Sports Med (2013) 43:257–265
DOI 10.1007/s40279-013-0026-0

SYSTEMATIC REVIEW

How Effective are Exercise-Based Injury Prevention Programmes for Soccer Players?

A Systematic Review

A. M. C. van Beijsterveldt · Nick van der Horst · Ingrid G. L. van de Port · Frank J. G. Backx

Published online: 8 March 2013

Abstract
Background The incidence of soccer (football) injuries is among the highest in sports. Despite this high rate, insufficient evidence is available on the efficacy of preventive training programmes on injury incidence.
Objective To systematically study the evidence on preventive exercise-based training programmes to reduce the incidence of injuries in soccer.
Data sources The databases EMBASE/MEDLINE, PubMed, CINAHL, Cochrane Central Register of controlled trials, PEDro and SPORTDiscus™ were searched for relevant articles, from inception until 20 December 2011. The methodological quality of the included studies was assessed using the PEDro scale.
Study selection The inclusion criteria for this review were (1) randomized controlled trials or controlled clinical trials; (2) primary outcome of the study is the number of soccer injuries and/or injury incidence; (3) intervention focusing on a preventive training programme, including a set of exercises aimed at improving strength, coordination, flexibility or agility; and (4) study sample of soccer players (no restrictions as to level of play, age or sex). The exclusion criteria were: (1) the article was not available as full text; (2) the article was not published in English, German or Dutch; and (3) the trial and/or training programme relates only to specific injuries and/or specific joints. To compare the effects of the different interventions, we calculated the incidence risk ratio (IRR) for each study.
Results Six studies involving a total of 6,099 participants met the inclusion criteria. The results of the included studies were contradictory. Two of the six studies (one of high and one of moderate quality) reported a statistical significant reduction in terms of their primary outcome, i.e. injuries overall. Four of the six studies described an overall preventive effect (IRR<1), although the effect of one study was not statistically significant. The three studies that described a significant preventive effect were of high, moderate and low quality.
Conclusions Conflicting evidence has been found for the effectiveness of exercise-based programmes to prevent soccer injuries. Some reasons for the contradictory findings could be different study samples (in terms of sex and soccer type) in the included studies, differences between the intervention programmes implemented (in terms of content, training frequency and duration) and compliance with the programme. High-quality studies investigating the best type and intensity of exercises in a generic training programme are needed to reduce the incidence of injuries in soccer effectively.

Electronic supplementary material The online version of this article (doi:10.1007/s40279-013-0026-0) contains supplementary material, which is available to authorized users.

A. M. C. van Beijsterveldt (✉) · N. van der Horst · I. G. L. van de Port · F. J. G. Backx
Department of Rehabilitation, Nursing Science and Sports, University Medical Center Utrecht, W01.121, P.O. Box 85500, 3508 GA Utrecht, The Netherlands
e-mail: a.m.c.beijsterveldt@umcutrecht.nl

N. van der Horst · I. G. L. van de Port
Clinical Health Sciences, Physiotherapy Sciences, University of Utrecht, Utrecht, The Netherlands

1 Introduction

With approximately 265 million participants, soccer (football) is the most popular sport in the world across both sexes and all age groups [1]. In addition to 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, sprinting, jumping and kicking are important performance components, requiring maximal strength and anaerobic power of the neuromuscular system [3, 4]. Consequently, this popular sport also has high injury rates [5].

Soccer injuries come in a wide variety, but most injuries affect the lower extremities, including the upper leg, knee and ankle [6, 7]. In view of the frequency of injury, the resulting costs and not least the personal suffering of the injured players, many studies have focused on injury prevention measures in soccer [8–10]. Several options for preventing soccer injuries have been developed, ranging from protective equipment (e.g. shin guards) [11–13], to warm-up and cool-down routines [11, 14–16].

