Epidemiology of injuries among Italian footballers: the role of the playing field

Francesco Paolo Bianchi,[1] Valter Veneziani,[2] Michele Alberto Cantalice,[1] Angela Notarnicola,[3] Silvio Tafuri[1]

[1]Department of Biomedical Science and Human Oncology, Aldo Moro University of Bari, Bari, Italy
[2]Degree course in Sport and Movement Science, School of Medicine, Aldo Moro University of Bari, Bari, Italy
[3]Orthopaedics Unit, Department of Basic Medical Science, Neuroscience and Sensory Organs, Faculty of Medicine and Surgery, University of Bari, General Hospital, Bari, Italy

Correspondence to
Professor Silvio Tafuri, Department of Biomedical Science and Human Oncology, Aldo Moro University of Bari, Bari 70124, Italy; silvio.tafuri@uniba.it

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ABSTRACT

Background Football has a higher injury rate compared with other team sports such as rugby, in terms of two main categories: intrinsic (individual) and extrinsic (environmental) factors. The playing field is an extrinsic risk factor which has been poorly investigated in the literature.

Purpose The aim of our study was to define the incidence and risk factors of injuries in a cohort of footballers comparing the role of three different types of playing field (hard court, natural grass or synthetic grass).

Study design This was a cross sectional prevalence study.

Methods The population comprised footballers recruited by a convenience sample; the instrument used for the survey was an anonymous self-administered questionnaire.

Results 267 football players were enrolled (average age 23.4±4.8 years), of whom 33.7% (n=90/267) played on hard court, 33.0% (n=88/267) on natural grass and 33.3% (n=89/267) on synthetic grass. The overall incidence of injury was 40.1 (95% CI 34.1 to 46.8) ×1000 person-years of training, with higher values for ankle and knee injuries. Ankle injuries (aOR 0.4; P=0.021) were associated with playing on natural grass as a protective factor, while playing on natural grass seemed to be a risk factor for muscular injuries (aOR 2.3; P=0.026).

Conclusion Our study showed a high lifetime prevalence of injury among footballers (57%), in particular among athletes who play and train on a hard court. We have studied a topic poorly investigated previously and provide the opportunity to understand interventions to increase the capacity of stakeholders in preventing injuries.

INTRODUCTION

Football is the most popular sport worldwide. The International Federation of Football Associations (FIFA) estimates that the number of football athletes worldwide is close to 270 million, of whom approximately 62 000 000 live in Europe and 5 000 000 live in Italy.[1]

Football is a complex contact sport that can influence conditional capacities: running, sprinting, jumping and kicking are important performance components, requiring maximal strength and anaerobic power of the neuromuscular system.[2 3] The high intensity of football activities is related to the risk of injury in professional, amateur and youth players during training sessions and matches. Athletes often play faster and, depending on the importance of the game, more aggressively than in the past, requiring elevated physical fitness levels and more intensive training (predominantly at the professional level).[4]

Football has a higher injury rate compared with other team sports, such as rugby, basketball or American football,[5 6] and 1000 times higher rate than certain high risk professions, such as those who work in construction and manufacturing.[7] Several surveys have estimated that the incidence of injury in adult male soccer players range from 2 to 8 per 1000 training hours and from 10 to 35 per 1000 match hours.[8 9]

The cost of injuries is important for clubs: it is estimated that an average of 37 days are lost for injuries in a 300 day season[9]; the cost of injuries is important from a socioeconomic point of view, with healthcare cost exceeding 30 billion US$ worldwide.[10 11] In this perspective, FIFA and its Medical Assessment and Research Centre (F-MARC) developed injury prevention programme, such as the '11' and 'FIFA 11+' in an effort to reduce the incidence of injuries.[12–19]

In the past 20 years, two large international surveillance systems have been activated to analyse injury risk, incidence and exposure specific to football. One of these systems was organised by FIFA in 1998. The other is the Union of European Football Associations' (UEFA) Champions League Injury Study, (commonly UEFA injury study) that began in 2001 and has involved between 27 and 33 European soccer teams from 10 different countries for a period of 11 seasons.[10] Data from these surveillance systems showed that football injuries vary widely but many authors agree that the majority of injuries affect the lower extremities (60–90%), including the upper leg, knee and ankle, with lower frequencies for the head and neck (15%), trunk (8%) and upper extremities (7%).[8 9 20 21] The most commonly diagnosed injuries are contusions (55%), sprains (15%) and strains (10%), and most (80%) occur from contact with another player; 45–50% of contact injuries result from foul play.[8 9 20 22]

