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The effect of changes in the score on injury incidence during three FIFA World Cups

Jaakko Rynänen,1,2 Astrid Junge,3,4 Jiri Dvorak,3,4,5 Lars Peterson,2,3,5 Jón Karlsson,2 Mats Börjesson6,7

ABSTRACT

Objective To study the effect of changes in the score and of different playing positions, as well as the effect of recovery time on injury incidence during Fédération Internationale de Football Association (FIFA) World Cups.

Design Prospective injury surveillance at three international championships in 2002, 2006 and 2010. Official match statistics were obtained for all the games played in the three championships.


Participants National team players as well as the team doctors reporting all the injuries at the 2002, 2006 and 2010 FIFA World Cups.

Main outcome measures Injury incidence and incidence rate ratios.

Results There were statistically significant differences in injury incidence related to changes in the score (p=0.026) and to the teams’ current drawing/losing/winning status (p=0.008). Injury incidence was lowest (54.8/1000 match-hours (mh), 95% CI 46.4 to 64.3) during the initial 0–0 score and highest (81.2/1000 mh, 60.5 to 106.8) when the score was even but goals had been scored. Winning teams had a tendency towards a higher injury incidence (81.0/1000 mh, 67.5 to 96.4) than losing or drawing teams (55.5/1000 mh, 44.4 to 68.4 and 59.7/1000 mh, 51.8 to 68.6, respectively). There were also statistically significant differences in injury incidence between the playing positions (p=0.001), with forwards having the highest injury incidence (85.7/1000 mh, 69.8 to 104.2), followed by defenders (76.4/1000 mh, 63.3 to 89.5), and midfielders (53.3/1000 mh, 46.5 to 60.4) and goalkeepers (46.6/1000 mh, 38.8 to 55.2).

Conclusions There is a considerable variation in injury incidence during a match in international men’s football related to changes in the score. Players in a winning team run a higher risk of suffering an injury than players in a drawing or losing team. Identifying time periods with a high injury incidence may be of major importance to players and team personnel, as it may enable them to take precautions.

INTRODUCTION

The incidence of time-loss injuries in football matches varies between 17 and 51 injuries/1000 match hours, with the highest incidences being reported in international tournaments.1–7 The most common cause of injury at international top-level tournaments is contact between players, causing between 63% and 86% of all injuries.3,8,9 This is a higher percentage than that reported in studies for full season league football.14 Between 35% and 80% of the contact injuries involve foul play,6 7 10 12 13 which appears to be the most important extrinsic risk factor for injuries.14

As football is a sport of a highly competitive nature, especially at the top level, changes in the score could probably affect the team strategies, the players’ attitudes and precautions, match intensity and, possibly as a consequence, also the incidence of injury within a game. Competitiveness as a background factor has previously been discussed by Hägglund et al.,9 who found that the incidence in men’s European Championship football was higher than the incidence in men’s football at the club level. The combination of fewer matches played in international tournaments than during full season leagues, and the additional pressure of the knock-out stage in such tournaments, may thus theoretically be reflected in a higher injury incidence.

The time (minute) in the match when injuries occur has been studied several times, providing somewhat varying results. In the most recent Fédération Internationale de Football Association (FIFA) World Cup (2010), the number of injuries steadily increased towards the end of the match, with approximately 67% of the injuries occurring in the second half.7 In the 2006 FIFA World Cup, the injury frequency was highest during the last 15 min of the first half,5 while in the 2002 FIFA World Cup, the incidence of injury was similar in both halves of the match, increasing towards the end of each half.6 A Union of European Football Association (UEFA) injury study, in which 23 first-team squads from the best teams in Europe were followed during the 2001–2008 seasons, revealed an increase in traumatic injuries over time towards the end of both halves, suggesting that tiredness may be an important factor.5 A study of English professional club team footballers showed a similar pattern, with an increasing number of injuries occurring towards the end of each half, with the incidence of injuries being significantly higher in the second half.4

The literature shows some differences regarding injury incidence between matches won, drawn and lost. Ekstrand et al.13 found a higher injury incidence during matches lost at the national team level. Another study on the European Championship level showed no significant differences between matches won, drawn or lost.9 However, the score during a game changes as goals are scored and neither study takes into account the current score at the moment of injury.

Other factors could also affect injury incidence by similar mechanisms. Inadequate recovery time between games could also possibly affect the risk of injury, but this has been difficult to show previously.3

The primary aim of the present study was, therefore, to investigate whether there is any variation in the injury incidence related to changes in the score in international top-level men’s football and to study whether the playing position had any effect on the injury incidence. A secondary aim was to study the effects of recovery time on injury incidence.

