Risk Factors for Recurrent Injuries in Male Amateur Soccer Players

A prospective cohort study

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"ONDERGETEKENDE

Bevestigt hierbij dat de onderhavige verhandeling mag worden geraadpleegd en vrij mag worden gefotokopieerd. Bij het citeren moet steeds de titel en de auteur van de verhandeling worden vermeld."

Samenvatting

Introductie: Met zo'n 265 miljoen participanten, zowel mannen als vrouwen en van alle leeftijden, is voetbal de populairste sport wereldwijd. De blessure-incidentie in voetbal is vergeleken met andere sporten erg hoog. Dit leidt tot hoge medische kosten, ziekteverzuim, verminderde prestaties van teams en persoonlijk leed van de geblesseerde speler. Ongeveer 12 tot 35 % van alle voetbalgerelateerde blessures bestaat uit recidiverend blessureletsel. Recidiverende blessures nemen langere revalidatieperioden in beslag, met als gevolg een langere absentie van competitie. Ter ontwikkeling van adequate preventiemaatregelen, dienen risicofactoren voor recidiverend blessureletsel eerst onderzocht te worden. Dit is de eerste studie welke potentiele risicofactoren voor recidiverend blessureletsel analyseert bij volwassen mannelijke amateurvoetballers.

Design: Prospectief Cohortonderzoek

Methode: Mannelijke amateurvoetballers spelend op 1^e klasseniveau tussen de 18 en 40 jaar werden uitgenodigd voor dit onderzoek. Basisgegevens, blessuregegevens en gegevens over de blootstelling werden vastgelegd. Alle spelers met initieel blessureletsel werden geïncludeerd in de analyses. Spelers met recidiverend blessureletsel werden vergeleken met spelers zonder recidiverend blessureletsel. Significante risicofactoren werden geïdentificeerd middels een achterwaartse stapsgewijze multivariate logistische regressie.

Resultaten: Via multivariate en univariate analyses werden leeftijd, BMI, jaren voetbalervaring, blessuregeschiedenis, de 'FIFA11'-interventie, veldpositie, ondergrond, wedstrijdblootstelling en trainingsblootstelling niet significant geassocieerd met een toegenomen risico op recidiverend blessureletsel.

Conclusie: Deze studie met als doel het identificeren van risicofactoren voor recidiverend blessureletsel bij volwassen mannelijke amateurvoetballers identificeerde geen significante risicofactoren. In toekomstige studies zou meer aandacht besteed moeten worden aan het analyseren van subgroepen met overeenkomstige etiologie gedurende meerdere opeenvolgende seizoenen.

Abstract

Background: With around 265 million participants, soccer is the most popular sport in the world including both sexes and across all age groups. Consequently, soccer also has one of the highest injury incidence rates leading to high medical costs, work absenteeism, reduced performance of teams and personal suffering of the injured player. Recurrent injuries account for 12 to 35% of all soccer-related injuries. Recurrent injuries also take extended rehabilitation periods compared to index injuries, causing longer absence of play. In order to implement adequate preventive measures, risk factors for recurrent injuries have to be determined. This is the first study analysing potential risk factors for recurrent injuries in male amateur soccer players.

Study design: Prospective Cohort Study

Methods: Male amateur soccer players between 18 and 40 years playing at first division level participated in this study. Information on baseline characteristics, injury data and exposure data were recorded. All players with an index injury were used for analysis. Players who sustained a recurrent injury were compared to players who did not sustain a recurrent injury. Significant predictors in the model were determined by a manual backward stepwise logistic regression method.

Results: Multivariate and univariate analyses on age, BMI, years of experience, history of injury, intervention 'The FIFA11', playing position, playing surface, training exposure and match exposure were not significantly associated with increased recurrent injury risk.

Conclusion: This study aimed to identify risk factors for recurrent injury in adult male amateur soccer players but found no significant predictors. Future studies on risk factors should focus on subgroups with similar aetiology over multiple consecutive seasons of play.