Injury risk factors are classified into two main categories: intrinsic (individual) and extrinsic (environmental) factors. Examples of intrinsic risk factors are gender, player age, previous injury, strength, flexibility and anatomical alignments, whereas extrinsic risk factors comprise level of competitions, weather condition, playing surface, standards of training, etc.[23 24]

Among the intrinsic risks, increased injury incidence has been reported with increasing age among

Table 1 Years of football activity, militancy in the current team" and years of play in the current category by type of playing field

Variable	Hard court	Natural grass	Synthetic grass	Total	Test	P value
Football activity (years)	13.3±4.8 (5.0–30.0)	14.1±4.4 (6.0–26.0)	14.3±5.0 (2.0–30.0)	14.3±5.0 (2.0–30.0)	F=4.4	0.014
Militancy in the current team (years)	2.4±2.3 (1.0–12.0)	2.3±2.0 (1.0–13.0)	2.0±2.0 (1.0–12.0)	2.2±2.1 (1.0–13.0)	k=2.3	0.309
Play in the current category (yrs)	2.3±2.2 (1.0–12.0)	2.7±2.4 (1.0–10.0)	1.8±1.6 (1.0–10.0)	2.3±2.1 (1.0–12.0)	k=6.5	0.039

Values are mean±SD (range).

football players.[21 25 26] A higher incidence of knee injuries among women athletes compared with male athletes has been noted.[27] A history of previous injury was shown to be a significant risk factor for ankle sprains,[28] and several studies indicated muscle strength or imbalance as a risk factor for overuse leg injury.[22 24]

Among the extrinsic risks, many researches have suggested that residual fatigue can impact on injury rates significantly.[29 30] Other studies showed that injury incidence is greater during competitions than in training sessions.[24] Moreover, preliminary findings indicated that clubs from the northern parts of Europe have a higher incidence of injury compared with clubs from southern countries, and hence the weather may also be an important discriminant of risk.[23 31]

The playing field is an example of an extrinsic risk factor that has been poor investigated in the literature and the few existing studies show that artificial turf may be associated with a greater risk of injury, especially to the lower limbs.[32] According to FIFA, matches may be played on natural or artificial surfaces, but in most parts of the world, including Italy, football can also be played on a dirt field.[33]

The aim of our study was to define the incidence and risk factors of injuries in a cohort of amateur footballers playing in Puglia (south of Italy, around 4 000 000 inhabitants and 47 767 football players associated with the regional official football federation[34]) and evaluate the risks of playing on three different types of playing field (hard court, natural grass or synthetic grass).

METHODS

This was a cross sectional prevalence study. The study population comprised 267 male footballers recruited by a convenience sample in 12 official football clubs (affiliated to the Italian Football Federation (FIGC)) in the Puglia region.

The survey was authorised by the chiefs of the enrolled clubs. The recruited clubs participated in the championships of excellence, promotion, first and second categories (regional and interregional championships of FIGC). Athletes were interviewed during the training sessions at the start of the annual activities (August/September 2017). The official Italian schedule for these teams involved 25/30 matches every year (around 1 per week) from October to May.

The instrument used for the survey was an anonymous self-administered questionnaire. The questionnaire was built by the authors after a review of the literature on the topic and has been validated in a restricted group of athletes before the start of the study. The questionnaire included information on:

- Club
- Age
- Years of football practice
- Years of enrollment in the current team and in the current category
- History of injury (yes/no) and number of episodes:
  - knee
  - hip
  - ankle
  - spinal column
  - muscle
  - other nature injury

The typology of the playing field (hard court, natural grass or synthetic grass) was attributed to each questionnaire regarding the club (the information was reported by the chief of the club at the start of the survey). Compiled questionnaires were inputted into a database created by Google Drive software and data analysis was performed by Microsoft Office Excel and STATA SE14 software. Continuous variables are described as mean±SD and range, and categorical variables as proportions. To calculate the person-years incidence rate, years of practising football was used to calculate the denominator; 95% CI were calculated for incidence rates.

