

Risk assessment in professional football: an examination of accidents and incidents in the 1994 World Cup finals

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Abstract

Objective—To assess the risks to footballers' health and safety during competitive international matches, with identification of the most common causes of injury.

Methods—Videos of 44 of the 52 matches played during the 1994 World Cup finals staged in the USA were analysed. During each match, several relevant variables were recorded, including the number of fouls, injuries, treatments, times of incidents, identity of players treated or injured, and the injury mechanism. Additional information on players' injuries was obtained from the extensive media coverage of the event.

Results—Only 29% of injuries resulted from foul play, whereas 71% of injuries to players occurred where no foul play was adjudged by the referee to have taken place ($P < 0.01$). Defenders were found to be proportionately subjected to a greater risk of injury than other players ($P < 0.05$). Fifteen per cent of all injuries were judged to be at least moderate, resulting in the player missing at least one match. Frequency of moderate injury was 1026 injuries per 100 000 hours played.

Conclusions—The major causes of injuries during international football matches were not found to be associated with foul play, as judged by the referees. However, in those cases where injuries occurred without a foul being committed, almost 50% involved player to player contact. This gives some cause for concern and is worth further investigation.

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Key terms: professional football; injury; risk factors

The ultimate aim of health and safety management is the elimination of accidents and ill health: in the case of professional football this would be equivalent to keeping all players fit, at all times, thereby allowing the club management to select from an injury-free squad. The benefits of such a situation accrue to both individual players, by possibly enhancing and prolonging their playing careers, and to the football clubs themselves, by maximising the return on their investment. One step towards achieving this aim would be to undertake an assessment of the risks to players' health and safety.¹ In the United

Kingdom, such an assessment is a general requirement of the Health and Safety at Work (HASAW) Act 1974² and a specific requirement of the Management of Health and Safety at Work (MHSW) Regulations 1992.³ In risk assessment the emphasis is on preventing accidents by identifying potential hazards (cause of injury), and determining the likelihood (frequency of injury) and consequences (extent of injury) of accidents arising from the hazards. Inadequacies in risk management, highlighted by the assessment, then help to determine the additional control measures that need to be implemented.

One of the underlying principles of successful health and safety management is loss control.⁴ The adoption of a total loss control approach seeks to identify and eliminate all incidents, irrespective of whether or not they result in injury. The severity of the outcome of an incident often depends on chance if hazards are not properly identified and the associated risks not controlled. Therefore, since the outcome of an incident cannot be accurately predicted, the only reasonable way in which to reduce injuries is to control all of the underlying causes. The use of accident triangles in loss control theory shows the relations between major injuries, minor injuries, and non-injury incidents.⁵

Incidents are seldom inevitable random events, and even though their immediate causes in professional football may differ, such as an unfair tackle or a shot on goal, the underlying cause may be similar. Injuries are usually the result of multiple causes, and it is the intrinsic and extrinsic factors alike, whether they be training aspects, management tactics, or individual attributes and attitudes, that need to be identified and controlled. The causal pathways are complex and the identification and examination of one possible risk factor can only partly begin to address the question of injury prevention. Accurate information concerning injuries is required, together with physical and physiological knowledge of the individual players to enable positive steps to be taken regarding injury prevention.

In professional football, research has previously identified that the majority of injuries occur during competitive games.^{6,7} Therefore it is essential as part of the overall risk assessment process to gain a closer insight into the types, causes, and frequencies of injuries to professional footballers during competitive games.

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Methods

The 1994 World Cup finals, staged in the USA, provided a four week period of intense football activity, which gave the opportunity of analysing injuries arising from the highest level of international football. During the competition a total of 52 matches were played and for this study 44 televised matches were recorded on videotape for analysis.

For each match, situations in which a free kick occurred arising from player contact and situations in which a player received treatment were recorded. The following variables were identified where appropriate for each incident:

- (1) the playing time elapsed in minutes as shown on the video recorder;
- (2) whether the treatment was a result of a foul (as indicated by the referee);
- (3) whether the foul was judged (by the referee) to be against or for the treated player;
- (4) whether no foul was judged (by the referee) to have occurred even though a player was injured.

