

Injury and illness epidemiology in soccer – effects of global geographical differences – a call for standardized and consistent research studies

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ABSTRACT: Soccer is the most popular sport in the world. While injuries and illnesses can affect the players' health and performance, they can also have a major economic impact on teams. Moreover, several studies have shown the favourable association between higher player availability and team success. Therefore, injury prevention could directly impact clubs' financial balance and teams' performance via increased player availability. To be able to develop effective methods of injury prevention, it is vital to first determine the scope and the degree of the problem: the mechanisms and types of injuries, their frequency and severity, etc. According to the most widely known prevention model, systematic injury surveillance is the first and most fundamental step towards injury prevention. Since epidemiological studies have shown that injuries and illnesses in soccer players differ from region to region, it is important to establish a specific injuries and illness database in order to guide specific preventive actions. Since Asia is the largest continent, with the highest number of soccer players, and in the light of the long-term research on injuries performed in UEFA clubs, the authors of the present article present the AFC surveillance. Some methodological issues related to this prospective design study are discussed. The definition of injury and illness and the methods to track players' exposure are described along with the potential challenges related to such a vast scale study. This article is also a call for action to have consistent and standardized epidemiological studies on soccer injuries and illnesses, with the aim to improve their prevention.

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INTRODUCTION

Soccer (known as European football) is not only the most popular sport in the world but it also has an important impact from a social and preventive viewpoint, as it has been shown that regular recreational soccer training is a valid method, as effective as running [1], to enhance population health [2].

At the professional level, the injury risk in soccer is much greater compared with high risk industrial occupations [3].

While injuries affect the players' health and performance, they also have a major economic impact on teams [4]. It is known that teams with lower injury incidence and greater consistent availability of personnel perform better [5,6].

As a consequence, more and more teams recognise the importance of injury prevention, which could directly impact teams' performance via increased players' availability [7]. In this context, national and international soccer federations should proactively work for protecting the health and safety of players and manage the risks associated with soccer participation [8].

To be able to develop effective methods of injury prevention, it is vital to first determine the scope and the degree of the problem: the

mechanisms and types of injuries, their frequency and severity. According to the most widely known prevention model, systematic injury surveillance is the first step towards injury prevention [9].

This has convinced the major soccer clubs and federations to support the development of injury epidemiology research, resulting, so far, in a good quantity of data at elite soccer level [10].

The dawn of soccer injury epidemiology

In the last two decades, the extent of surveillance has increased both at club [11] and national team levels [12]. FIFA (Fédération Internationale de Football Association) and UEFA (Union of European Football Associations) regularly perform studies during main tournaments at national teams level for men's [13], women's [14] and youth soccer players [10]. Moreover, in 2001, UEFA started a prospective injury study at club level, recruiting teams participating in the UEFA Champions League. This study results have been widely published in the literature, bringing additional valuable knowledge to injury science, practitioners can rely on [15].

Nevertheless, the field of injury epidemiology has a longer history.

The first papers on sport injuries are from the 1940s [16], while prevention studies date back to the 1960s [17]. Soccer-related injury research, despite a few reports in the 1950s [18], grew consistently during the 1970s [19]. The first studies on soccer injury epidemiology date from the 1980s and were mainly conducted by Ekstrand and co-workers in Sweden [20]. The first studies were mainly performed in the northern European countries [21] with sporadic investigation taking place in non-European countries [22].

In those years, soccer injuries were, for the first time, examined in relation to extrinsic (training load [23] and playing surface [24]) and intrinsic (physical maturity [25]) risk factors. During the 1990s different cohorts, such as youth [26] and female players [27], were studied and surveillance expanded geographically [28] and, more importantly, research started to strongly focus on risk factors [29].

Geographic regional differences in soccer injuries: a call for action

Is the soccer injury epidemiology at elite level similar in every part of the globe? No. Indeed, some geographical differences have been shown by several studies.

In the UEFA Champions League, Walden *et al.* [30] described higher incidence of match, overuse and severe injuries in English and Dutch clubs compared to teams from southern European countries located near the Mediterranean Sea. They also found a higher non-contact ACL injury rate in southern European clubs than in northern European clubs [30]. Dissimilarities in training and severe injuries have been described between the Danish and the Swedish first divisions [11], while a study on female soccer showed a higher match injury incidence in northern than in southern Sweden [31].