Key terms: Prediction, Risk Factors, Recurrent Injury, Soccer

Introduction

With around 265 million participants, soccer is the most practised sport in the world including both sexes and across all age groups.[1] Beside the social aspect of the sport, soccer also has beneficial health-related effects.[2] It challenges physical fitness by requiring a variety of skills at different intensities. Running is the predominant activity. Sprinting, duelling, jumping and kicking are other important performance factors, requiring maximal strength and anaerobic power of the neuromuscular system.[3] [4]

However this popular sport also has high injury rates, specifically in male amateur competitions.[5] The total incidence of soccer injuries in male amateur players is 12 to 35 injuries per 1000 playing hours.[6] Injury incidence increases during match-play (27.5 / 1000h) compared to training (4.1 / 1000h).[7] In the Netherlands, 38% of these injuries require medical treatment with direct and indirect costs (medical costs and work absenteeism) leading up to € 1.3 billion a year.[8]

Recurrent injuries account for 12 to 33 % of all soccer-related injuries.[9] Recurrent injuries take extended rehabilitation periods compared to first-time injuries, causing longer absence of play.[10] Additionally, Kucera et al showed that players with one previous injury had a twofold greater Injury Risk Ratio (IRR 2.6), and players with two or more previous injuries had a threefold greater risk of injury (IRR 3.0) compared to players with no previous injury.[11]

As recurrent injuries lead to longer absence of match play, coaches should be aware of the importance of identification of risk factors for recurrent injury. Injury incidence is also significantly associated with reduced team performance.[12] Evidently, coaches are challenged to identify players at risk for recurrent injury. Although 'intuition' of coaches has been stated to be a proper method for identifying problems within a certain area of expertise, findings from Gabbett et al have shown that injury information obtained from training and match play monitoring could be used more effectively.[13] [14] Their model had far greater accuracy predicting injuries (62%) compared to the decision making of strength and conditioning staff (<14%). Given the success in predicting injuries and the fact that the total proportion of incorrect predictions was small (24%), these results suggested that an injury prediction model provides greater sensitivity than the sole judgement of staff.

Considering medical costs, work absenteeism, personal suffering of the injured player and reduced team performance, it is essential to identify risk factors for

recurrent injuries in soccer. It can guide clinical decision making by providing the information necessary to select appropriate treatment options or even address the need for treatment in the first place.[15] Additionally, identifying specific risk factors for recurrent injuries may contribute to improved prevention programs and injury management.[16] Furthermore it facilitates the players' education and counseling regarding his injury.[15]

Only few studies have focused on potential risk factors for increased recurrent injury rate in soccer. These studies have focused solely on risk factors for specific locations like recurrent hamstring and recurrent ankle injuries.[17] [18] Therefore, the aim of this study was to identify possible risk factors for recurrent injury in adult male amateur soccer players.

Patients & Methods

Design

For this prospective longitudinal cohort study, data was used from a cluster-randomized trial by van Beijsterveldt et al in which the effect of an injury prevention program 'The FIFA11' on injury incidence was investigated.[19]

Data was collected over two consecutive soccer seasons.

Participants

Participants were recruited at the start of the season 2009-2010 from two regional soccer districts in the Netherlands that were geographically separated to prevent contamination. These competitions were selected in cooperation with the Royal Dutch Soccer Association (KNVB).

Only male adult players from 18 to 40 years of the first senior teams in the first division were included. At the start of the second season 2010-2011, new players from included teams were added to the study population. All teams had match and practice sessions 3-4 times a week. Written informed consent was obtained from all soccer players. No differences in player injury incidence between the intervention and control group were found. Therefore, all data was used to determine risk factors for recurrent injury.

Sample size calculation

Approximately 70% of all male soccer players between 18 and 35 years of age will get injured each year.[20] Research has shown recurrence rates in male amateur soccer varying from 12% to 33% (averaged 22.5%).[7] [20] Based on literature, eight variables were selected as candidate predictors. Each candidate predictor required a minimum of 10 events.[21] With a power of 0.80 and alpha at 5%, an estimated 508 players must take part in the study.

Data collection

In order to collect valid information, instruction sessions on data collection were organised by the researchers. Laptops with a unique injury surveillance system (BIS) were provided to each participating team. Before the start of the 2009-2010 season, all teams were asked to fill out an intake form to record baseline characteristics. At the start of the 2010-2011 season, new players from the included teams also filled out the intake form. Baseline characteristics were age, length, weight, years of soccer experience and leg dominance. Injury characteristics were prospectively recorded by medical staff (physiotherapists, coaches and/or medical staff) during the 2009-2010 and 2010-2011 competitive season from the first competition match (September) until the last regular competition match of the season (May). Used definitions for data collection are displayed in table 1.