The incidence rate ratio (IRR) of the injuries was calculated by considering as 'unexposed' those athletes who play on natural grass and 'exposed' as those who play on hard court and synthetic grass; 95% CI were calculated for IRR values and the χ^2 test was performed. To calculate the incidence, only the first accident in the same body area was considered as an accident case. For continuous variables, the normality analysis was performed and, where consistent, a normalisation model was set using the logarithmic function. Normalised continuous variables were compared by one-way ANOVA with Bonferroni correction (parametric); non-normalised continuous variables were compared by the Kruskall–Wallis test (non-parametric). Categorical variables were compared by the chi-square test and Fisher's exact test. For each of the following outcomes:

- injury
- knee injury
- hip injury
- ankle injury
- spine injury
- muscle injury
- injury of other nature

multivariate logistic analysis, association with type of playing field (hard court, natural grass or synthetic grass), age, years of football practice, years of militancy in current team and years of play in current category, were evaluated.

The adjusted OR (aOR) values were calculated, with 95% CI, and the test z score. For all tests, significance was set at $P<0.05$.

RESULTS

A total of 267 football players were enrolled, of whom 33.7% (n=90/267) played on hard court, 33.0% (n=88/267) on natural grass and 33.3% (n=89/267) on synthetic grass.

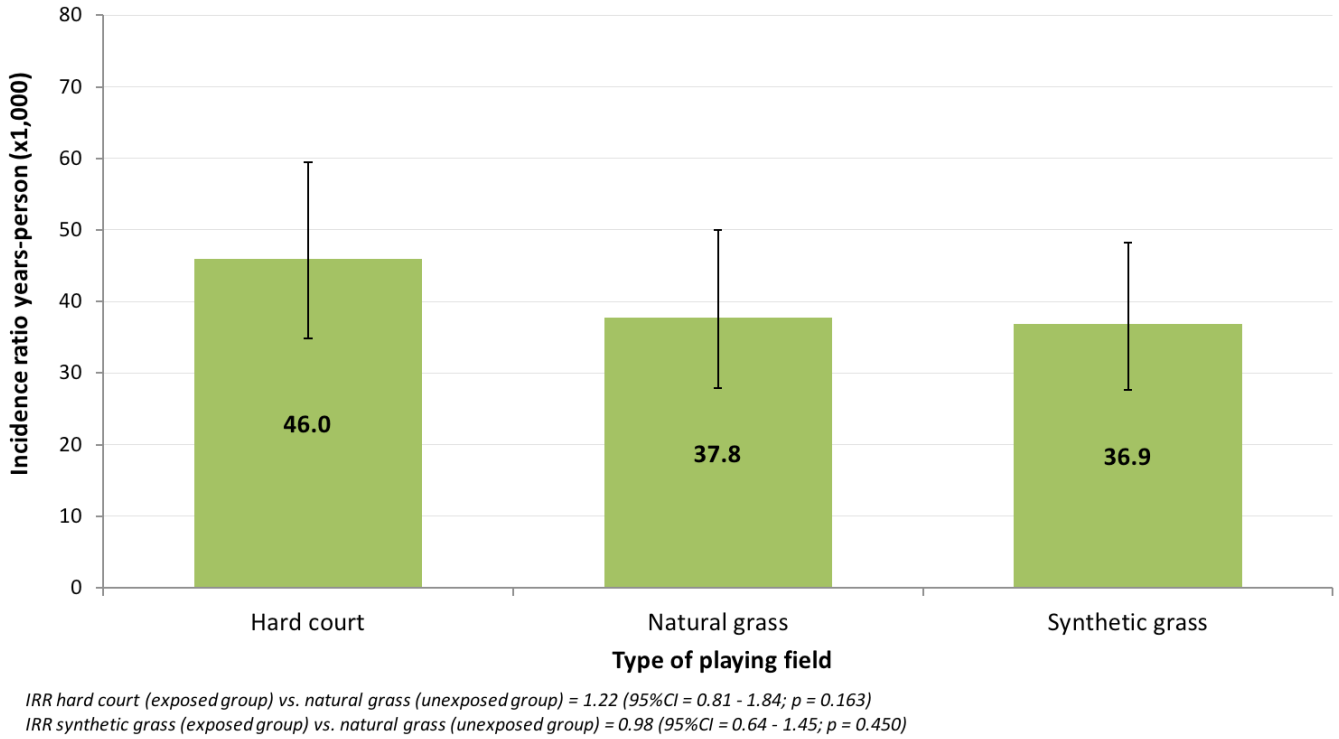

Figure 1 Incidence of injury ×1000 person-years of training, by type of playing field. IRR, incidence rate ratio.