MATERIALS AND METHODS

The material consists of injury reports from the FIFA World Cups in 2002 (Korea–Japan), 2006 (Germany) and 2010 (South Africa), as well as match statistics for all the 192 matches of these championships, provided on FIFA’s official webpage.16 In each of the three world Cups, a total of 64 matches were played by 32 teams (total of 736 players). The total number of injury reports included in the present study was 441 (171, 145 and 125 for the three World Cups, respectively).5–7

The injury report forms and data collection are presented in several earlier studies of FIFA tournaments.5–8 The injury reports contain details of the type and location of the injury, the time when the injury occurred, the circumstances (non-contact, contact and foul play) and consequences (referees’ sanction and treatment) of injury, as well as an estimate of the absence from training and/or playing football resulting from the injury. An injury was defined as any physical complaint incurred during the match that received medical attention from the team physician regardless of the consequences with respect to absence from the match or training, as described earlier by the FIFA Medical Assessment and Research Centre (F-MARC) in 2006.17 Ethical approval for injury surveillance has been obtained.

The score and the teams’ drawing/losing/winning status at the time of injury

The injuries were grouped according to the score at the time of injury into four groups: score 0–0, even score with goals scored, one-goal difference and two or more goals’ difference, and according to the team’s drawing/losing/winning status at the time of injury into three groups: drawing, winning and losing. For the time of injury, the information provided on the injury report form was used, while the score at the time of injury was assessed from official match statistics. The time of the different match-periods was calculated by using the times of goals from official match statistics.16

The incidence of injury was calculated separately for the different score groups, as well as the groups based on the teams’ current drawing/losing/winning status. The injury incidence for the three latter groups was also calculated separately for outfield playing positions (forwards, midfielders and defenders).

Playing position

The injuries were grouped according to the playing position of the injured player. The incidence of injury was calculated for all positions, assuming a hypothetical 1:4:4:2 formation (one goalkeeper, four defenders, four midfielders and two forwards).18

Recovery time between matches

The number of full days of recovery (whole days between match-days) between all matches after the first round of group play was assessed for all the teams, according to the tournament schedules obtained from FIFA’s official website.16 The total numbers of injuries per match were also assessed for all the teams. The matches were grouped based on the number of full days of recovery for the teams and the injury incidence was calculated for all the groups.

Statistical analysis

The incidence of injury was calculated using the formula: (number of injuries × 1000 match-hours)/(minutes of exposure/60) × N players exposed) and expressed as the number of injuries per 1000 match-hours. The number of players exposed was 22 for calculations of incidence in the different score groups and 11 for calculations of incidence for the drawing, losing or winning teams, as well as for teams based on the number of full days of recovery between matches. For calculations of the incidence for different playing positions, the assumption was that all teams played in the 1:4:4:2 formation (one goalkeeper, four defenders, four midfielders and two forwards).18 The consequence of possible expulsions on the number of players exposed was not taken into account. The minutes of possible extra time were taken into account in the calculation of injury, whereas the minutes of additional time were not taken into account.

The injury incidence rates (per 1000 match-hours) with 95% CI were calculated assuming a Poisson distribution. The incidence rate ratios (IRRs) and the test for a significant trend in injury incidence rates across the different groups, as well as in relation to days of recovery, were calculated using Poisson regression models or negative binomial regression models when appropriate. STATA V.12.1, StataCorp LP (College Station, Texas, USA) statistical package was used for the analyses.

RESULTS

Injury incidence in relation to the current score

For 415 injuries (94.1%), the time of injury was reported, and for all these injuries the score at the moment of injury could be established. The total injury incidence for the three tournaments was 67.8/1000 match-hours (95% CI 61.7 to 74.5). The incidence of injury varied significantly (p=0.026) between the four score groups. Table 1 shows the incidence of injury for four different score groups and their IRRs in relation to the matches’ initial 0–0 score (reference). The injury incidence was lowest (54.8/1000 match-hours, 46.4 to 64.3) during the initial 0–0 score and highest (81.2/1000 match-hours, 60.5 to 106.8) when the score was even but goals had been scored.

