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Br. J. Sports Med. 2007;41;44-46; originally published online 11 May 2007; doi:10.1136/bjsm.2007.037960

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Head injuries in the female football player: incidence, mechanisms, risk factors and management

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Although all injuries in sports are a concern for participants, head injuries are particularly troublesome because of the potential for long-term cognitive deficits. To prevent any specific injury, it is important to understand the basic frequency and incidence of injury and then the mechanism of injury. Once these are established, prevention programmes can be tested to see if the rate of injury changes. A primary problem with head injuries is recognising that the injury has occurred. Many athletes are not aware of the seriousness of concussive injury, thus this type of injury is probably under-reported. Once the diagnosis of a concussion is made, the next difficult decision is when to return a player to the game. These two management issues dominate the continuing development of understanding of concussive head injury. This paper explores the known gender differences between head injuries and highlights the areas that need to be considered in future research.

EPIDEMIOLOGY OF INJURY

The rates of injury in football vary depending on the age, level of play, skill and gender of the player. The lack of uniform methods in sports injury research makes direct comparisons a challenge. In general, the overall rate of injury in football increases with age and level of play (tables 1 and 2), in some cases to over 50 injuries/1000 match hours in international men’s tournaments. Injuries in recreational and schoolboy football are quite low whereas rates of injury in international championship events are high. There is a direct relationship between age and rates of injury in female players.

INJURY PATTERNS AND GENDER

A recent, interesting finding is that the patterns of football injury show notable gender-related differences. Fuller et al examined all head injuries from six years of FIFA competitions and found that there was a higher rate of head injury, a different spectrum of injury and different mechanism of injury in female compared with male footballers. This paper explores the reasons for these differences.
The most commonly diagnosed injury was a soft-tissue contusion (57% for men and 41% for women). The next most common injury in men was a laceration (21%), but for women, the next most common head injury was a concussion (22%). A concussion was the fourth most frequent injury in the men (8%). When concussions alone were considered, the incidence rate was 1.1/1000 player hours for men and 2.6/1000 player hours for women, a 2.4-fold higher rate. Delaney et al reported a similar, 2.5-fold greater, rate in women whereas Barnes et al stated a 2.2-fold greater rate in men. The conclusions of the earlier studies were based on numbers of injuries recorded over fixed time periods rather than on exposure.

**MECHANISM OF HEAD INJURY IN FEMALE FOOTBALL PLAYERS**

There are limited data on gender differences and injury mechanism, even though they are critical for designing prevention programmes. Fuller et al studied tackle-related injuries, looking for common factors associated with injuries. The goal was to identify situations that place the player at risk of injury, in order to devise methods of prevention. From video recordings, the authors identified six factors leading to injury in matches: location on the pitch, possession status, direction of challenge, mode of challenge, action during challenge and intent to cause injury. The same methods were applied to a project specifically focused on head injuries. Heading is not like challenging for a free ball while an opponent is in possession, so possession status is essentially a free ball. Heading challenges that lead to injury nearly always include jumping and the over intent is fair play with little intent to injure the opponent. Thus, the factors of interest can be reduced for analysis of head injury incidents. Table 4 shows the risk factors of injury according to diagnosis and gender. The common locations are the defensive or offensive outfield (between the penalty area and midfield line). A player jumps for the ball from the side (male player) or front (female player). A noticeable difference is that the point of contact to the head is the upper extremity in male players whereas it is a head–head impact for female players (table 4).

Fuller et al also noted that the distribution of injuries as a function of playing position was markedly different between men and women. In men, head injuries predominantly occurred among the defenders (51 (40%)) followed by forwards (30 (23%)), midfielders (28 (22%)) and goalkeepers (19 (15%)), whereas in women the injuries was more evenly distributed, being fairly equal, among the defenders (12 (34%)), midfielders (10 (29%)) and the forwards (10 (29%)), with the goalkeepers (3 (9%)) being least often injured. There were significant differences between men and women for possession status at the time of injury (p = 0.01) and for intent (p = 0.009). The distributions for the mode of approach to the injury event did not differ significantly (p = 0.05). Match referees deemed that 30% of the incidents analysed that led to a head/neck injury were foul challenges with no significant differences noted by gender (men: 31%; women: 27%).

Data from experimental studies suggest there are differences between the responses of male and female head-neck segment kinematic and neuromuscular control variables to an external force; this may in part explain the differences noted in injury patterns. Females showed considerably greater head-neck segment peak angular acceleration and displacement than males despite initiating muscle activity much earlier and using a greater percentage of their maximum head-neck segment muscle activity. The differences in head-neck segment angular acceleration may be because females had markedly lower isometric strength, neck girth, and head mass, resulting in lower levels of head-neck segment stiffness. The data suggest that there are intrinsic differences in the ability of female and male athletes to withstand equivalent blows to the head-neck complex.