Yoon *et al.* showed a higher injury rate at national team level in Asia compared with Europe [32]. The authors explain this by the higher reliability of the data due to the presence of medically trained independent observers who were able to observe the match live and note the injuries that were subsequently cross referenced with the reports of the teams' medical staff. Methodological procedures are indeed important aspects to consider when comparing study results. However, the latter researchers also hypothesise regional differences, possibly linked to the level of play, amongst other factors. Based on the results of international soccer matches, the level of play in Asia can be considered lower than in Europe; therefore, a lower injury rate might be expected. However, the authors explain their findings speculating that this could be partially due to the inferior physical conditioning that has been found in Asiatic soccer players compared with their European counterparts, putting the latter players at a higher risk of injury [33,34]. In addition to the variables discussed above, some cultural and/or religious factors could also impact the injury patterns in soccer players. For instance, a study from Qatar [35] showed no impact of Ramadan fasting on the injury rates of fasting soccer players, while another study conducted on a Tunisian team [36] showed a higher rate of overuse injuries in fasting players. Differences of culture and habits sometimes mixed with religious practice could therefore have an impact on the injuries/illness outcome.

The geographical/cultural differences in soccer injury and illnesses epidemiology imply that the same prevention programmes cannot be implemented everywhere. Therefore, clinicians worldwide cannot simply rely on data coming from European professional soccer, for instance; injury and illnesses surveillances rather have to be performed everywhere with the ultimate aim of developing specific prevention programmes. In that regard, the authors of the present article would like to focus on Asia, which is the largest continent in the world with the highest number of soccer players [37].

Soccer injury epidemiology in Asia

Asia is the largest continent of the globe and has been estimated as having the largest number of soccer players (85 million), which equates to 33% of the world soccer players' community [37]. Despite the number of players involved, soccer injury epidemiological research in Asia is still limited.

In the past century, there have been a few reports evaluating soccer injuries in Asia, but none had a prospective design [22]. The first published study with a prospective design on senior male soccer injury epidemiology in Asia was performed in 2004 and analysed the injuries that occurred during 50 senior and U-20 men's matches at national team level [32]. As outlined above, it showed injury incidences higher than those observed in European soccer, but similar injury patterns. Specifically, the incidence of injuries during the first round was 42.4 per 1000 hours, which increased to 64.7 in the knockout stage. Data from Qatar national football team confirmed these findings, showing a high match injury incidence (65.9/1000 h). This was also found by a study from Iran showing a high match injury rate (62.0/1000 h) [38]. However, this study followed one team for part of the season (four months) and therefore provides just a glimpse of the epidemiological injury profile of the professional soccer players of the region.

Conversely, data from the professional soccer league in Qatar showed a lower injury rate. The injury rate during matches was 14.5/1000 h of exposure and 4.4/1000 h during training sessions [39]. The patterns of injury were comparable with European findings, but with some particularities such as a high match incidence of hamstring strains.

Another study was performed at National Team level on Saudi players followed prospectively for a few months, during official competitions on both natural and artificial grass; however, the results cannot be compared with previous findings because a different injury definition (medical attention) was used [40].

More recently, a 15-year prospective study in the Japanese Football League (Soccer) was published, but it examined only match injuries resulting in a time loss of at least seven days. This may not only overlook a large number of injuries but also limit the comparability of these findings with other studies [41].

Another study on sport injuries performed in Kuwait [42] showed a lower prevalence of injuries in soccer (69%) compared with other sports such as volleyball and handball (79%) and basketball (71%),

although its cross-sectional design is a limitation for the estimation of the impact of soccer injuries in that region.

The development of the Asian Football Confederation (AFC) Champions League Injury and Illness Surveillance Programme

Due to its popularity, Asian soccer deserves attention from an injury prevention viewpoint.