<p>| Table 1 | Incidence of injury for four different score groups based on the current score of the match |
|-----------------|-----------------|------------------|-----------------|-----------------|-----------------|-----------------|</p>
<table>
<thead>
<tr>
<th>Number of injuries</th>
<th>Exposure hours</th>
<th>Incidence (95% CI)</th>
<th>IRR (95% CI)</th>
<th>p Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>0–0</td>
<td>150</td>
<td>2736.4</td>
<td>54.8 (46.4 to 64.3)</td>
<td>1.00 (reference)</td>
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<tr>
<td>Even</td>
<td>51</td>
<td>628.1</td>
<td>81.2 (60.5 to 106.8)</td>
<td>1.48 (1.08 to 2.04)</td>
</tr>
<tr>
<td>1-goal difference</td>
<td>149</td>
<td>2310.4</td>
<td>64.5 (54.5 to 75.7)</td>
<td>1.18 (0.94 to 1.48)</td>
</tr>
<tr>
<td>≥2-goal difference</td>
<td>65</td>
<td>826.1</td>
<td>78.7 (60.7 to 100.3)</td>
<td>1.43 (1.07 to 1.92)</td>
</tr>
</tbody>
</table>

IRR, incidence rate ratio.
Injury incidence in relation to the teams’ winning/drawing/losing status

The teams currently winning had a higher injury incidence (81.0/1000 match-hours, 67.5 to 96.4) than losing or drawing teams (55.5/1000 match-hours, 44.4 to 68.4 and 59.7/1000 match-hours, 51.8 to 68.6, respectively, table 2). The differences in injury incidence between the groups were statistically significant (p=0.008).

Injury incidence in relation to the playing position

Table 3 shows the injury incidences for the four playing positions. The differences between the groups were statistically significant (p<0.001). Forwards had the highest injury incidence 85.7/1000 match-hours, 69.8 to 104.2, followed by defenders (68.8/1000 match-hours, 58.6 to 80.2). The lowest incidence was calculated for goalkeepers (35.6/1000 match-hours, 22.1 to 54.5).

Figure 1 shows the drawing, winning and losing injury incidence for outfield playing positions (defenders, midfielders and forwards). The interaction between playing position and score group was statistically significant (p<0.001). Forwards had a tendency of lower injury incidence during game periods when the team was winning (11.2/1000 match-hours, 7.7 to 15.8), in contrast to defenders and midfielders who had a tendency towards the highest incidence of injury during game-periods when the team was winning (78.9/1000 match-hours, 57.6 to 105.6; the same value for both groups).

Injury incidence in relation to recovery time

The teams’ number of full days of recovery between matches varied between two and five. As the number of full days of recovery between the matches increased, the injury incidence increased in a linear fashion (figure 2, p=0.043). The incidence of injury was 85.9/1000 match-hours (95% CI 66.9 to 108.8) for teams playing after five full days of recovery and 54.9/1000 match-hours (95% CI 31.4 to 89.1) for teams playing after two full days of recovery. The incidence of injury for teams playing after three and four full days of recovery was 63.1/1000 match-hours (95% CI 51.4 to 76.8) and 66.8/1000 match-hours (95% CI 56.5 to 78.4), respectively.

DISCUSSION

The main finding of the present study is that the injury incidence during a FIFA World Cup match is related to changes in the score. We also found that the injury incidence is related to the teams’ current drawing/losing/winning status, with the highest risk of injury being for teams that are currently winning. The third finding was that there was a significant difference in the injury incidence between different playing positions, with forwards being at the highest risk. The different outfield playing positions also had different patterns of variation in injury incidence, according to the teams’ drawing/losing/winning status. Furthermore, there was a linear relationship between injury incidence and days of recovery, with a significant association between a higher injury incidence and increasing number of days of recovery.

To the best of our knowledge, no previous studies of football or other sports have taken into account the effect of the current score in the match on injury incidence. According to the hypothesis, changes in the score might affect, for example, the intensity of the match and team strategies, thereby possibly leading to an increased risk of injury. We do know that football matches show periods and situations of high-intensity activity followed by low-intensity periods and that actions often crucial for the match outcome are representative of high-intensity periods of anaerobic metabolism. The results of the present study show that the injury incidence changes significantly when the scores change (table 1). The injury incidence was lowest during match-periods with the initial 0–0 score (54.8, 46.4 to 64.3; reference), and was significantly higher during match-periods when the score was even but goals had been scored (81.2, 60.5 to 106.8; p=0.015), and during match-periods when there was a two or more goals’ difference between the teams (78.7, 60.7 to 100.3; p=0.016). As every match begins with a 0–0 score, of course, this result is more common at the beginning of games, making it difficult to determine the difference between the impact of fatigue (or other possible time-related factors) and the effect of the score on injury incidence. However, the relation between increasing fatigue and increasing injury incidence towards the end of a football match has not been proved beyond doubt. In addition, in the present study, the exposure was highest during the initial 0–0 score, suggesting

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<table>
<thead>
<tr>
<th>Table 2</th>
<th>Incidence of injury for drawing, losing and winning teams</th>
</tr>
</thead>
<tbody>
<tr>
<td>Number of injuries</td>
<td>Exposure hours</td>
</tr>
<tr>
<td>Drawing</td>
<td>200</td>
</tr>
<tr>
<td>Losing</td>
<td>87</td>
</tr>
<tr>
<td>Winning</td>
<td>127</td>
</tr>
</tbody>
</table>

IRR, incidence rate ratio.