For each treatment additional information was recorded:

- (1) the identity of the player(s) involved;
- (2) his playing position;
- (3) the injury mechanism;
- (4) future involvement in the game (for example, was he taken off immediately, taken off later, or did he complete the remainder of the game?).

Analyses of both the video recording and newspaper reports confirmed the identity of players involved in all analysed games, times of substitutions, and the players cautioned or sent off. Any additional relevant information from match commentaries and newspaper reports was also recorded. The wide and extensive media coverage enabled complete team profiles to be constructed, and allowed reasons for game to game team changes to be identified (for example, suspension, injury). In performing statistical analyses the incidents were assumed to follow a Poisson distribution and the χ^2 significance test was used; statistical significance was accepted at the $P < 0.05$ level.

ACCIDENT/INCIDENT ASSESSMENT

Accident ratio triangles

The ratios between accidents and incidents of varying levels of severity can be represented as accident triangles. For general accident analysis, the Health and Safety Executive (HSE)⁵ identified three categories and defined them as: over-3-day injury accidents; minor injuries (for example, first aid only); and non-injury accidents or incidents. The work of Ekstrand and Gillquist⁸ could be represented in this way, with four categories being identified: major – absence from practice for more than one month; moderate – absence from practice for more than one week but less than one month; minor – absence from practice for less than one week; and non-injury incidents (see below). Three levels of accident

and incident were defined and used in this study.

- “Moderate” injury: players received treatment on the field of play, or were otherwise identified as having been injured, and subsequently missed at least the following game.
- “Minor” injury: players received treatment on the field of play, or were otherwise identified as having been injured, but were involved in the following game.
- “Non-injury” incident: fouls (referee’s judgement) not resulting in injury or treatment.

“Free-kicks”: relates solely to fouls arising from player contact (excludes off-side, dissent etc).

The ratios between accidents of varying levels of severity were represented as accident triangles.

Injury frequency rates (IFR)

Accident frequency rates can be compared with accident statistics published by external sources, such as the HSE. They are usually calculated per 100 000 hours worked. The formula used for calculating accident frequency rate (AFR) is:

$$AFR = \frac{\text{Number of injuries in period}}{\text{Total hours worked during period}} \times 100\,000$$

The total hours worked during a period takes into account the number of hours worked and the number of people involved. In exactly the same way IFRs in professional football can be calculated per 100 000 hours played and be compared with industrial figures.

Results

The 44 World Cup games analysed, four of which included extra time, represented 85% of the total playing time during the competition. In addition, 44 matches approximates closely to the typical number of league matches played by each club in the English Premier League (1994/95 – 42) and First Division (1994/95 – 46). Before the start of the World Cup competition all referees were briefed on the required standards by FIFA: hence the level of refereeing over the period would be expected to be reasonably consistent. During the 44 World Cup games analysed, 1272 fouls were committed in the referees’ judgement, resulting in an average of 28.9 (SD 5.4) free kicks per game. There was a total of 94 treatments, made up of 33 (35%) resulting from a foul compared to 61 (65%) where no foul had been committed ($P < 0.01$). Of the 33 treatments associated with free kicks, 10% were given to the culprit himself, and 90% to the victim. In addition to the 94 treatments described above there were 20 other instances, throughout the analysed games, where players were judged to be injured but received no treatment during the course of the game. These injuries could not be associated with a foul and as the timing and mechanisms of these injuries were not known they could not be used in several of the analyses carried out.

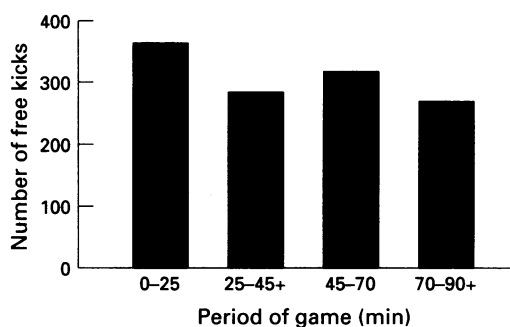


Figure 1 Total number of free kicks in each quarter of the game.