Intervention programmes focusing on intrinsic risk factors for specific injuries have achieved significant reductions of soccer injuries. For instance, previous studies showed that eccentric strength training reduced the risk of hamstring injury in heterogeneous populations of soccer players [17–19]. It has also been shown that neuromuscular training appears to be effective to reduce the risk of anterior cruciate ligament (ACL) injury in both male and female soccer players [20, 21]. A set of exercises focusing on balance, strength, flexibility and stability has been found to reduce the risk of ACL injuries in female youth soccer players [22, 23].

Despite the relatively high incidence of injuries in soccer, insufficient evidence is available on the efficacy of generic (non-specific) preventive training programmes in reducing injury incidence. These multifaceted programmes contain different exercises focusing on multiple joints and/or muscle groups and target prevention of the most common soccer injuries. The purpose of this review is to systematically examine the evidence on the effect of preventive exercise-based training programmes to reduce the incidence of soccer injuries in general.

2 Methods

2.1 Search Methods

The databases EMBASE/MEDLINE, PubMed, CINAHL (Cumulative Index to Nursing and Allied Health Literature), Cochrane Central Register of controlled trials, PEDro (the physiotherapy evidence database) and SPORTDiscus™ were searched for relevant articles, from inception until 20 December 2011. The search strategy for MEDLINE was set by one author (NvdH), after which this strategy was modified for use in the other databases. The following combination of key words was used: ((prevention AND training) AND (soccer OR football) AND injury). The searches in CINAHL and SPORTDiscus™ were restricted to peer-reviewed articles. The full search strategy is available on the Online Resource 1. Subsequently, the databases were searched independently by two authors (NvdH, AvB). The results of these searches were combined and duplicates were removed. Reference lists of included studies and relevant systematic reviews were also screened for relevant studies.

2.2 Eligibility Criteria

The relevant citations were first screened on the basis of title and abstract. Articles were independently selected by two authors (NvdH, AvB) if the study met the following criteria.

Inclusion:

- Randomized controlled trial (RCT) or controlled clinical trial (CCT).
- Primary outcome of the study is the number of soccer injuries and/or injury incidence.
- Intervention focusing on a preventive training programme, including a set of exercises aimed at improving strength, coordination, flexibility or agility.
- Study sample of soccer players (no restrictions as to level of play, age or sex).

Exclusion:

- The article was not available as full text.
- The article was not published in English, German or Dutch.
- The trial and/or training programme relates only to specific injuries and/or specific joints.

Full text of relevant articles was obtained and checked for inclusion and exclusion criteria independently by two authors (NvdH, AvB). Disagreements between the two authors regarding a study's eligibility were resolved by discussion until consensus was reached or, where necessary, a third author (IvdP) made the final decision.

2.3 Data Collection

The following data were extracted by two authors (NvdH, AvB): first author; year of publication; follow-up period; number of participants; sex and age of participants; definition primary outcome; description of the intervention; and effect of the intervention.

Initially, the effect of the intervention was assessed by analysing the results in terms of the primary outcome of a study. If different methods are used to describe the primary outcomes in the included studies, the incidence risk ratios (IRRs) were calculated to compare the effects of the intervention between the studies. The IRR is the ratio of the

injury rate (injured players divided by all players) in the intervention group divided by the corresponding rate in the control group. In addition, statistically significant results in terms of secondary outcomes were recorded.

2.4 Assessment of Risk of Bias in Included Studies

Two authors (NvdH, AvB) independently assessed the methodological quality of the included studies using the PEDro scale [24]. The PEDro scale is an 11-item checklist, based on expert consensus, which can be used to rapidly determine the internal validity and statistical quality of RCTs or CCTs [25]. The first item is not used to calculate the total PEDro score, so the maximum score was 10 points. Criteria were only scored as 'yes' or 'no'. Disagreements on the PEDro score were resolved by discussion between the two assessors. If consensus was not achieved, a third author (IvdP) was consulted. A study was considered of moderate quality if the PEDro score was at least 4, and of high quality if the score was 6 or higher [26, 27].