Mean age of the enrolled sample was 23.4±4.8 years (range 17.0–45.0 years) without no statistically significant differences between types of playing field (hard court, 23.2±4.6 years; natural grass, 23.2±4.6 years; synthetic grass, 23.8±5.4; k=0.4; P=0.809). The enrolled subjects had played football for 14.3±5.0 years (range 2.0–30.0 years). Time in the current team was 2.2±2.1 years (range 1.0–13.0 years) and in the current category 2.3±2.1 years (range 1.0–12.0 years).

One-way ANOVA analysis showed a statistically significant difference in average time of football practice by type of playing field (F=4.4; P=0.014). In particular, the Bonferroni correction showed that the length of time of football practice was less among those who played on hard compared with those who played on synthetic grass (t=0.3; P=0.011). There were no statistically significant differences in the average time of playing in the current team by type of playing field (k=2.3, P=0.309), while there was a statistically significant difference in the average time of playing in the current category, with the synthetic grass group showing a smaller value (k=6.5, P=0.039) (table 1).

A total of 153 of 267 respondents (57.3%) reported at least one injury due to the football activity, and the overall incidence rate of injury was 40.1 (95% CI 34.1 to 46.8) × 1000 person-years of training (figure 1).

The IRR among those who played on hard court (exposed group) and those who played on natural grass (unexposed group) was 1.22 (95% CI 0.81 to 1.84, P=0.163), and IRR among those who played on synthetic grass (exposed group) and those who played on natural grass (unexposed group) was 0.98 (95% CI 0.64 to 1.45; P=0.450).

A total of 73 of 267 footballers interviewed (27.3%) reported at least 1 knee injury due to football activity, 11/267 (4.1%) reported at least 1 hip injury, 59/267 (22.1%) reported at least 1 ankle injury, 6/267 (2.3%) reported at least 1 spinal injury, 39/267 (14.6%) reported at least 1 muscular injury and 27/267

Table 2 Incidence rate of injury ×1000 person-years of training, per single injury site (knee, hip, ankle, spine, muscle injury or other) and typology of the playing ground

	Hard court		Natural grass		Synthetic grass	
Site of injury	Incidence rate × 1000	95% CI	Incidence rate × 1000	95% CI	Incidence rate × 1000	95% CI
Knee	20.9	13.6 to 30.7	16.9	10.5 to 25.7	19.5	12.9 to 28.3
Hip	5.0	1.8 to 10.9	2.4	0.5 to 7.0	1.4	0.2 to 5.2
Ankle	21.7	14.3 to 31.7	10.5	5.6 to 17.8	14.5	8.9 to 22.2
Spine	2.5	0.5 to 7.3	0.0	0.0 to 3.0	2.2	0.4 to 6.3
Muscular injury	9.2	4.6 to 16.4	15.3	9.2 to 23.8	6.5	3.0 to 12.3
Other	9.2	4.6 to 16.4	5.6	2.3 to 11.6	6.5	3.0 to 12.3

Table 3 Incidence rate ratio among athletes playing on hard court (exposed group) and those playing on synthetic grass (exposed group) and those playing on natural grass (unexposed group), for single type of injury

	Hard court – Natural grass			Synthetic grass – Natural grass		
Site of injury	IRR	95% CI	P values	IRR	95% CI	P values
Knee	1.24	0.66 to 2.32	0.239	1.16	0.63 to 2.15	0.312
Hip	2.09	0.44 to 12.8	0.159	0.60	0.05 to 5.23	0.304
Ankle	2.09	1.03 to 4.41	0.014	1.38	0.65 to 3.02	0.184
Spine*	–	–	–	–	–	–
Muscular injury	0.60	0.26 to 1.33	0.091	0.43	0.17 to 0.99	0.016
Other	1.63	0.58 to 4.97	0.159	1.16	0.38 to 3.65	0.392

*Not computable for presence of value 0.
IRR, incidence rate ratio.