FOULS AND INJURIES

Matches during the competition typically consisted, with injury time, of two periods of 50 min play. For the purposes of analysis, this playing time was split into four periods of approximately equivalent times (that is, 0 to 25 min, 25 min to half time, start of the 2nd half (45 min) to 70 min, and 70 min to full time). Figure 1 shows the number of free kicks awarded and fig 2 shows the number of player treatments in each period. Free kicks and treatments occurring during the extra time periods in the four matches were not included in these figures. The greatest number of free kicks occurred in the first 25 minutes (30%, $P < 0.01$), although there was no statistical significance in the difference between the two halves (53% v 47%). There was, however, a significantly greater number of treatments in the second half (61%, $P < 0.05$), with 36% occurring in the first 25 min after half time.

Based on the typical 1:4:4:2 (goalkeeper, defenders, midfielders, forwards) playing system used by teams in the competition, a statistically significant difference was found between the incidence of injury and number of players for defenders and midfielders (43% v 36% and 26% v 36%, respectively, $P < 0.05$). However, the ratio of injuries arising from fouls compared to other causes showed no significant differences between playing positions.

The kick off times for matches had no significant influence on the incidence of injuries, the number being evenly distributed across mid-day, afternoon, and evening games.

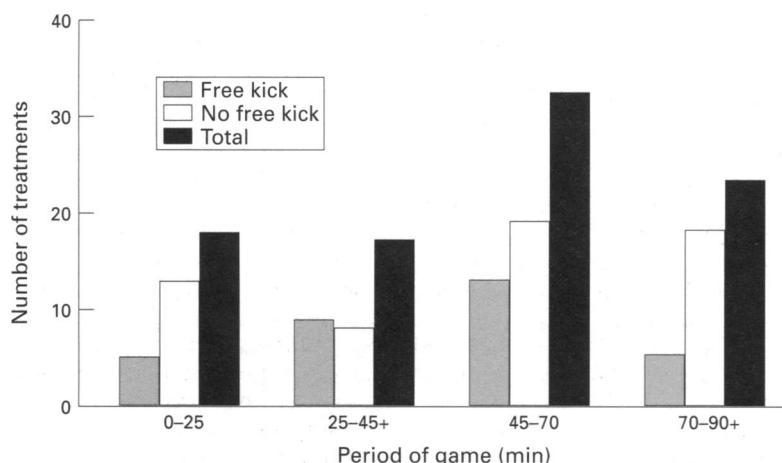


Figure 2 Total number of treatments in each quarter of the game with respect to refereeing decision.

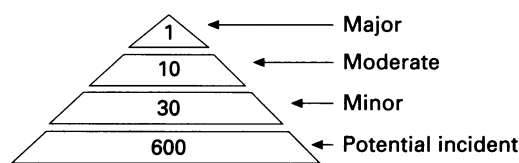


Figure 3 A typical four category accident triangle.

ACCIDENT RATIO TRIANGLES

The approach used by Bird and Germain⁹ and Heinrich¹⁰ to analyse the underlying causes of injuries was used. The technique involves determining the ratios of major, moderate, minor, and non-injury incidents occurring in the area of work being analysed. From these data it is then possible to construct accident triangles and compare the results with other activities. A typical accident ratio triangle is shown in fig 3.⁴

ALL "INJURIES"

There was a total of 17 moderate injuries, 97 minor injuries, and 1239 "no injury" (fouls) incidents recorded during the World Cup competition. Therefore, for every moderate injury that prevented participation for a minimum of one game there were six minor injuries and 73 incidents which could potentially have led to an injury (fig 4).

These results can be subdivided into two categories: those injuries resulting from fouls and those where no foul was committed.