3 Results

3.1 Study Selection

Electronic and manual searching yielded 925 relevant articles, with 265 duplicates. Of the remaining 660 articles, 639 were excluded after screening the title and abstract. Twenty-one articles were retrieved from the literature search and subsequently evaluated. After reading the full text we excluded a further 15 articles, without disagreements between the two authors regarding a study's eligibility. No additional reports were found by screening the reference lists and reviews. Articles were predominantly excluded because the intervention protocol used was not in agreement with our definition or the article did not describe an outcome in terms of injuries and/or injury incidence (Fig. 1).

3.2 Study Characteristics

Six studies with a total of 6,099 participants were included in this review [28–33]. Four studies were RCTs [28, 31–33] and two CCTs [29, 30]. The number of participants per study ranged from 194 to 2,540 players. The samples consisted of youth and adult soccer players, both male and female. Except for the study by Emery and Meeuwisse [28], all studies involved outdoor soccer players. All included studies had a follow-up period of one season (ranging from 20 weeks to 8 months), except for the study by Junge et al. [30] (their follow-up period was 1 year during two seasons). Table 1 shows the main characteristics of the included studies.

3.3 Methodological Quality

The PEDro scores ranged from 2 to 8 points, with a median of 5 points. The results of the quality assessment after consensus are presented in Table 2. Three of the six included studies [28, 31, 33] were of high methodological quality, two others of moderate quality [29, 32] and one of low quality [30]. Some limitations in the low- or moderate-quality studies were lack of randomization [29, 30], low statistical power or inadequate sample size calculation [29, 30, 32], no intent-to-treat analysis [29, 30, 32], no exposure registration [29], and a high dropout rate [30, 32].

3.4 Interventions and Effects

The definition used for injury was similar in nearly all studies, *viz*. an injury that results in a player being unable to take full part in future soccer training or match play ('time-loss' injury) [34]. Two studies also used this definition, but with the additional element of "or any physical complaint caused by soccer that lasted for more than two weeks" [30] and "soccer injuries resulting in medical attention and/or removal from a session and/or time loss" [28].

All six studies prescribed soccer-specific exercises aimed at improving strength, coordination, flexibility or agility. One study [32] required participants to do home-based wobble-board exercises, and one study [28] combined soccer-specific exercises with home-based wobble-board training. The participants in the control group of the latter study engaged in a home-based programme including only the stretching components. One study [30] used a multimodal intervention programme consisting of warm-up, cool-down, taping of unstable ankles and rehabilitation combined with an exercise-based programme. The exercises focused on balance, flexibility, strength, coordination, reaction time and endurance. The other three studies implemented a preventive training programme during the warm-up of training sessions [29, 31, 33]. One programme, the Frappier Acceleration Training Programme, consists of exercises to improve speed and agility [29]. Another one, called The11, focuses on core stability, balance, dynamic stabilization and eccentric hamstring strength [33], while the last one, The11+, combines key exercises from The11 and additional exercises to provide variation and progression with running exercises [31]. The teams in the control groups of these studies were asked to continue their warm-up and training as usual during the season. More detailed information about the interventions studied is provided in Table 1.

Only two of the six studies reported a significant reduction in terms of their primary outcome, i.e. injuries

