Soccer is a vigorous sporting activity with relatively high injury incidence (17–24 injuries per 1000 playing hours) compared with many other sports. The costs of injuries to soccer players are enormous; the cost of treatment and loss of production through time off work has been estimated at about £1 billion in Britain each year. To minimise the number of injuries and the associated costs, avoid the early retirement of professional soccer players, and provide a safe and healthy sports environment, preventive programmes are recommended. These preventive programmes require information on injury and the risk of injury associated with different aspects of the game.

A great deal of research on soccer injuries has been carried out, and a number of facts about their nature, causative mechanisms, and characteristics have been established. For example, over 75% of injuries to professional players are strain, sprain, and contusion injuries. Lower extremity injuries represent 60–85% of the total injuries incurred by soccer players of both sexes, with the most susceptible joint being the knee, followed by the ankle. Injury severity is usually classified as minor, moderate, or major depending on the length of time needed for recovery, with over 65% being minor, 25% moderate, and 10% serious. About half of the injuries arise from actions such as running, shooting, turning, and heading. Although most researchers have noted that the playing position does not influence the occurrence of injury, Hawkins and Fuller found that defenders had a greater risk of injury than other players, suggesting that playing position may be an influential factor. The final quarter of each half is the period when most injuries occur, and the risk of injury is greater in the second half than in the first half, reflecting the most intensive periods of play. Most epidemiological studies indicate that injuries to soccer players are about three times more likely in competition than training.

Most injuries are thought to be unintentional, resulting from an error by the player injured or another player. The error may cause an accident and some of these accidents lead to injury. Although the risk of injury is influenced by various factors, it is conventionally assessed by the injury incidence rate, defined in terms of the number of injuries and the exposure to injury, usually in terms of time. However, this is an expression of risk to players for the game as a whole and does not detail the risk associated with specific actions that may lead to injury. For example, the number of injuries caused by a tackle has been reported, but not the number of tackles from which these injuries occurred. Thus the injury risk associated with tackles is based on a count of the tackles that have led to
injury not the incidence of injury from tackles (defined as the number of injuries from tackles divided by the total number of tackles made). Further, many actions take place that do not often lead to injury, but have some potential risk associated with them depending on the vigour, context, and nature of the action. There is a risk associated with these non-injury generating actions, which is generally ignored in the literature. Consequently, to understand fully the risk of injury to which a player is exposed during soccer play, it is necessary to analyse the actions made in a game and to relate these actions to the risk they may possess and the subsequent injuries that may result from them. This approach to the assessment of injury risk is fundamentally different from previous studies, as it attempts to express injury risk in terms of the actions used in play and the potential these actions have for injury. It therefore provides a more detailed understanding of injury risk, which will have importance for designing appropriate injury prevention and rehabilitation programmes.

Several factors are thought to be related to injury risk in addition to the type of playing action used, such as location on pitch, period of play, and whether playing at home or away. As the role of playing actions before the actual occurrence of the injury event has not previously been investigated, the purpose of this study was to assess the exposure of players to injury risk during English Premier League soccer matches in relation to a number of selected factors that may influence that risk.

**METHODS**

To assess the injury risk in soccer performance with respect to (a) types of playing action, (b) periods of the game, (c) zones of the pitch, and (d) playing either at home or away, 10 games from the English Premier League 1999–2000 were chosen for analysis. A TV monitor and a video recorder (Panasonic NV-HD 685) were used to view the games and enable notation of events to take place. The video was paused after every event that occurred (for both home and away teams) and the action, location, and time were noted on paper. Sixteen soccer specific playing actions (table 1) were noted; the pitch was divided into 18 zones (fig 1), and the playing time was divided into six periods of 15 minutes each.

The analysis in this study was limited to actions involving the ball. Although some movements without the ball—that is, running—have been reported as causes of injury in soccer, these were not included because the games were recorded from television broadcasts and attention was focused on activity around the ball. As such, movements of all players on the pitch are rarely visible. To cover all the movements made in play, other methodologies would be necessary and were beyond the scope of this study.