"Injuries" resulting from fouls

From the 1272 fouls recorded, three incidents resulted in moderate injuries, with a further 30 classified as minor injuries. These results included one case where a player sustained a fractured skull in his country's final game and as this would definitely have caused him to miss any subsequent games the injury was categorised as moderate. Three other players were treated in their countries' final games, one of whom was substituted. It was assumed, however, in the absence of other information that they would have been fit if any further games had been played, and so these injuries were classed as minor. This produced an accident ratio of 1:10:413, shown in fig 5.

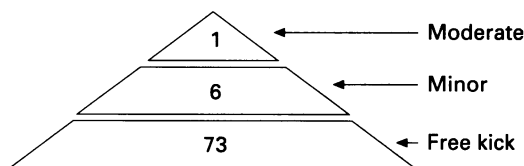


Figure 4 Accident ratios for all injuries with respect to potential incidents.

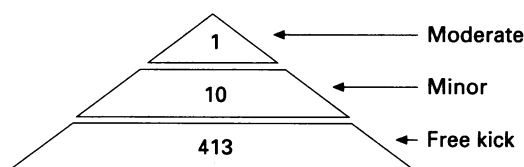


Figure 5 Accident ratios for injuries resulting from fouls with respect to potential incidents.

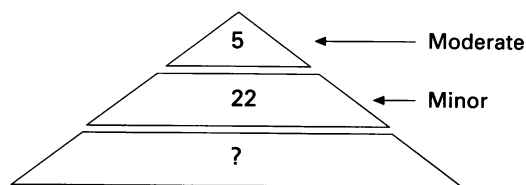


Figure 6 Accident ratios for injuries where no fouls were committed.

"Injuries" not resulting from fouls

Fourteen injuries were judged to be at least moderate. Seven of the 14 received treatment during the game, the remainder did not. There were a further 67 minor injuries, 54 receiving treatment during the game. Twelve of the injuries occurred in a country's final game, with two of the players being substituted. In the 13 where they did not receive treatment, seven were substituted in their team's final game. By normalising the results on the injuries resulting from fouls, there was then a ratio of 5:22 moderate and minor injuries (fig 6). Possible underlying causes of these injuries are discussed later.

INJURY INCIDENCE RATES

If the 24 teams represented in the World Cup used all 22 players in their squads then 528 players would have been involved in the 52 games. However, only two countries used all their players and in total 427 players were involved. In the 44 games covered in this analysis a total of 412 players was involved. Therefore, the injury incidence in this study, per player for all injuries, was 27.7% (8.0% and 19.7% as a result of a foul and no foul, respectively), with moderate injuries representing 4.1% (0.7% and 3.4% as a result of a foul and no foul, respectively) of the total.

INJURY FREQUENCY RATES

From the number of moderate and minor injuries recorded during the 44 games, the average frequency of injuries with respect to an individual team and an individual player can be calculated (table 1).

For the determination of injury frequency rate (IFR), it was assumed that there were 100 minutes in each standard game, 130 minutes in games where extra time was played, and that 22 players were involved at all times. This gives the total equivalent playing hours as 1657 hours.

From equation 1 the IFRs per 100 000 playing hours were calculated for both minor and moderate injuries where fouls and no fouls were indicated (table 2).

Table 1 Average injury frequency rates for each team and individual players

	Fouls		No fouls	
	Minor	Moderate	Minor	Moderate
Team				
Number of injuries/team-game	0.34	0.03	0.76	0.16
Number of games for one team player to be injured	2.9	29.3	1.3	6.3
Player				
Number of injuries/player-game	0.031	0.003	0.069	0.014
Number of games for an individual player to be injured	32.3	322.7	14.4	69.1

Table 2 Injury frequency rates per 100 000 playing hours

	Injuries/100 000 hours	
	Minor	Moderate
Resulting from fouls	1811	181
Not resulting from fouls	4043	845
Total	5854	1026

The overall injury frequency rate was 6880 injuries per 100 000 hours played.