(10.1%) reported at least 1 accident of another nature; table 2 describes the incidence of injuries × 1000 person-years of training, for a single injury site (knee, hip, ankle, spine, muscle injury or injury of other nature) and typology of the playing ground.

Table 3 describes the IRR for athletes who played on hard court (exposed group) and those who played on synthetic grass (exposed group), per type of injury.

Table 4 describes the mean number of injuries per injury site. For muscular injuries, the average number was different for different playing fields (F=4.0; P=0.026), and Bonferroni correction showed a statistically significant difference between hard court and synthetic grass (t=0.6; P=0.032).

Multivariate logistic regression analysis showed a statistically significant association between occurrence of injuries and years of football practice (aOR 1.1; 95% CI 1.1 to 1.2; z=2.0; P=0.045) and years of playing in the current category (aOR 1.2; 95% CI 1.0 to 1.4; z=2.2; P=0.027). Ankle injuries (yes/no) were associated with playing on natural grass (aOR 0.4; 95% CI 0.2–0.9; z=2.3; P=0.021) and time of playing in the current category (aOR 1.2; 95% CI 1.1 to 1.4; z=2.2; P=0.031).

Finally, muscular injuries (yes/no) were associated with playing on natural grass (aOR 2.3; 95% CI 1.1 to 4.9; z=2.2; P=0.026), time of football practice (limits of statistical significance: aOR 1.1; 95% CI=0.9 to 1.2; z=1.9; P=0.054) and years of play in the current category (limits of statistical significance: aOR 1.2; 95% CI 0.9 to 1.4; z=1.9; P=0.055).

DISCUSSION

Our study showed a high rate of life time injuries among football athletes (57%); the incidence of injuries was 40×1000 person-years of training with a higher value among footballers who trained and played on hard court (47×1000) compared with thosed who trained and played on natural or synthetic grass (38×1000 and 37×1000, respectively). The knee was the anatomical area with the highest prevalence of injury (27%), followed by the ankle (22%). The high frequency of injuries to the lower limb is consistent with the motor skills of this sport[35]: high speed running, sprint running, dribbling and kicking the ball.

Muscle injury were also very common (15%); despite not having differentiated the anatomical sites, in the literature they are reported as thigh muscle strains, with the most common being the adductors, hamstrings and quadriceps.[36] The prevalence of muscle injury seemed to be lower in our sample than in elite players: a Brazilian study in 2018[37] analysed the injuries of elite players in two main divisions (A1 and A2) of the São Paulo Football Championship, estimating that overall, muscle injuries reached 36–43% of all accidents. A 2016 study[38] focused on injuries in footballers during the 2015 America Cup, concluding that muscle and tendon injuries were the most frequent. This difference could be due to the different composition of the sample (elite groups in the cited studies, regional/inter-regional categories in our study). It is probably related to the differences in the training programmes; among elite players, the intensity of the workouts is higher and the number of weekly games is greater.

Our data are consistent with the literature that reported the frequency of quadricep and hamstring strains, anterior cruciate ligament ruptures and ankle syndesmosis injuries in soccer.[3] Collision with another player, and tackling and running without contact are the common mechanisms of injury. Some authors[25 39] reported that about half of the traumas are caused by contact, and the other half involved no body contact. Even the characteristics of the type of playing ground can be responsible for the onset of sports injuries. Numerous injuries have been attributed to playing on hard court or artificial turf.[40] More recently, newer generations of artificial turf have been developed to duplicate the playing characteristics of natural grass. Potential mechanisms for differing injury patterns on more rigid surfaces (hard court, synthetic grass) compared with the softer ones (natural grass) include increased peak torque and rotational stiffness properties of shoe–surface interfaces, decreased impact attenuation properties of surfaces, differing foot loading patterns and detrimental physiological responses.