**Table 1** The list of playing actions recorded during the game

<table>
<thead>
<tr>
<th>Actions</th>
<th>Definitions</th>
</tr>
</thead>
<tbody>
<tr>
<td>Dribbling the ball</td>
<td>With close control to take the ball past on opponent using the foot with 3 or more touches.</td>
</tr>
<tr>
<td>Goal catch</td>
<td>Goalkeeper catches and holds on to the ball.</td>
</tr>
<tr>
<td>Goal punch</td>
<td>Goalkeeper punches the ball and doesn’t keep possession.</td>
</tr>
<tr>
<td>Goal throw</td>
<td>Goalkeeper distributes the ball by throwing the ball towards a teammate.</td>
</tr>
<tr>
<td>Heading the ball</td>
<td>Player makes direct contact with the ball using the head.</td>
</tr>
<tr>
<td>Jumping to head</td>
<td>Player leaves the ground before making direct contact with the ball with the head.</td>
</tr>
<tr>
<td>Kicking the ball</td>
<td>Player makes direct contact with the ball with the foot.</td>
</tr>
<tr>
<td>Making a tackle</td>
<td>Player actively moves his body or limb towards the ball when the ball is in the possession of an opponent.</td>
</tr>
<tr>
<td>Making a charge</td>
<td>Player makes physical contact with opponent during a tackle.</td>
</tr>
<tr>
<td>Passing the ball</td>
<td>Player plays the ball with the foot with the intention of a teammate receiving it.</td>
</tr>
<tr>
<td>Receiving a ball</td>
<td>Player receives and controls ball with any part of the body.</td>
</tr>
<tr>
<td>Receiving a tackle</td>
<td>Player in possession receives a tackle by opponent.</td>
</tr>
<tr>
<td>Receiving a charge</td>
<td>Player in possession receives a tackle by opponent.</td>
</tr>
<tr>
<td>Shot on goal</td>
<td>Any attempt made by an attacking player with a shot (kick) directly towards the goal.</td>
</tr>
<tr>
<td>Set kick</td>
<td>A free kick situation anywhere on the pitch.</td>
</tr>
<tr>
<td>Throw in the ball</td>
<td>Restart of the game with hands following the ball going outside the touchline.</td>
</tr>
</tbody>
</table>

Each playing action was classified into one of three categories according to its likelihood to cause an injury. These categories were “no injury potential”, “injury potential” (both assessed subjectively on the likelihood of the actions to produce an injury), and “actual injury” (defined as receiving medical treatment on the pitch). The “no injury potential” category was used for actions, such as an easy pass to a team player, where there was no discernible likelihood of injury. The “injury potential” category was divided into three subcategories: grade 1 was a minor injury where there was evidence of injury and the player received “first aid” inside the field of play (but without any additional treatment); grade 2 was a moderate injury when the player received treatment off the field of play but continued for the remainder of the game; grade 3 was a major injury when the player received treatment and left the field for the remainder of the game. It should be noted that these descriptions of minor, moderate, and major injuries do not correspond to general definition of injury severity used in the literature, as information on the subsequent effect of the injury was not available.

To quantify the injury risk associated with a playing action, the playing action injury risk incidence (PAIRI) was defined as the number of actions with some level of injury risk plus all actual injuries in a specific playing action category divided by...
The total number of actions made in that category, expressed as a percentage. In this study it was decided to use the sum of moderate and high (grades 2 and 3) injury potential to express the genuine risk of injury because a level of mild risk is accepted as a part of the game. Playing action injury incidence (PAIRI) is defined as the number of actual injuries in a specific playing action category divided by the number of actions made in that category as a percentage. All data were collected by one of the authors, and in a pilot study analysis were shown to be reliable ($r = 0.99$). The data were analysed using $\chi^2$ to compare categories, and a level of $p<0.05$ was used to indicate significance.

**RESULTS**

The total number of play actions recorded was 17,877. Altogether, 7667 actions were judged to have possessed some level of injury potential, and 20 actions resulted in actual injuries (an average of two per game) (fig 2). The total exposure in terms of player hours was 374 (22 players, 10 games, 1.7 hours games). The injury incidence rates (as defined by Hawkins and Fuller) for minor, moderate, and major injuries were 27, 16, and 11 per 1000 hours played respectively. The overall injury incidence rate was calculated to be 53 injuries per 1000 hours played.

**Playing actions**

The minor injuries were caused by receiving a tackle (50% of all minor injuries), making a tackle (20%), receiving a “charge”, kicking the ball, and catching the ball (10% each) (table 2). The moderate injuries resulted from receiving a tackle (83% of all moderate injuries) and making a tackle (17%). The major injuries were all attributable to receiving a tackle. The PAIRI values for actions leading to injury were 1.54% (receiving a tackle), 0.43% (goal catch), 0.33% (making a tackle), 0.17% (receiving a charge), and 0.04% (kicking the ball).

