precision (e.g. 95% confidence interval)</th>
<th>No. of items with low risk of bias</th>
<th>Comments</th>
</tr>
</thead>
<tbody>
<tr>
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<td>Blockland et al 2016</td>
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<td>1*</td>
<td>1</td>
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<td>1</td>
<td>5</td>
<td>(2) n129 agreed to participate AND gave written informed consent as stated on p.287</td>
</tr>
<tr>
<td>AA</td>
<td></td>
<td>1</td>
<td>0*</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>4</td>
<td>(2) Selection of participants not clearly stated.</td>
</tr>
<tr>
<td>GJ</td>
<td></td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>4</td>
<td>(2) confirmed study information and informed consent page 287</td>
</tr>
<tr>
<td>LM</td>
<td>Engström et al 1991</td>
<td>1</td>
<td>0</td>
<td>0*</td>
<td>0*</td>
<td>0*</td>
<td>1</td>
<td>(2) Abstract states ‘elite female players’. Methods section states, ‘premier division’ AND ‘amateur’. Inconsistent / unclear participants.</td>
</tr>
<tr>
<td>AA</td>
<td></td>
<td>1</td>
<td>0</td>
<td>1*</td>
<td>1*</td>
<td>1*</td>
<td>4</td>
<td>(2) agreement with LM</td>
</tr>
<tr>
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<td>1</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>1</td>
<td>(3) Unclear that individual player exposure training/match play was measured</td>
</tr>
<tr>
<td>LM</td>
<td>Östenberg &amp; Roos 2000</td>
<td>0*</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>4</td>
<td>(1) No explicit report of study period including pre-season</td>
</tr>
<tr>
<td>AA</td>
<td></td>
<td>1*</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>5</td>
<td>(1) Reports season as 1996 soccer season p. 280</td>
</tr>
<tr>
<td>GJ</td>
<td></td>
<td>0</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>4</td>
<td>(1) confirmed no information related to season length / duration (including pre-season), States 1996 season only, p. 280</td>
</tr>
</tbody>
</table>

The five items were based on the “Strengthening the reporting of observational studies in epidemiology” (STROBE) statement (von Elm et al., 2007), and have been used previously (Walden et al 2015). For each item the studies were assessed as having a low risk (1) or high risk (0) of bias. For all items, studies were assessed as having a high risk of bias if reporting was lacking or unclear. Examples extracted from Walden et al (2015) are below.

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2. Unclear eligibility criteria, unclear selection or biased selection of teams/players for inclusion (e.g. the best 15 players in a team), large dropout (≥25%) of teams or players during study
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4. Unclear injury definition, or uncertainty regarding accuracy of measurement of injuries
5. Unclear regarding number and/or rates of injury per 1000 hours, and precision estimate lacking
Supplementary Appendix S9: Injury tally counts

S9a Injury tally by anatomical site in domestic club football

S9b Injury tally by tissue type in domestic club football
**S9c** Injury tally by anatomical site in tournament football from utilising a medical attention injury definition

**S9d** Injury tally by anatomical site in tournament football utilising a time loss injury definition
**S9e** Injury tally by tissue type in tournament football utilising a medical attention injury definition

**S9f** Injury tally by severity in domestic club football
**S9g Injuy tally by severity in tournament football utilising a medical attention injury definition**

**S9h Injury tally by severity in tournament football utilising a time loss injury definition**