<table>
<thead>
<tr>
<th>Table 3</th>
<th>Injury incidence for the different playing positions</th>
</tr>
</thead>
<tbody>
<tr>
<td>Number of injuries</td>
<td>Exposure hours</td>
</tr>
<tr>
<td>Defenders</td>
<td>162</td>
</tr>
<tr>
<td>Midfielders</td>
<td>139</td>
</tr>
<tr>
<td>Forwards</td>
<td>101</td>
</tr>
<tr>
<td>Goalkeepers</td>
<td>21</td>
</tr>
</tbody>
</table>

IRR, incidence rate ratio.
that the match-periods with a 0–0 score do not represent only the initial minutes of matches. In 13 of the 192 matches included in the present study, 0–0 was also the final score of the match and in 68 matches, the first goal was not scored until during the second half of the match. While the low injury incidence during the 0–0 score in the present study may include a source of bias, changes in the score may be regarded as one of the underlying factors, or at least markers, of injury risk.

It has been shown previously that the incidence of injury increases towards the end of each half and this has generally been attributed to increasing fatigue of the players, which appears to have an essential role. Aoki et al also discussed the possibility that playing attitude among players was a factor. The changes in the score may alter player attitudes and team strategies and subsequently lead to a more aggressive style of play for the other team or both teams. Fuller assessed the relationship between behaviour and injury in the workplace for footballers and found that injuries in football were likely to be caused by deliberately aggressive behaviours on the part of certain players. Interestingly, Junge et al found that 90% of footballers are ready to commit a professional foul if required, depending on the score and importance of the match. As between 35% and 80% of the contact injuries involve foul play, and as a World Cup football match is most probably of great importance for the players, it appears logical that the players’ attitudes account for at least part of the variation in injury frequency.

A study by Hägglund et al on the epidemiology of injuries in European (EURO) football showed no differences in injury incidence between matches that were won, drawn or lost, while Ekstrand et al found an increased risk of injury during matches lost at the national team level. However, these results were based on the final score only and changes in the score during the match were not taken into account. In the present study, the incidence of injury was found to differ significantly (p=0.008) between game-periods according to the teams’ current drawing/losing/winning status. While there was no statistically significant difference between the incidence of injury for drawing (reference) and losing teams (p=0.56), the incidence of injury for winning teams was significantly higher (p=0.007). No earlier studies on the incidence of injury during current winning/drawing/losing statuses have been published. The higher injury incidence for the team in the lead may be partly explained by possible changes in team strategy, for example, by applying a more defensive strategy or aiming to stay in possession of the ball in order to prevent the opponent from scoring, that the team in the lead may apply in order to maintain its lead. Moreover, the team that is losing may apply a more aggressive style of play in order to equalise the score and thereby increase the risk of injury for the team in the lead. It has been shown that, in most injuries resulting from tackling, the injury affects the player who is tackled rather than the tackling player. Rascle et al found differences in soccer players’ perceived legitimacy of aggression, partly dependent on the current score. Fuller studied the differences in foul/tackle ratios between the winning, drawing and losing teams and found them to be similar. However, Fuller also found that the level of injury in World Cup football caused by the weaker teams (teams that were eliminated at the group stage) was greater than that caused by the stronger teams, suggesting that weaker teams may play more aggressively. Likewise, a study on aggressive behaviour in professional ice hockey showed no differences in the frequencies of aggressive behaviours, depending on the teams’ winning/drawing/losing status. However, it seems clear that injury incidence is multifactorial and a foul/tackle ratio is only one way to assess the behaviour of the players.