Table 1. Injury definitions.[22]

Definition	Defined as
Injury	Any physical complaint sustained by a player that results from a football match or football training, irrespective of the need for medical attention or time-loss from football activities
Recurrent injury	An injury of the same type and at the same site as an index injury and which occurs after a player's return to full participation from the index injury. A recurrent injury occurring within 2 months of a player's return to full participation is referred to as an 'early recurrence'; one occurring 2 to 12 months after a player's return to full participation as a 'late recurrence'; and one occurring more than 12 months after a player's return to full participation as a 'delayed recurrence'
Match exposure	Play between teams from different clubs
Training exposure	Team-based and individual activities under the control or guidance of the team's coaching or fitness staff that are aimed at maintaining or improving players' football skills or physical condition
Injury Incidence	Number of injuries per 1000 player hours

Weekly data entry of each individual player consisted of information concerning soccer injuries (causes, circumstances), medical and paramedical treatment. Training and competition hours and absenteeism from work, education and/or sports were also recorded. Regular monitoring via telephone by the researchers supported compliance on consistent data entry of participants. Data on the total amount of

playing hours during match and training per individual player were collected by the coaches via an exposure form.

Selection of potential risk factors

Previous studies on risk factors for index soccer injuries identified intrinsic factors like injury history, time since index injury, increased body mass, older age and leg dominance.[11] [17] [23] [24] Injury history in this study was defined as having a previous soccer injury of any kind one year prior to the start of the study. Extrinsic factors have also been stated as potential risk factors for soccer injuries. Playing on artificial turf has been suggested to increase injury risk, although findings are contradictory.[25–27] Furthermore playing position, use of preventive measures like taping, bracing and exercises and increased exposure have been identified as risk factors for recurrent soccer injuries.[17] [25] [28]

Age, BMI, history of soccer injury, intervention 'The FIFA11', playing position, playing surface, injury on dominant vs non-dominant leg and total exposure were selected as candidate risk factors for recurrent injury from this data based on literature and hypothesis of the primary investigator.

Statistical analysis

Quantitative data were collected using continuous and categorical data. SPSS version 20.0.0 was used for analysis.

In order to identify potential risk factors for recurrent injuries in male soccer players all the players with an index injury from the study by van Beijsteveldt et al were selected for analysis.[19]

Baseline characteristics such as age, length, weight, BMI, years of experience, injury history and exposure data were presented via descriptive statistics including means and standard deviations. Players sustaining a recurrent injury were compared to players without a recurrent injury. Significant risk factors in the model were determined by a manual backward stepwise logistic regression method using 0.05 as significance level.[29] By transformation of logistic regression coëfficient, an estimate of the effect of a risk factor variable on the risk was reflected by an odds ratio (odds=risk/(1-risk)).[29]

The rule of thumb that logistic models should be used with a minimum of 10 events per predictor variable was applied for identifying risk factors.[21]

Results

Participants

A total amount of 653 players participated in this study. After completion of the study, 354 players sustained an index injury. Of all injured players, 27% were followed for two consecutive seasons. The remaining 73% was followed for one of either seasons.

Of the 354 injured players, 86 players sustained a recurrent injury. Mean age of the injured players was 23.9 years, mean length was 183 cm and mean weight was 78.1 kg. Playing positions were 8% goalkeepers, 33% defenders, 33% midfielders and 26% attackers.

Mean exposure per player during the study was 87.3 hours for training and 36.4 hours for match-play. Total exposure per player was 123.8 hours.

Characteristics of all injured players are displayed in Table 2.

Table 2. Characteristics of injured players

Characteristics (n=354)	Mean + sd
Age (yr)	23.9 (4.2)
BMI (kg/m^2)	23.3 (1.8)
Height (m)	1.83 (0.06)
Weight (kg)	78.1 (7.8)
Soccer Experience (yr)	17.2 (4.6)
Injuries past year	1 (0.8)
Training exposure (hr)	87.3 (41)
Match Exposure (hr)	36.4 (22)
Total Exposure (hr)	123.8 (61)

Index injuries

In total, 54% of the population (n=354) sustained an index injury. A total of 664 injuries were recorded during the two seasons leading to an incidence of 15.2 injuries per 1000 playing hours. Injury incidence increased for match play (18.6 / 1000 playing hours) compared to training (2.8 / 1000 playing hours). When applicable and measured, injuries were equally distributed over dominant and non-dominant leg (10% vs 9% respectively).

Recurrent injuries

Recurrent injury incidence was 2 per 1000 playing hours. Recurrent injury incidence increased for match play (4.9 / 1000 playing hours) compared to training (0.7 / 1000 playing hours). Recurrences consisted of 63% early recurrences, 30% late recurrences and 7% delayed recurrences. The median time-interval for a recurrent injury to appear was 31 days after full return to play. Hamstring (26%), ankle (23%) and knee (14%) were the most frequent recurrent injury locations. Early recurrences were also dominant in all frequent recurrent injury locations. Ankle recurrent injuries had 70% early recurrences, knee reinjuries (58%) and hamstring reinjuries (59%). Delayed recurrences only showed in knee recurrent injuries (17%) and hamstring recurrent injuries (5%).