Discussion

Previous research on soccer injuries has in most cases been based on youth¹¹⁻¹⁴ or semi-professional football.^{8 15 16} Other information has been obtained from hospital medical records^{6 17} and insurance claims.⁷ In the cases of hospital records and insurance claims, detailed information concerning minor injuries is unavailable and with information from the lower levels of soccer, the exercise intensity is less, with a smaller number of physical contacts than with higher levels of competition¹⁸; consequently the risk of injury may be lower. The main objective of this study was to address the issues of injury frequency and causation at the international level. In this respect, the 1994 World Cup finals provided an ideal opportunity to observe and record a large number of competitive games involving the best 24 national teams in the world at the time. With the comprehensive media coverage, much information was obtained which otherwise would only be available from working directly with the teams.

INJURY CAUSATION

All injuries and treatments were divided into those that resulted from a foul and those that did not. However, one problem was that the cause of some reported injuries could not be identified; some players possibly received an injury without receiving treatment and played on. Twenty players were identified as having sustained an injury during a game without receiving treatment during the game; none of these injuries was the result of a foul. However, there were a further 34 instances throughout the whole tournament where players may have received minor or moderate injuries, during training or games, resulting in their missing games due to their injuries. The fact that these were not included in the analyses – together with other training and playing injuries not reported – suggests that there may be an underestimation of the level of injury. This hypothesis is supported in a study by Jorgenson,¹⁹ where 47% of reported injuries did not receive medical attention but were still defined as a handicap or preventing participation altogether.

In the present study 28.9% of all treatments received on the pitch were found to be the result of a foul. This is a slightly higher level than that obtained by other investigators,^{6 19-21} who have reported that fouls were responsible for 19-28% of game injuries. No correlation was found, however, between free kicks and injuries, and on the basis of the accident ratios,

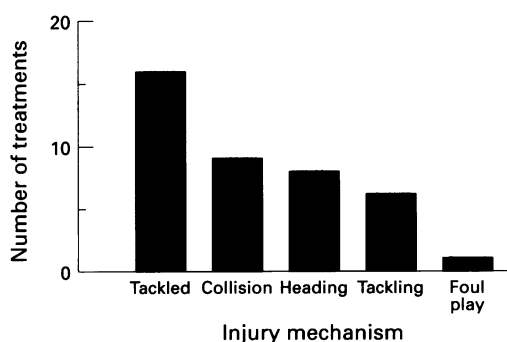


Figure 7 Mechanisms of the player to player contact injuries where no fouls were committed.

only 2.6% of fouls committed actually led to a player requiring treatment. Moderate injuries were found to occur five times more frequently without a foul being involved than to be the result of a foul.

Where an injury results from a foul, then the cause of the injury can easily be identified. Sixty six per cent of these recorded treatments were due to players sustaining an injury when being tackled, the free kick being awarded in favour of the injured player in 95% of those cases. The laws of the game are written to protect players from such incidents, and the few injuries sustained from foul play compared to other causes seem to suggest that the laws act as a deterrent and are being properly enforced. There are occasions, though, where no fouls have been deemed by the referee to have been committed but injuries still arise. The immediate causes of these are not always identifiable; however, of the 81 injuries analysed in this category (minor and moderate), 49% were associated with contact with another player, 20% did not involve another player, and in 31% an immediate cause could not be established from the information available. An analysis of the events leading to the player to player contact injuries is shown in fig 7. The high number of injuries arising from player to player contacts, which were not deemed to be fouls, gives some cause for concern and is worth further investigation to determine whether minor changes to the laws of the game could reduce this figure. Overall, 64% of the observed injuries involved player to player contact, which is in accordance with results reported by other researchers: Hoff and Martin¹⁴ reported 66% and Sandelin *et al*⁷ 52%.

The results showed that 43% of injuries were sustained by defenders, indicating that they are subjected to a greater risk of injury than other players, a finding similar to that of Hunt and Fulford,¹⁵ who reported that defenders

sustained 55% of 200 injuries researched. Ekstrand and Gillquist,⁸ however, did not find any difference in the incidence of injury between playing positions. Comparisons of different investigations are difficult owing to the different designs and populations under study, but the high injury incidence among defenders in the World Cup could well be attributed to the attacking football that was encouraged through recent FIFA directives, and the need for defenders to take greater risks and be more reactive to prevent attacking situations developing and goals being scored.