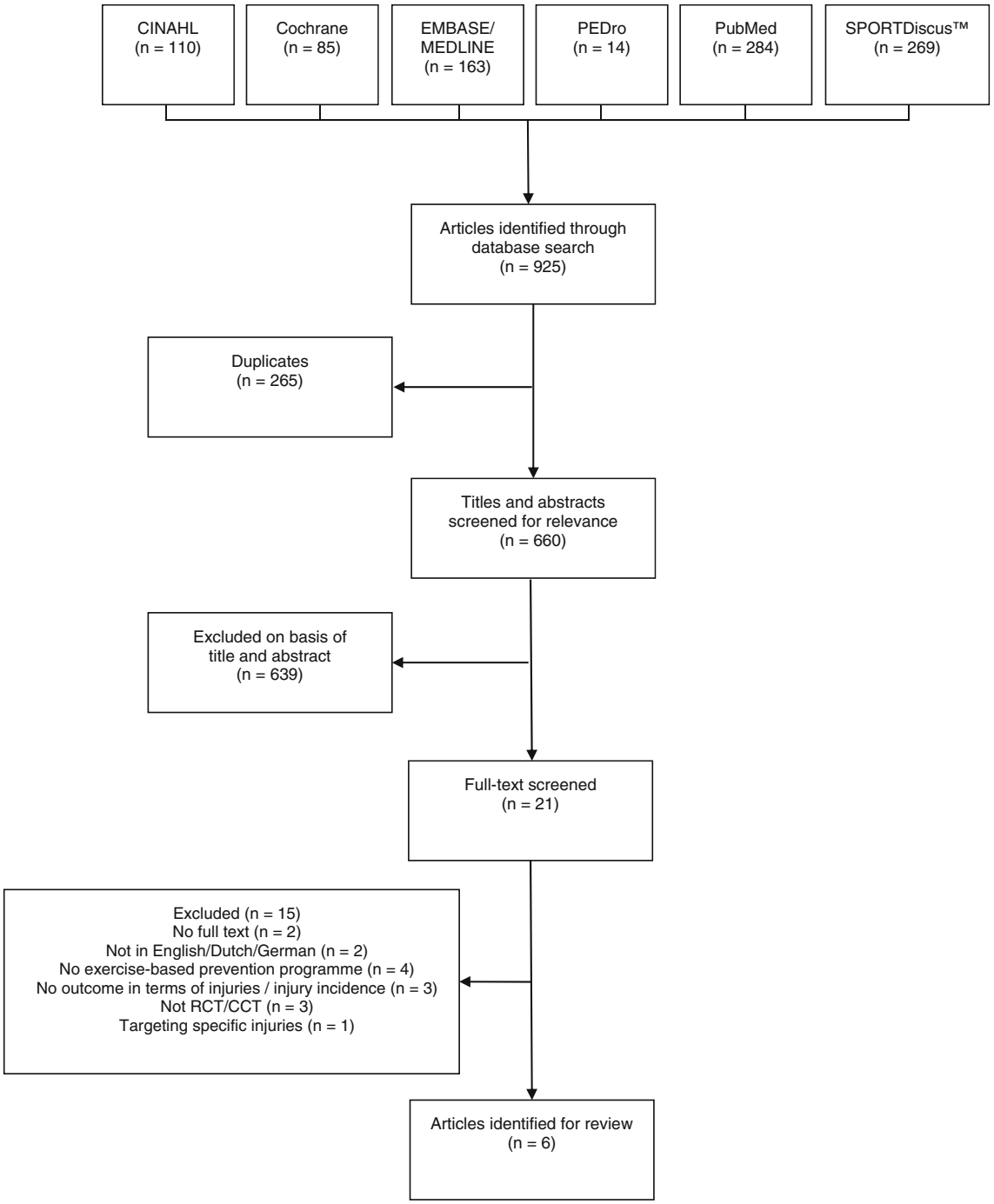

Fig. 1 Flow diagram literature search and selection. *CCT* controlled clinical trial, *RCT* randomized controlled trial

overall. One of these studies was a high-quality study [28], the other was of moderate quality [29]. Emery and Meeuwisse [28] showed that the injury rate in the intervention group was significantly lower (2.08; 95 % CI 1.54, 2.74 injuries/1000 h) than in the control group (3.3; 95 % CI 2.65, 4.17 injuries/1000 h). Heidt et al. [29] reported a significantly lower injury incidence in the intervention group than in the control group (14.3 % vs. 33.7 %). The statistically significant results in terms of secondary outcomes are presented in Table 1.