Table 4 Number of injuries per site of injury and typology of the playing ground

Site of injury	Hard court	Natural grass	Synthetic grass	Total	Test	P value
Knee	1.2±0.7 (1.0–4.0)	1.3±0.5 (1.0–2.0)	1.3±0.6 (1.0–3.0)	1.3±0.6 (1.0–4.0)	k=0.5	0.764
Hip	1.0±0.0 (1.0–1.0)	1.0±0.0 (1.0–1.0)	1.0±0.0 (1.0–1.0)	1.0±0.0 (1.0–1.0)	k=0.0	1.000
Ankle	1.5±0.9 (1.0–5.0)	1.5±0.7 (1.0–3.0)	1.1±0.3 (1.0–2.0)	1.4±0.3 (1.0–5.0)	k=3.3	0.195
Spine	0.03±0.18 (0.0–1.0)	0.0	0.03±0.18 (0.0–1.0)	1.0±0.0 (1.0–1.0)	k=0.0	1.000
Muscular injury	2.4±1.3 (1.0–5.0)	1.6±0.9 (1.0–4.0)	1.2±0.4 (1.0–2.0)	1.7±1.0 (1.0–5.0)	F=4.0	0.026
Other	1.3±0.6 (1.0–3.0)	1.3±0.5 (1.0–2.0)	1.1±0.3 (1.0–2.0)	1.2±0.5 (1.0–3.0)	k=0.3	0.850

Values are mean±SD (range).

The IRRs among subjects who played on hard court and synthetic grass (exposed group) and those who played on natural grass (unexposed group) were >1 (P>0.05), and hence athletes who play on these types of playing field seem to be more at risk of injuries compared with those who play on natural grass. For all analysed areas, the incidence rate of injury was higher in footballers playing on hard court, except for muscular injuries, for which we found a higher incidence rate in subjects who played on natural grass.

Playing on hard court seemed to be a risk factor for ankle injuries (IRR 2.1; P=0.04), while playing on natural grass seemed to be a risk factor for muscular injuries (IRR 0.4: P=0.016); this last evidence was confirmed in the regression model in which muscular injuries seemed to be associated with playing on natural grass (aOR 2.3; P=0.026) although we found a greater average number of individual muscle injuries in subjects who played on hard court that in those who played on natural grass (P=0.032). Furthermore, playing on natural grass seemed to be a protective factor for ankle injuries (aOR 0.4; P=0.021) and, overall, injuries seemed to be associated with a greater number of years of practice.

As already specified, we found very few papers in the scientific literature on this issue. A 2011 review[41] showed similar incidence rates of injuries in footballers who play on artificial turf and those who play on natural grass; in particular, there was an increased risk of ankle injury playing on artificial turf (IRR 0.7–5.2) and beneficial inference of an artificial surface on muscle injuries. Both studies are consistent with our results.

A 2017 Japanese study[42] investigated 400 soccer players surveyed for 12 year after conversion of the field from soil to artificial turf, showing that there was a significant increase in the incidence of upper extremity trauma and a significant decline in the incidence of lower extremity muscle strain; this is consistent with our observation. To our knowledge, there are no studies showing the impact of hard court on the epidemiology of injuries in football players.

The strength of our study is the balanced sample, the investigation time (14 years) and having dealt with a topic that has been poorly studied in the literature. In particular, previous studies focused only on elite footballers that often play and train on natural grass; the choice of investigating athletes from regional and inter-regional categories allowed analysis of the role of the playing surface. The major limitation of the study is that we did not investigate the characteristics of the injuries (ie, severity, type of trauma (acute/chronic), recovery time, period (training/season match), number of training/match per week, phase of the season, etc). Also, the design of the study did not involve the use of medical records, and the accuracy of self-reported diagnosis is a concern. In addition, we did not investigate the individual characteristics of the soccer players (anthropometric data, previous injuries, nutritional programme) and if the athlete was subjected to specific training for the prevention of injuries. Furthermore, we did not evaluate the incidence of injuries for specific role of play (goalkeeper, defender, midfielder, etc) or if the injury occurred on the home field or on the field of the away team (that could be different than the training/home field). Finally, we did not evaluate the cost associated with injuries and the status of the court (new or recently restructured vs old court). In the future the study should be repeated recruiting more football players and investigating the critical issues described above.