**GENDER DIFFERENCES IN INJURY OUTCOME**

Both clinical and experimental studies have shown gender differences in outcome following all forms of traumatic brain injury. A meta-analysis of eight studies concluded that traumatic brain injury outcome was worse in women than in men for 85% of the 20 measured variables, with an average effect size of −0.15. The conclusions were limited by the small percentage of the total published reports on traumatic brain injury outcome that described outcome separately for men and women; nevertheless the authors highlighted an area of concern in injury management.

Gender has also been shown to be an independent predictor of survival following brain injury. In these studies mortality following moderate to severe traumatic brain injury was found to be 1.28 times higher in females than males, with the greatest difference of 2.14 in deaths after discharge. Controlling for age, admission Glasgow Coma Score, penetrating versus blunt injury, and the presence of multiple trauma, females were 1.75 times more likely than males to die of their brain injury (95% CI 1.09–2.82). Furthermore, females were 1.57 times more likely to experience poor outcomes (e.g., severe disability, persistent vegetative state) than males.

With regard to sports-related concussion, in a study of 2340 male and female US high school and collegiate athletes, individuals who sustained sports-related concussions (155

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**Table 3** Rates of injury among female football players by age

<table>
<thead>
<tr>
<th>Country</th>
<th>Age</th>
<th>Injury rate/1000 player hours</th>
<th>Injuries/1000 match hours</th>
<th>Injuries/1000 training hours</th>
</tr>
</thead>
<tbody>
<tr>
<td>USA</td>
<td>7–18</td>
<td>1.1</td>
<td>5.1</td>
<td>7.6</td>
</tr>
<tr>
<td>Sweden</td>
<td>14–15</td>
<td>5.1</td>
<td>7.6</td>
<td>9.0</td>
</tr>
<tr>
<td></td>
<td>15–16</td>
<td>5.1</td>
<td>7.6</td>
<td>9.0</td>
</tr>
<tr>
<td></td>
<td>16–17</td>
<td>5.1</td>
<td>7.6</td>
<td>9.0</td>
</tr>
<tr>
<td></td>
<td>17–19</td>
<td>5.1</td>
<td>7.6</td>
<td>9.0</td>
</tr>
<tr>
<td>Overall</td>
<td></td>
<td>9.1</td>
<td>1.5</td>
<td></td>
</tr>
</tbody>
</table>

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**Table 4** Summary of common factors leading to head and neck injuries in FIFA-sponsored tournaments (adapted from Fuller et al)

<table>
<thead>
<tr>
<th>Head and neck injury category</th>
<th>Location on pitch</th>
<th>Direction of challenge</th>
<th>Action during challenge</th>
</tr>
</thead>
<tbody>
<tr>
<td>By diagnosis</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Contusion</td>
<td>Attacking outfield</td>
<td>From the side</td>
<td>Use of upper extremity</td>
</tr>
<tr>
<td>Laceration/abrasion</td>
<td>Defensive outfield</td>
<td>From the side</td>
<td>Use of head/upper extremity</td>
</tr>
<tr>
<td>Concussion</td>
<td>Defensive outfield</td>
<td>From the side</td>
<td>Use of head</td>
</tr>
<tr>
<td>Male</td>
<td>Defensive outfield</td>
<td>From the side</td>
<td>Use of upper extremity</td>
</tr>
<tr>
<td>Female</td>
<td>Defensive outfield</td>
<td>From the front</td>
<td>Use of head/upper extremity</td>
</tr>
</tbody>
</table>

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What is already known on this topic

- There are few direct male–female comparisons of football-related injuries in general, and head injuries in particular. In FIFA competitions, a higher rate, spectrum and mechanism of injury has been found in female footballers compared with male footballers.

What this study adds

- This review summarises the available data on the nature of head injuries in women. The literature indicates that symptoms, cognitive deficits and outcomes may be more severe in female football players, but this needs to be confirmed.
- Future work may lead to gender being considered as a specific factor influencing management decisions.

subjects) were evaluated by gender using standardised cognitive tests. Female athletes had markedly greater declines in simple and complex reaction times relative to pre-season baseline levels, and they reported more post-concussion symptoms compared with age-matched male athletes. As a group, the female athletes were cognitively impaired approximately 1.7 times more frequently than male athletes following concussions. The authors stated that current return-to-play management must be made on an individual basis, including consideration of factors such as gender.

None of the current studies in football has analysed gender-specific symptom scores, physical signs, cognitive deficits or outcomes following concussive injury.

SUMMARY

There is limited published literature on injuries in the female football player. What is known is that the nature and pattern of injuries differs from injuries to male footballers, at least at professional level, and that the risk of head injury is double that of males. The literature and experimental research on traumatic brain injury indicates that symptoms, cognitive deficits and outcomes may be much more severe in the female player, although this remains to be confirmed in football studies. This raises the issue whether current return-to-play guidelines need to take into account gender as a specific factor influencing management decisions.

REFERENCES


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Competing interests: No author or related institution has received any financial benefit in connection with this study.

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