To compare the effects of the different interventions we calculated the IRR for each of the included studies (see Table 1). Four of the six studies [28–31] reported an overall preventive effect (IRR<1), although the effect in one study was not statistically significant [31]. The three studies that described a significant preventive effect were

Table 1 Study characteristics of the included studies

Study, year	Follow-up period	Participants (n)[a]	Primary outcome	Intervention[b]	Effect of intervention	IRR
Emery and Meeuwisse 2010 [28]	1 season of 20 weeks	Male and female indoor soccer players (744) (intervention group: 380, control group 364), aged 13–18 years	Injuries overall, defined as all soccer injuries resulting in medical attention and/or removal from a session and/or time loss	Warm-up (15 min) including 5 min stretching and 10 min soccer-specific neuromuscular training programme and a 15 min home-based balance training programme	Significant reduction of the primary outcome ($p = 0.045$): injury rate in intervention group = 2.08 (95 % CI 1.54, 2.74) injuries/1000 h, control group = 3.35 (95 % CI 2.65, 4.17)	0.66 (statistically significant)
Heidt et al. 2000 [29]	1 year of competitive soccer participation	Female high-school soccer players (300) (intervention group: 42, control group: 258), aged 14–18 years	Injuries overall, defined as all injuries that caused the player to miss a game or a practice	Frappier Acceleration Training Programme: sport-specific programme of cardiovascular conditioning, plyometric work, sport cord drills, strength training, and flexibility exercises. Twenty sessions over 7 weeks during pre-season	Significant reduction of the primary outcome ($p < 0.05$)	0.42 (statistically significant)
Junge et al. 2002 [30]	1 year (during two seasons)	Male soccer players (194) (intervention group: 101, control group: 93), aged 14–19 years 16.5 ± 1.2	Injuries overall, defined as any physical complaint caused by soccer that lasted for more than 2 weeks or resulted in absence from a subsequent match or training session	General interventions such as improved warm-up, regular cool-down, taping of unstable ankles, adequate rehabilitation and promotion of the spirit of fair play as well as 'F-MARC Bricks': balance, flexibility, strength, coordination, reaction time, and endurance. Once a week supervised by a physiotherapist	No significant reduction of the primary outcome. Statistically significant differences were found for number of injured players, mild injuries, overuse injuries, noncontact injuries, injuries incurred during training, and injuries of the groin	0.64 (statistically significant)
Söderman et al. 2000 [32]	One season of 7 months	Female soccer players (221) (intervention group: 121, control group: 100 (140) 20.5 ± 5 years	Acute lower extremity injuries resulting in absence from at least one scheduled practice session or game	Balance board training at home (10–15 min). Initially each day for 30 days and then three times a week during the rest of the season	No reduction of the primary outcome. Significantly higher injury rate of severe injuries in intervention group	1.16 (not statistically significant)
Soligard et al. 2008 [31]	One season of 8 months	Female soccer players, (2,540) (intervention group: 1,320, control group: 1,220), youth, aged 13–17 years (1892) 15.4 ± 0.7	All lower extremity injuries causing the player to be unable to fully take part in the next match or training session	The11+ intervention programme (20 min): running exercises, strength, balance, jumping, speed running. Every training session during the season (2–5 times a week)	No significant reduction of the primary outcome. The risk of severe injuries, overuse injuries and injuries overall was significantly reduced in the intervention group	0.67 (not statistically significant)
Steffen et al. 2008 [33]	One season of 8 months	Female soccer players (2,092) (intervention group: 1,091, control group: 1,001), aged 13–17 years (2,020) 15.4 ± 0.8	Injuries overall, defined as all injuries causing the player to be unable to fully take part in the next match or training session	Warm-up (20 min) including 5 min of jogging and 15 min of The11 intervention programme: core stability, balance, dynamic stabilization and eccentric hamstring strength. Initially every training session for 15 consecutive sessions and thereafter once a week during the rest of the season	No reduction of the primary outcome	1.20 (not statistically significant)

CI confidence interval, *F-MARC* = FIFA (Fédération International de Football Association) Medical and Research Centre, *IRR* incidence risk ratio