Several studies have assessed the relationship between the risk of injury and playing position, and with the exception of a few studies, the injury risk for different playing positions has not been shown to differ. However, the different methodology in the studies makes comparisons of the results difficult. In top-level club football, Carling et al found a variation in the incidence of injury between different positional roles, with the highest incidence being for centre-forwards. On the other hand, Hawkins and Fuller found that the defenders had a
higher risk of injury than other playing positions, using video analysis and media coverage as injury data, and possibly less precise data. In the present study, the incidence between the playing positions differed significantly (p<0.001). Forwards had a substantially higher injury incidence compared with the other positions. Tscholl et al. found a similar trend for women in international football, but without statistical significance. One plausible explanation for the higher injury incidence for forwards could speculatively be the importance of the result of a single match in international tournaments, resulting in heavy pressure on the forwards to score goals. Forwards may attract more intense attention from the media than players in other playing positions, thereby increasing the pressure on them and possibly affecting their injury incidence.

An interesting finding of the present study is that the outfield playing positions had different trends in the changes in injury incidence depending on the teams’ drawing/losing/winning status. For defenders and midfielders, the injury incidence was highest when their team was winning (78.9, 57.6 to 105.6). This might be the consequence of their role in defending the lead. Forwards had a substantially higher incidence when their team was drawing (73.6, 53.7 to 98.4) compared with game periods when their team was losing or winning (13.7, 9.7 to 18.7 and 11.2, 7.7 to 15.8, respectively). It could be speculated that forwards have a higher pressure to score when their team is drawing compared with game periods when their team is already winning. However, the low injury incidence for forwards during match-periods when their team was losing was surprising.

The match schedule during a World Cup is intense and teams may have only two whole days to recover between two matches. The effect of a tight match schedule on injury incidence in soccer is not clear. The present study surprisingly showed a significant relationship between higher injury incidence and a higher number of full recovery days between matches (p=0.043), though the opposite might be expected. Some possible explanations may be speculated. A longer break between matches may affect the player’s concentration and direct their orientation away from match play. Another plausible explanation could be that players have more energy after a longer break and play with a higher intensity resulting in a higher risk of injury. Ekstrand et al. showed that 29% of the international players who played more than one match for their clubs during the season incurred an injury during the following World Cup, even though they did not have an increased risk of injury during the season. They suggested that a congested match calendar could increase the risk of injury or underperformance during the following period. The results of the present study, going somewhat against previous opinion, show the need for further and larger studies, specifically designed to look at recovery time between matches and injury incidence. The clinical significance of these findings is potentially considerable.

Study limitations
As for the timing of the injury, it is possible that some reported injury times are merely approximations instead of exact minutes, as team doctors manually filled in the injury reports. A change in the score that occurred in close proximity to an injury may therefore, in some cases, have been a possible source of bias. Further sources of bias may have been the exclusion of minutes of additional time; In addition, the assumption that all teams played in the 1:4:4:2 formation (one goalkeeper, four defenders, four midfielders and two forwards) may also have been a source of bias.

What are the new findings?

- A part of the variation in injury incidence during a game in international adult men’s football is related to changes in the score.
- There are changes in injury incidence according to the teams’ current drawing/losing/winning status, with the highest incidence being recorded for winning teams.
- The injury incidence in men’s World Cup football varies between playing positions, with forwards tending to have the highest injury incidence.

How might it impact on clinical practice in the near future?

- Identifying time periods with a high injury incidence within a match may be of use to players and team personnel, as it could enable them to take precautions during these periods.
- Through interaction with both players and team management, the team medical personnel may be able to prevent injuries to players at increased risk.
- The findings may help to improve the planning of medical services and injury prevention during major football tournaments.

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The authors gratefully acknowledge FIFA (Fédération Internationale de Football Association) for the funding of this study and greatly appreciate the cooperation of all the team physicians who provided the injury data. They also express their gratitude to Professor Ilkka Kiwanta (University of Helsinki) whose initiative was essential for this project to initiate and to Dr Hannu Kautiainen for statistical assistance.

Contributors
JAIR planned the study, conducted the statistical analysis (with close assistance from statistician Dr Hannu Kautiainen), collected part of the data and wrote a major part of the report. All the authors have participated in the study design in revising and partly writing up the research plan as well as the manuscript. AJ, JD and LP were in key positions in the collection of injury data. JK supervised and took part in all the phases of the study since the planning, as well as revising and partly writing up the manuscript. MB participated in revising and writing up the manuscript.

Funding
Fédération Internationale de Football Association (FIFA).

Competing interests
None.

Ethics approval
Ethics approval has previously been obtained. FIFA/F-MARC has ethics approval for injury surveillance in FIFA tournaments since 1998, and the data for this study have been obtained through this surveillance following the approved procedures. Other articles relying partly on the same data have been published earlier, even in BJSM (for example Medical report from the 2006 FIFA World Cup Germany, Br J Sports Med 2007;41:578–81).

Provenance and peer review
Commissioned; externally peer reviewed.

REFERENCES