Injuries were more common in the second half of matches ($P < 0.05$), and although the time of day of the games had no effect on the number of injuries, heat stress could well have been a contributory fatiguing factor, as several games were played in excess of 100°F. In a number of games, the incidence of non-contact injuries was particularly high in the first five minutes of the second half. This may reflect a general failure to maintain muscle flexibility during the extended mid-game breaks which were common during the competition. Details on the mechanism and aetiology of injuries were not available, though, to make informed judgements on this.

INJURY FREQUENCY RATES

For each team the average injury incidence for moderate injuries was 113/1000 game hours; this is lower than the 300/1000 game hours reported by Ekstrand and his colleagues.¹⁶ However, as discussed above, the figures reported in this study are considered to be conservative as there may be injuries which have not been identified. The total injury incidence was 27.7% per player, which is similar to the figures reported by Jorgenson¹⁹ and Hoy *et al*,⁶ of 36% and 18% respectively. For "moderate" injuries alone the incidence was 4.1%, which can be compared to "over-3-day injuries". The highest incidence of these reportable (over-3-day) injuries in industry is for open cast coal workings, where there is an incidence rate of 4.4% per employee per year, while the average rate for all industries is 0.7% per employee per year.²²

Industrial accident frequency rates in the UK are normally reported as accidents per 100 000 working hours. The industrial category of accidents resulting in more than three days' absence from work can be considered equivalent to the "moderate" category used in this study of football injuries, and examples of these are compared in table 3.

Compared to the accident statistics issued by the Health and Safety Commission, the injury frequency rates in football are three orders of magnitude higher than in many industries. Put in another context, based on the frequency of football injuries, the average person who works a 40 hour week in industry would expect to obtain a moderate injury and be absent from work for at least three days every third week.

INJURY COSTS

The financial loss to professional football clubs due to injuries is not known. There have been

Table 3 Industrial accidents and football injuries per 100 000 working and playing hours respectively

Employment category	Accidents/Incidents per 100 000 working/playing hours	
	"Over-3-day injuries"	Missing at least one game
Open cast coal workings	1.8	—
Construction	0.6	—
Banking and finance	0.04	—
Professional football	—	1026

reports of insurance companies paying out large sums of money,¹⁷ but these most probably do not compensate for the direct costs (for example, medical treatment, player's wages while unable to play) and indirect costs (for example, loss of matches, buying a replacement player) incurred by clubs. In a Swedish Division IV team (semiprofessional) Ekstrand²³ reported a loss of \$US 420 000 due to medical care costs and sick leave over one season.

In industry the subject of the costs of accidents is more clearly understood and appreciated. Compensation received by people injured at work often involves large sums of money; however, the extent of the losses from less serious injuries is not so well known. The HSE's Accident Prevention Advisory Unit⁵ conducted a series of case studies, the aim being to accurately identify the full cost of accidents. In football, equivalent costs may involve medical fees, increased insurance premiums, and reduced income from lower match attendances. Few clubs, if any, have the mechanism or resources to identify the losses separately, and probably none actually identify and examine them systematically. The accident ratios reported by the HSE can be conveniently compared with those representing all the injuries reported in the present study, giving some indication of the possible extent of the preventable financial losses that clubs sustain. Four studies produced an average accident ratio of over-3-day injury accidents : first aid only : non-injury accidents of 1:7:189 which is comparable to the figures in the present study of 1:6:73. The average annualised reported loss for each company was over £1.2 million.

In professional football, especially at the highest level, the financial consequences of injuries to clubs is expected to be proportionately more than in industry, as the relative number of injuries in football greatly over-

shadows industrial figures. To accurately identify the full cost of injuries to a professional football club requires an in depth investigation and our current research is addressing this issue.

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