As described before, soccer injury epidemiological research in Asia is limited. However, due to regional differences in soccer injury epidemiology, it may be difficult to simply transfer results from European elite clubs to Asia, or any other region. Due to the vastness of this continent, it would also be inaccurate to use data from single Asiatic countries. An international standardised approach is needed to better understand the outcome of comparative data among confederations and provide recommendations that will benefit each club.

Therefore, it is critical to develop systematic injury surveillance in Asia, so that Asian clubs understand what the specificities of injuries in their teams are: the mechanisms leading to injuries, the frequency, characteristics and severity of the different injuries. Only this will allow prevention efforts to be better directed, tailoring specific prevention programmes, greatly enhancing their prospect of success.

The AFC Champions League is the highest level of club soccer in Asia, thus promising the most conducive conditions for the implementation of systematic injury surveillance requiring basic infrastructure such as a medical team and adequate communication means. Moreover, the economic impact of injury prevention at this level can be significant. For this reason, we believe that implementing an injury surveillance programme in Asian soccer is critical.

Furthermore, the significance of illness on the performance of athletes has been more closely assessed and its surveillance is promoted by the International Olympic Committee [43]. It has so far been investigated only to a limited degree in international elite soccer [44]. Any illness causing time loss implies potential financial loss for the club, and player unavailability can also impact team performance. In Europe, it seems illness is not a major contributor to time loss. However, data from the Asiatic continent are lacking and geographical differences of illness rates in professional soccer players cannot be excluded, as well as differences in potential epidemic outbreaks within a big continent like Asia [45]. Therefore, we decided to monitor prospectively not only injuries but also illnesses in high level Asian soccer.

Study design

The surveillance has a prospective design because, for the assessment of risk factors, prospective cohort studies are more appropriate than case-control studies. With a prospective design, potential risk factors can be measured at the beginning of the exposure period, before an injury or illness occurs. Moreover, a prospective design avoids recall bias in relation to injuries [46].

Injury definition

Choosing the injury definition to be used is arguably the most important decision as different injury definitions may lead to different conclusions [47], but especially because results from studies using different definitions are not comparable.

Some studies have focused on 'medical attention' injuries, for which the player seeks medical care [48]. This definition is mostly used during short-term international tournaments at national team level [13]. This definition allows the consideration of a large number of injuries, including overuse injuries and other complaints not causing time loss [7]; however, and importantly, an unequal level of access to medical attention may create bias. While each AFC Champions League club is provided with medical staff, the staff composition may be quite dissimilar both in type and number of practitioners, causing dissimilarities in the access to medical care, and therefore we chose to avoid using the "medical attention" definition. Additionally, the latter injury definition may be biased by soccer players' subjective factors, such as motivation and pain threshold/perception. However, this remains a speculation because there are no studies assessing such factors on the Asian population from a football injury viewpoint.

Some scientists recommend the use of an 'anatomical tissue' injury definition, which has been used in several studies. An anatomical tissue injury is defined as any tissue damage caused by sporting activity regardless of subsequent absence from participation or medical attention [47]. This is potentially a more objective definition; however, the objective diagnosis can only be made with high level technology and specialist knowledge, and we cannot guarantee that all the teams included in our study (as with most epidemiological studies across the globe) will have equal access to these facilities and expertise.

The most commonly used definition in prospective cohort studies in elite soccer is the "time loss" injury definition, which implies that the injury obliges the athlete to miss at least one future training session or match [48].

Its main limitation is that players may sometimes continue soccer activity despite an injury, possibly due to their motivation or pain threshold, or due to external causes, such as external pressure (for instance, pressure of the coach, the club or the environment in general such as press and supporters). Also, key players may be forced to play and train despite an injury due to their impact on team performance. Hammond et al. showed that at least one injured player participated in almost half of the surveyed matches in three divisions of English professional soccer [49]. These findings show how injuries are managed by soccer players through competitive matches. Of note, the results also indicate no negative impact on the result of the game obtained by a team using injured players [49].

The underestimation of the actual impact of injuries by using a time loss definition was confirmed in a Dutch study where 27% of players were still symptomatic when returning to play after injury [50]. Despite this limitation, the use of the time loss definition of injury

allows the comparison of the results with established injury surveillance in professional soccer, especially with the UEFA Elite Club Injury Study [15]. Therefore, the time loss definition of injuries as well as illnesses will be used in this study.