The most important recipients of our results are the sports federations that have responsibility for deciding rules about sports fields. These rules must be periodically reviewed based on the results of scientific studies on the effects of playing fields on sport performance and the safety of athletes. If the results of our study are confirmed in other surveys, the football federation have to consider revising the rule for accreditation of the court, avoiding the use of hard courts for clubs who train several days a week, for example. Also, clubs must pay attention to this topic, in particular because often the same playing field is used for sport initiation courses, and the theme of prevention of injuries is crucial for athletes and cadets. We believe that our study can influence the practical choices of clubs regarding a reduction in injury risk; knowledge of the characteristics of the playing field can direct clubs towards rational management of their athletes in order to optimise their performance for the achievement of seasonal sports objectives.

What is known about this subject

- Several studies have identified the epidemiology of injuries in sports and in football and have identified intrinsic and extrinsic risk factors

What this study adds to existing knowledge

- Very few studies have analysed the role of different types of training/competition playing fields as a risk factor for injuries

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Patient consent Not required.

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REFERENCES

1 Fédération Internationale de Football Association (FIFA), 2006. FIFA Big Count 2006: 270 million people active in football. Available from: https://www.fifa.com/mm/document/fifafacts/bcoffsurv/bigcount.statspackage_7024.pdf
2 Krustrup P, Aagaard P, Nybo L, *et al*. Recreational football as a health promoting activity: a topical review. *Scand J Med Sci Sports* 2010;20(Suppl 1):1–13.
3 Hoff J, Helgerud J. Endurance and strength training for soccer players: physiological considerations. *Sports Med* 2004;34:165–80.
4 Pfirrmann D, Herbst M, Ingelfinger P, *et al*. Analysis of injury incidences in male professional adult and elite youth soccer players: a systematic review. *J Athl Train* 2016;51:410–24.
5 Koutures CG, Gregory AJ, American Academy of Pediatrics. Council on Sports Medicine and Fitness. Injuries in youth soccer. *Pediatrics* 2010;125:410–4.
6 Wong P, Hong Y. Soccer injury in the lower extremities. *Br J Sports Med* 2005;39:473–82.
7 Drawer S, Fuller CW. Evaluating the level of injury in English professional football using a risk based assessment process. *Br J Sports Med* 2002;36:446–51.
8 Junge A, Dvorak J. Soccer injuries: a review on incidence and prevention. *Sports Med* 2004;34:929–38.
9 Ekstrand J, Hägglund M, Waldén M. Injury incidence and injury patterns in professional football: the UEFA injury study. *Br J Sports Med* 2011;45:553–8.
10 Jones NS. Update: soccer injury and prevention, concussion, and chronic groin pain. *Curr Sports Med Rep* 2014;13:319–25.
11 Junge A, Lamprecht M, Stamm H, *et al*. Countrywide campaign to prevent soccer injuries in Swiss amateur players. *Am J Sports Med* 2011;39:57–63.