Table 2 gives the total numbers of occurrences with injury potential for each playing action. A significant difference ($\chi^2 = 1101.6, p = 0.001$) was found between the playing action categories. Those with more than 50% of actions judged to have some degree of injury potential were categorised in terms of risk. Actions classed as having mainly a mild injury risk (because they had their highest percentage of actions with injury potential in the mild category) were kicking the ball (89% of all kicking the ball actions), set kick (83%), heading the ball (68%), and shot on goal (73%). Actions categorised as having a predominantly moderate injury risk were receiving a “charge” (72%), making a tackle (49%), and goal punch (47%), whereas one action (receiving a tackle, with 54% of all tackles received) was categorised as having a predominantly high injury risk.

Moderate and high injury risk is also expressed by the PAIRI, which for the four playing actions identified above were receiving a tackle (95.5%), receiving a charge (82.2%), making a tackle (50.4%), and goal punch (60%). Of these, only one (goal punch) did not lead to injury. Two playing actions had low PAIRI values but led to an injury; these were kicking the ball (4.7%) and goal catch (20.4%). The former may have occurred because of the high number of kicking actions made, and the latter did not figure in any injury risk category and may be a chance occurrence.

**Periods of the game**

Figure 3 illustrates the number of actual injuries per period. No significant difference ($\chi^2 = 1.58, p>0.05$) was found between the six 15 minute periods of the game. Most actual injuries occurred in the first 15 minutes of the first half ($n = 5$) and the first 15 minutes of the second half ($n = 4$). The first half tended to contain more actual injuries than the second half (11 and 9 incidents respectively), but this difference was not significant ($\chi^2 = 0.04, p>0.05$).

Figures 4, 5, and 6 illustrate the number of actions with mild, moderate, and high injury potential respectively per period. A significant difference was found in mild and moderate injury potential between halves, with the first half having more actions with injury potential ($\chi^2 = 9.59, p = 0.008, \chi^2 = 10.47, p = 0.005$ respectively). The number of actions with high injury potential was similar in the two halves (51% vs 49%). A significant difference between periods ($\chi^2 = 39.79, p
The first 15 minute period having significantly more actions with mild injury potential than any other period of the game. A significant difference ($\chi^2 = 25.08, p = 0.001$) in actions with moderate injury potential was found; the last 15 minute period had significantly more of these actions than any other period of the game. Although the first and last 15 minute periods had more occurrences of actions with high injury potential than other periods, they were not significantly different ($p>0.05$).

**Zones of the pitch**

The number of actual injuries observed was small so it was not possible to analyse these formally per zone. Altogether, 40% of injuries occurred in the midfield area, 30% in the defending area, and 30% in front of the main attacking area (table 3). There was a significant association ($\chi^2 = 517, p = 0.001$) between the number of actions with injury potential and the zone of play (table 3). Most actions with mild injury potential occurred in the attacking zones (14, 17), defending zones (2, 5), and midfield zones (7, 12), with about 60% of all events with mild injury potential occurring in these six zones. The number of actions with moderate and high injury potential also occurred in the same attacking and defending zones, with about 40% of all events with moderate injury potential and about 44% of all events with high injury potential occurring in the four zones numbered 5, 7, 12, and 14. Furthermore, it can be noted that 38% of events with injury potential occurred in the midfield area, 31% in the attacking area, and 31% in the defending area.

**Playing either at home or away**

The number of actions with actual injuries for away teams (13) exceeded that for home teams (7), but the difference between them was not significant ($\chi^2 = 1.8, p = 0.12$). The actions with mild, moderate, and high injury potential were also not significantly different between home and away teams.

**DISCUSSION**

The aim of this investigation was to assess the exposure to injury risk during competitive English Premier League matches, by identifying the most common critical incidents and the actual injury potential and injury associated with them. Injury potential and actual injury were assessed with respect to playing actions, periods of the game, zones of the pitch, and playing at home or away. The overall injury incidence rate in this study was found to be 53 per 1000 hours played, which is higher than reported by Inklaar and Arnason, probably because of the method of defining injury used in this study.