[a] Age is presented as mean age ± SD where stated

[b] The control groups were generally asked to train (and warm-up) as usual

Table 2 Assessment of the methodological quality of the included studies with PEDro criteria [24]

Study, year	Random allocation	Concealed allocation	Baseline comparability	Blinded subjects	Blinded therapists	Blinded assessors	Adequate follow-up	Intent-to-treat analysis	Between-group comparisons	Point estimates and variability	Total
Emery and Meeuwisse 2010 [28]	1	1	1	0	0	1	0	1	1	1	**7**
Heidt et al. 2000 [29]	1	0	0	0	0	1	1	0	1	0	**4**
Junge et al. 2002 [30]	0	0	1	0	0	0	0	0	1	0	**2**
Söderman et al. 2000 [32]	1	0	1	0	0	0	0	0	1	1	**4**
Soligard et al. 2008 [31]	1	1	0	0	0	1	0	1	1	1	**6**
Steffen et al. 2008 [33]	1	1	0	0	0	1	1	1	1	1	**7**

0 no, *1* yes

of high [28], moderate [29] and low quality [30]. The mean reduction in injury rate in these studies was 44 % [28–30]. The mean overall reduction (for the six included studies) was 19 % [28–33].

4 Discussion

This review systematically describes the evidence from RCTs and CCTs on the effect of generic exercise-based programmes to prevent soccer injuries. The conclusions of the six included studies were contradictory. Only two studies reported a significant reduction in terms of the primary outcome [28, 29]. The result of our analysis is inconclusive, however, as different outcome measures and injury definitions were used. As regards the effect of the interventions in terms of one identical outcome, namely IRR, four of the six studies [28–31] described a preventive effect, although the effect in one (high-quality) study was not significant [31]. The three studies that described a significant preventive effect were of high [28] moderate quality [29] and low quality [30]. The other high-quality study reported no differences between the two groups at all [33].

The possible effect of an intervention depends on several factors, which were not identical for all included studies. The first aspect is the study sample in the included studies. Only two studies included male soccer players [28, 30], and one of these showed a significant reduction in terms of the primary outcome, i.e. injuries overall [28]. The other four studies included only female players and two of them showed a significant preventive effect of the intervention [29, 31]. Each sex may have its own risk factors and its own risks of sustaining an injury, or more specifically an ACL injury [35]. It is well-known that female players have a 2–3 times higher ACL injury risk than male players [36, 37]. Nevertheless, a recently published review reported that females benefit less from ACL prevention programmes than males (risk reduction of 52 % vs. 85 %, respectively) [38].

Another important factor that deserves further attention is the content of the intervention programmes analysed in this review. Despite the fact that we defined the content in the inclusion criteria, the contents did differ, which limits their comparability. In the study by Junge et al. [30] the exercise programme was part of other general preventive interventions such as taping, rehabilitation and promotion of fair play. This makes it difficult to identify the specific effect of the set of preventive exercises alone. Two other studies primarily focused on balance training [28, 32], while the remaining three studies described the effects of a training programme focusing on several aspects like core stability, balance, strength and flexibility [29, 31, 33]. A general comment regarding the content of the programme is about the rationale for specific parts of the intervention programmes in the included studies. One can imagine that, for example, neuromuscular training cannot reduce head injuries. The hypothesis is that performing certain exercises on a regular basis would reduce the incidence of the most common (lower extremity) injuries. However, Soligard et al. showed no significant reduction for their primary outcome (all lower extremity injuries), while a significant risk reduction is found for overall injuries in the intervention group [31]. The majority of the included studies targeted prevention of all injury [28–30, 33].