12 Verhagen EA. Costing an injury prevention program in amateur adult soccer. *Clin J Sport Med* 2013;23:500–1.
13 Bizzini M, Junge A, Dvorak J. Implementation of the FIFA 11+ football warm up program: how to approach and convince the Football associations to invest in prevention. *Br J Sports Med* 2013;47:803–6.
14 Silvers-Granelli H, Mandelbaum B, Adeniji O, *et al*. Efficacy of the fifa 11+ injury prevention program in the collegiate male soccer player. *Am J Sports Med* 2015;43:2628–37.
15 Bizzini M, Impellizzeri FM, Dvorak J, *et al*. Physiological and performance responses to the "FIFA 11+" (part 1): is it an appropriate warm-up? *J Sports Sci* 2013;31:1481–90.
16 Grooms DR, Palmer T, Onate JA, *et al*. Soccer-specific warm-up and lower extremity injury rates in collegiate male soccer players. *J Athl Train* 2013;48:782–9.
17 Barengo NC, Meneses-Echávez JF, Ramírez-Vélez R, *et al*. ***The impact of the FIFA*** 11+ ***training program on injury prevention in football players: a systematic review***. *Int J Environ Res Public Health* 2014;11:11986–2000.
18 Nakase J, Inaki A, Mochizuki T, *et al*. Whole body muscle activity during the FIFA 11+ program evaluated by positron emission tomography. *PLoS One* 2013;8:e73898.
19 Petersen J, Thorborg K, Nielsen MB, *et al*. Preventive effect of eccentric training on acute hamstring injuries in men's soccer: a cluster-randomized controlled trial. *Am J Sports Med* 2011;39:2296–303.
20 Junge A, Dvorak J. Injury surveillance in the World Football Tournaments 1998-2012. *Br J Sports Med* 2013;47:782–8.
21 Faude O, Rößler R, Junge A. Football injuries in children and adolescent players: are there clues for prevention? *Sports Med* 2013;43:819–37.
22 Ekstrand J, Gillquist J. Soccer injuries and their mechanisms: a prospective study. *Med Sci Sports Exerc* 1983;15:267–70.
23 Waldén M, Hägglund M, Orchard J, *et al*. Regional differences in injury incidence in European professional football. *Scand J Med Sci Sports* 2013;23:424–30.
24 Murphy DF, Connolly DA, Beynnon BD. Risk factors for lower extremity injury: a review of the literature. *Br J Sports Med* 2003;37:13–29.
25 Chomiak J, Junge A, Peterson L, *et al*. Severe injuries in football players. Influencing factors. *Am J Sports Med* 2000;28(5 Suppl):S58–68.
26 Ostenberg A, Roos H. Injury risk factors in female European football. a prospective study of 123 players during one season. *Scand J Med Sci Sports* 2000;10:279–85.
27 Arendt E, Dick R. Knee injury patterns among men and women in collegiate basketball and soccer. NCAA data and review of literature. *Am J Sports Med* 1995;23:694–701.
28 Engebretsen AH, Myklebust G, Holme I, *et al*. Prevention of injuries among male soccer players: a prospective, randomized intervention study targeting players with previous injuries or reduced function. *Am J Sports Med* 2008;36:1052–60.
29 Bengtsson H, Ekstrand J, Hägglund M. Muscle injury rates in professional football increase with fixture congestion: an 11-year follow-up of the UEFA Champions League injury study. *Br J Sports Med* 2013;47:743–7.
30 Dellal A, Lago-Peñas C, Rey E, *et al*. The effects of a congested fixture period on physical performance, technical activity and injury rate during matches in a professional soccer team. *Br J Sports Med* 2015;49:390–4.
31 Waldén M, Hägglund M, Ekstrand J. UEFA Champions League study: a prospective study of injuries in professional football during the 2001-2002 season. *Br J Sports Med* 2005;39:542–6.
32 Arnason A, Gudmundsson A, Dahl HA, *et al*. Soccer injuries in Iceland. *Scand J Med Sci Sports* 1996;6:40–5.
33 Fédération Internationale de Football Association (FIFA), 2016. Law of the Game – 2015/2016. Available from: https://img.fifa.com/image/upload/datdz0pms85gbnqy4j3k.pdf
34 Italian Football Federation (FIGC), 2015. Report Calcio 2015. Available from: http://www.figc.it/other/ReportCalcio_2015.pdf
35 Malone S, Owen A, Mendes B, *et al*. High-speed running and sprinting as an injury risk factor in soccer: can well-developed physical qualities reduce the risk? *J Sci Med Sport* 2018;21:257–62.
36 Cross KM, Gurka KK, Saliba S, *et al*. Comparison of thigh muscle strain occurrence and injury patterns between male and female high school soccer athletes. *J Sport Rehabil* 2018;27:451–9.
37 Arliani GG, Lara PHS, Astur DC, *et al*. Orthopaedics injuries in male professional football players in Brazil: a prospective comparison between two divisions. *Muscles Ligaments Tendons J* 2017;7:524–31.
38 Pangrazio O, Forriol F. Epidemiology of soccer players traumatic injuries during the 2015 America Cup. *Muscles Ligaments Tendons J* 2016;19;6:124–30.
39 Larruskain J, Lekue JA, Diaz N, *et al*. A comparison of injuries in elite male and female football players: a five-season prospective study. *Scand J Med Sci Sports* 2018;28:237–45.
40 Rahnama N, Reilly T, Lees A. Injury risk associated with playing actions during competitive soccer. *Br J Sports Med* 2002;36:354–9.
41 Williams S, Hume PA, Kara S. A review of football injuries on third and fourth generation artificial turfs compared with natural turf. *Sports Med* 2011;41:903–23.
42 Fujitaka K, Taniguchi A, Kumai T, *et al*. Effect of changes in artificial turf on sports injuries in male university soccer players. *Orthop J Sports Med* 2017;5:232596711771 9648:232596711771964.