Unlike the previous work referred to, our study focused on the thousands of events observed over the 10 games analysed, and the small numbers of actual injuries occurring would not allow inferences about injury to be drawn. It should be noted that the concern of the study was with injury risk associated with actions around the ball, rather than injuries attributed to running off the ball (and the associated risk from locomotion), although all of the injuries recorded were due to actions made in contesting the ball.
Some playing actions were associated with a greater risk than others. Based on the PAIRI values and the different levels of injury potential, it seems that the playing action with the greatest injury risk is receiving a tackle. Receiving a charge and making a tackle also have substantial risk associated with them. Other playing actions such as goal catch, goal punch, kicking the ball (including shot at goal and set kick), and heading the ball all have a significant risk of injury. Other playing actions have a much smaller risk associated with them. Making a “charge” appears to be relatively low risk compared with receiving one, presumably because it is planned by the player doing the charging. As some actions have a higher injury risk than others, more attention should be paid to these by the coach when planning training, by the referee when judging a match, and by players who may also need to practice avoidance manoeuvres to protect themselves in such instances. Inspection of the data in table 2 shows that some playing actions (such as kicking the ball) are characterised by a large number of “low injury potential” occurrences whereas others (such as making and receiving a tackle and receiving a charge) are characterised by a smaller total number but a higher occurrence in the moderate or high injury potential category. In both cases, these can lead to actual injuries. In the former case an injury may occur simply because the large number of events increases the chance of one of them becoming a critical incident (as illustrated in fig. 2). In the latter case, the higher level of risk associated with certain actions means that they are more likely to lead to a critical incident or injury. An exception to this appears to be the goal catch, which has a low number of actions and has a predominantly low injury potential, but generated one injury. However, in any action, there is always some element of risk depending on the context and it may be that this particular action represents a chance event because of the small but important number of events with high injury potential.

A significant difference was found between periods of the game with respect to injury risk. The opening 15 minutes had significantly more actions with mild injury potential than any other period of the game. The contest is arguably at its most intense in the initial period of play because the players are fresh, more energetic, and wish to “register their presence” with the opposition. The closing 15 minutes of the game had the most frequent actions with moderate injury. This may be the result of fatigue of the muscles and other body organs as muscle glycogen stores near depletion and players become dehydrated. At this stage of the game, the players are tired but the contest may still be intense. The consequence may be that predisposition to injury is exposed as fatigue sets in or damage incurred earlier in the game becomes more evident as play is sustained. More attention should be paid by game officials and players (and the team's medical staff) to the first and last periods of the game if actions including some risk of injury are not to lead to actual injury.

No significant difference in actual injuries per period of the game was observed, mainly because of the small numbers involved. Most actual injuries occurred in the first 15 minutes of the first half. This may be because this is the period with the greatest effort occurs. The first 15 minutes of the second half of the game again had a relatively high number of injuries. In this instance, the players may not have warmed up properly after the half time intermission. These results differ from those of Hawkins et al.,14 who reported that more injuries were observed during the final 15 minutes of the first half and the final 30 minutes of the second half. These differences may reflect, in part, the different definitions of injury (they classified injury severity by the length of time that a player was subsequently absent from training or competition), methods of data collection, observation periods, study designs, and sample characteristics. There was no significant difference between the two halves of play in terms of incidence of actual injury, accounting for 11 (55%) and 9 (45%) incidents respectively. Hawkins and Fuller1 found that the number of injury incidents in the second half was significantly greater than in the first half (57% v 43%), although Ekstrand and Gillquist24 have shown some similarities to our research—that is, more injuries at early stages of a game.

In conclusion, data available from this investigation suggest that some playing actions were associated with higher injury risk than others. In particular, receiving a tackle, making a tackle, and receiving a charge were actions with a substantial risk of injury. The first and last 15 minutes of the game contained the highest risk, although the greatest number of injuries tended to be in the first period of each half. Exposure to injury risk was concentrated on those parts of the pitch where possession of the ball is most vigorously contested, being specific attacking, defending, and midfield zones. Playing at home or away does not affect a player's risk of injury.
Injury risk in soccer

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Players’ beliefs are a barrier to preventing injury in junior Australian football

An effective strategy for preventing injuries in junior Australian football needs to tackle how players perceive injury affects their playing prospects, according to a survey of top junior players aged 16–18 years.

The questionnaire was completed by junior players in six football league under 18 clubs in Victoria and explored their own attitudes to injury and their perceived attitudes to injury and safety within their local clubs. Only 6% of 103 juniors responding believed it was safe to play with an injury, and nearly 70% recognised long term dangers and need for full rehabilitation before returning to play. Nevertheless, 58% were willing to do so, 77% to ensure consideration for a team in the league. About half thought that the media glorified league players who continued to play despite injury, and an appreciable proportion admired them.

Perceptions of support for injured players at the three team levels were significantly different. The league under 18 clubs were thought to be better than local or school clubs in overall support and providing first aid, medical support, and rehabilitation. However, local clubs outperformed the others in support from the coach. Significantly more players ranked the league clubs higher in safety during the game (90%) and in training (85%).

Australian football accounts for more than 20% of sports injuries requiring medical treatment in Australia. The players in football league under 18 clubs have a significantly higher incidence of injuries than football league players, who are over 18.

Injury risk associated with playing actions during competitive soccer

N Rahnama, T Reilly and A Lees

doi: 10.1136/bjsm.36.5.354

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