Ruptures and strains (31%) were the most frequent type of recurrent injury, followed by bruises (14%).

Characteristics of players who sustained a recurrent injury and players who did not sustain a recurrent injury are displayed in table 3.

Table 3. Characteristics of players who sustained recurrent injury (RI+) and did not sustain recurrent injury (RI-)

Characteristics	RI+ (n = 86) Mean+sd	RI- (n = 268) Mean+sd
Age (yr)	23.9 (4.4)	23.9 (4.1)
BMI (kg/m^2)	23.5 (1.8)	23.2 (1.8)
Height (m)	1.83 (0.06)	1.83 (0.07)
Weight (kg)	78.4 (7.7)	78 (7.9)
Soccer experience (yr)	17.5 (5.1)	17.1 (7.9)
Injuries past year	1.1 (0.8)	0.9 (0.8)
Training exposure (hr)	85.3 (43)	88 (41)
Match exposure (hr)	34 (20)	37.2 (23)
Total exposure (hr)	119.3 (60)	125 (61)

Logistic regression

Age and years of experience were significantly correlated (Pearson Correlation Coefficient 0.884, sig. 0.000). Therefore, only age was included in the logistic regression. Total exposure was significantly correlated with training exposure (Pearson Correlation Coefficient 0.986, sig. 0.000) and match exposure (Pearson Correlation Coefficient 0.933, sig. 0.000). Consequently, only total exposure was included in the logistic regression.

In a manual backward stepwise multivariate logistic regression procedure age, BMI, history of soccer injury, intervention 'The FIFA11', playing position, playing surface,

injury on dominant vs non-dominant leg and total exposure. None of the potential risk factors were significantly associated with increased recurrent injury risk.

Discussion

This prospective cohort study aiming to identify possible risk factors for recurrent injury in male amateur soccer players identified no statistical significant risk factors. In a multivariate logistic regression analysis potential risk factors age, BMI, history of injury, intervention 'The FIFA11', playing position, playing surface, injured leg (dominant vs non-dominant) and total exposure were not significantly associated with increased recurrent injury risk.

The recurrent injury incidence described in this study (12.9%) is in accordance with previous literature on specific types of recurrent injuries. Recurrent incidence of 13.9 to 63.3 percent have been reported for hamstring injury, whereas the incidence of recurrent ankle injuries ranges between 3 and 34 percent.[30] [31]

Three specific recurrent injury locations were identified as the most frequent in this study: 26% hamstring injuries, 23% ankle injuries and 14% knee injuries. These locations have been identified in previous epidemiologic research as the most frequently injured locations as well.[6] [9] [32]

History of injury was not significantly associated with increased risk of recurrent injuries, which is in contrast with previous findings on specific injury types. Previous hamstring injury, groin injury, knee injury and ankle injury have been shown to be associated with a two to three fold increase in risk of an identical injury in the same leg. [11] [23] [24] This study demonstrated that the included predictor 'history of injury' is not a risk factor for all recurrent injuries, although this conclusion could have been limited because of registration method. Previous injuries were self-reported by the players which could have led to recall bias as recalling injury information over time can be difficult for players.[33] Gabbe showed that after one year, only 61% of players were entirely accurate when recalling their injury history.[33]

One of the strengths of this study was the data collection procedure. Included clubs from the present study were provided with laptops and a unique injury surveillance system (BIS). Coaches and medical staff registered data in to this online database directly after training and match play. Regular meetings with team staff were

organised to ensure valid registration on injury and exposure data. Proper data collection procedures are essential as they influence conclusions and recommendations.[34] Additionally, if the data collection procedure is not fully appreciated by coaches and other data collectors, the finite resources available within sports are unlikely to be allocated effectively.[35] By optimizing data entry procedures and regular contact with data collectors, collection of valid and consistent information was warranted.

This study could have been limited by the registration period. As recurrent injuries can occur after periods longer than one year, most studies on recurrent injuries in sports took place on consecutive seasons.[36] [37] Although this study was performed during two consecutive seasons as well, only 27% of all injured players were followed for these consecutive seasons. Teams that started during the season 2009-2010 were not always willing to participate the subsequent season. Additionally, because of team mutations after the first season, players that joined a team at the start of the 2010-2011 season were only followed for one season. As most players were only followed for one season, the timeframe for monitoring of the index injuries and recurrent injuries was short. This could have led to loss of information, specifically on recurrent injuries as these occur later in time compared to index injuries.