It can be argued that, in this way, many injuries, especially those due to overuse, will be overlooked and a different definition should be used. Despite not causing time loss, such injuries are certainly relevant because performance may be affected and neglected overuse pathologies may lead to worse conditions leading to a longer period of time loss, such as stress fractures and groin injuries.

New approaches have been developed to quantify injuries in epidemiological surveillances [51,52], but they require the direct involvement of soccer players through questionnaires [53] and, as this cohort is being explored from an injury and illness epidemiology perspective for the first time, language and cultural barriers may affect such information. Therefore, we prefer to avoid employing this methodological study option.

Exposure

In soccer epidemiological studies, exposure has been recorded both individually [11] and on a team basis [31]. We will record the exposure of players individually, as exposure to soccer activity of each component of the team could be different in some cases, leading to team-based records inaccuracy. In fact, despite injuries being the major reason of absenteeism from soccer activities, individual differences in exposure may also be due to incomplete training sessions or games participation, illnesses, non-soccer related injuries, social events, or technical or disciplinary decisions. For these reasons, collecting injury data on a team basis would probably lead to exposure overestimation and injury rate underestimation. Furthermore, tracking individual exposure allows deeper analysis of individual injuries/illnesses related to the actual exposure of each player.

Data collection

Injuries should be recorded as soon as possible after the event because the injury characteristics (severity, type, location and mechanism of injury) may be inaccurate when registered too late [47]. Audits performed during soccer tournaments at the national team level (such as the FIFA World Cup) usually require the compilation of the medical report forms after each match, which captures data on the match itself as well as the previous training sessions [13]. In this study, the data will be collected daily and reported monthly to the study group, as per similar study recommendations [29,48].

Monthly reports to the study group will allow eventual feedback in case of missing or incorrect data, with limited risk of recall bias in case any subsequent review is necessary.

Commonly, in soccer epidemiological studies, data have been collected by the head doctor or physiotherapist [11] although some surveillance studies used information provided by coaches, fitness coaches, or players [31]. Ideally, to increase reliability and unifor-

mity of diagnosis, injuries should be recorded by a member of the medical staff, and this will be compulsory in the AFC injury and illness surveillance programme. Preferably, such data will be recorded by the team physician, in order to have, in all teams, contact persons with equivalent educational backgrounds. While this has not been assessed in current research, we believe it should increase the standardisation of injury evaluation.

Potential challenges

Interacting with different clubs is always one of the challenges in multicentre epidemiological studies. We expect difficulties in communication due to cultural, language and/or informatics barriers which may affect compliance and reliability. This possibility will be overcome and minimized by common language contacts in addition to the English speaking team physicians, as English will be the official language of the study.

However, it is likely that a minority of the doctors or physiotherapists of the participating clubs will be English native speakers; therefore, misunderstandings due to linguistic differences cannot be excluded. To our knowledge, none of the participating clubs has previously been part of a similar study. Therefore, it is possible that accuracy may increase season by season due to the experience accumulated by the medical personnel responsible for the collection of data.

As previously stated, the same educational background would possibly positively influence the uniformity of diagnosis. However, we cannot exclude dissimilarities in medical staff composition, and therefore we may be obliged to rely on a professional with a different educational background (physiotherapist, fitness coach, etc) as the possible contact person. In that regard, one of the drawbacks of many epidemiological studies concerns the fact that they do not clearly disclose such factors that may potentially impact the reliability of the data. It is the intent of the investigators of the AFC study to report any information about the potential bias of the data that will be reported.

CONCLUSIONS

The development of surveillance systems for soccer players' injury and illnesses in different geographical regions of the globe is vital. The Asian Football Confederation (AFC) Champions League Injury and Illness Surveillance Programme is the first important monitoring step at elite club level for the Asian continent; however, further studies on different cohorts (female, youth) and at different levels of play (amateur, semi-professional) are warranted, especially in the Asiatic continent, where some countries are lacking resources for sports injury diagnosis and where treatment and injury prevention therefore becomes essential. We expect other research groups to conduct such epidemiological studies, for the good of the sport.

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