Recurrent injuries registered in the current study predominantly consisted of early recurrences. About two third of all recurrent injuries were classified as early recurrences.[22] The impatience of the soccer player, strengthened by the pressure from team and coaches, could have led to early return to training and match play regardless of residual symptoms. Premature return to play has been linked to increased risk of recurrent injury in the early phase after rehabilitation.[38] Residual symptoms in the location of the index injury increases the risk of recurrent injury.[39]
Remaining deficits in physical conditioning or proprioception, or altered movement patterns after a previous injury could also provide a plausible link to an anatomically unrelated injury in a following season.[23] For instance, previous anterior cruciate ligament injuries have shown to increase the risk of new knee injuries, specifically overuse injuries.[40] Player characteristics such as risk taking behaviour and several psychological factors are most likely of proportionally importance in the first weeks after return to play.[41] Rehabilitation is often prolonged and many studies have

confirmed that adequate rehabilitation programs reduce the number of recurrent injuries.[42–44] This study did not analyse residual symptomps and player characteristics although these findings could possibly explain the distribution of early, late and delayed recurrences in this study and could have contributed to the prediction model.

With a total number of 653 players throughout all of Netherlands this study consisted of a large representative sample of high amateur level male soccer players. Sample size calculation was computed in advance of the present study and a sufficient number of male first class soccer players was included. The objective of risk factor analysis is to identify clinically relevant, not just statistically significant factors. Bahr and Holme stated that for detecting moderate to strong associations 20 to 50 injury players are needed, whereas small to moderate associations would need about 200 injured players.[45] Strong associations are required for risk factors to be clinically relevant with sufficient precision rates. The current study adopted Portney and Watins' rule of thumb in which a minimum of 10 events per predictor variable should be applied for identifying risk factors.[21] Nevertheless, the strength of the potential risk factors investigated provides no indication that any of the factors could be helpful as risk factors for clinical use.

A possible explanation for the fact that this study did not identify any risk factors for recurrent injury incidence could be the heterogeneity of recurrent injury locations and recurrent injury types. Recurrent injuries in this study were divided among all bodyparts of players, from extremities to lower back and head.
Additionally, a widespread variety of different diagnoses was collected. Injuries and recurrent injuries were diagnosed as ruptures, bruises, fractures, joint dislocations and more. Additional analyses for more homogeneous subgroups on injury location and/or comparable etiology could provide more information on potential risk factors. Potential subgroups could be ankle sprains, hamstring strains, bruises or a seperation of contact and non-contact injuries. Although this study was performed on a large population, consisting of 354 injured players with 86 recurrent injuries, the statistical power was too limited for such multivariate analyses on similar subgroups.

This study mainly focused on anthropometric variables such as age, weight, and BMI and sports-related factors such as exposure, playing position, playing surface and participation on 'the FIFA11'. Other domains that could provide potential risk factors were not analysed. For instance, performance tests have shown to provide valuable risk information.[46–49] Besides potential biomedical risk factors, psychological variables could also lead to increased risk of recurrent injury. Trait anxiety, negative life event stress, daily hassle, mistrust and ineffective coping could contribute to increased (recurrent) injury risk as well.[50–53] Additionally, imaging techniques such as MRI could provide important information on the potential risk of recurrent injury occurrence by assessing physiological parameters.[18] [54] Researchers aiming to build prediction models should keep an open view to which factors can assist clinicians in prescribing adequate preventive measures and study potential risk factors accordingly so.

There are no published articles known to the investigator where risk factors for recurrent injury in soccer were described. Publication bias could be a limiting factor since studies finding no statistically significant results are less likely to be published than studies with significant results.[55] This study gathered data on a large population of high level male amateur soccer players. Additional research is necessary before these findings can be be extrapolated to other sports, indoor soccer, females, youth players or other levels of play.

Conclusion

No significant risk factors for recurrent injuries in male amateur soccer players were identified in this prospective cohort study. Future studies on risk factors should focus on subgroups of recurrent injuries with similar aetiology over multiple consecutive seasons of play. Additionally, in order to build clinically relevant prediction models researchers should attempt to identify predictive factors in multivariate models from multiple domains such as anthropometric variables, sports-related variables, and psychological variables.

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