Besides the content of the programme, training frequency and duration also varied greatly between the included studies. The frequency of the intervention programmes ranged from one to five sessions a week, during an intervention period that ranged from 7 weeks to 8 months. The three studies reporting a significant preventive effect of the intervention programme differ greatly [28–30]. The participants of one study had 20 sessions over a 7-week period [29]. In the second study a physiotherapist weekly visited one training session per team and supervised the performance of the intervention programme. It is not reported that the teams also perform the programme without supervision of the physiotherapist [30]. The third study did not report the training frequency, but the participants performed the intervention during a 20-week season [28]. Although the participants of the study by Söderman et al. [32] performed the intervention three times a week, the effect of preventive exercises in general may be positively influenced by a higher frequency (more than once a week). Since the differences in intensity of the programme compared with the effect of the intervention in the included studies it would be interesting to study any underlying dose-response relationship in more detail.

Compliance may also be a key factor in the potential effect of an intervention programme. Soligard et al. [39] confirmed in a previous study that the risk of overall and acute injuries was reduced by more than one-third among players with high compliance compared with players with intermediate compliance. Four of the six included studies recorded the participants' compliance with the intervention. The study by Emery and Meeuwisse [28], the high-quality study that showed a preventive effect of the intervention, did not clearly report compliance. The authors stated that response in terms of self-reported compliance with the home-based programme was very poor (<15 %). Completion of warm-up was indicated for every practice and game at all teams for which weekly exposure data were complete. It is unclear, however, whether all components of the prescribed warm-up were completed for each session [28]. In the two Norwegian studies, compliance with the The11 programme was 52 % [33] versus 77 % for The11+ [31]. Finally, Söderman et al. [32] excluded 30 % of the participants who had completed the study but had performed the prescribed balance board training during fewer than 35 training sessions.

It is hard to conclude from the present review, which components are relevant in injury prevention programmes. To be able to develop effective training programmes, it is highly important to establish the aetiology and mechanisms of injuries before introducing and implementing a preventive measure [40, 41]. The training programmes implemented in the studies included in this review involve different exercises focusing on the prevention of the most frequently reported soccer injuries. Since these injuries have their own aetiologies and risk factors, it is hard to design a 'one size fits all' intervention programme. Even when focusing on one common type of injury in soccer (knee injuries), it still seems difficult to decide which exercises should be implemented in a preventive programme. The literature reports contradictory effects of different exercises. Some studies reported positive, preventive effects on knee injuries [22, 23, 42], while others reported only a trend towards reduction [43, 44], or no reduction at all [45, 46]. Sadoghi et al. [38] recently reported on the effectiveness of ACL injury prevention training programmes. In their review, they suggested that such programmes have a substantial beneficial effect. However, they were not able to recommend a specific type of prevention programme on the basis of the currently published evidence [38]. This confirms the difficulties of designing an exercise-based intervention programme.

Before introducing and implementing a preventive training programme, it also seems relevant to improve the ability to identify players at risk for sustaining an injury [5]. This would make it possible to design such programmes specific enough to achieve the maximum effect. Finally, external factors like behaviour/fair play [41, 47] and sports culture [40] play a role in sustaining injuries. A better understanding of these factors may lead to improvements in the prevention of soccer injuries.

A limitation of our review is that the generalizability of the results remains unclear. The included studies predominantly focused on young, female outdoor soccer players. The participants' age was below 19 years in five studies [28–31, 33]. However, the largest group of active participants in soccer worldwide concerns is that of adult male players, who also have high injury rates [1, 5]. It is also unclear if the results of our review can be generalized to other levels of play and/or across sexes. Only two studies included male participants: 44.6 % of the sample in the study by Emery and Meeuwisse [28] (n = 332) and the entire study sample used by Junge et al. [30] (n = 194). Generalizing the results of our review to the largest soccer population (adult male players) must be done with considerable caution. Finally, it is unclear whether the results reported by Emery and Meeuwisse [28], who included only indoor soccer players, can be generalized to outdoor soccer players. Although indoor and outdoor soccer have several similarities, it is not evident that the injuries are comparable. Some studies reported that indoor soccer has a higher injury incidence/risk than outdoor soccer [5, 48], while others described no differences between indoor and outdoor soccer in injury incidence or risk factors [49].

Drawing conclusions about the effectiveness of an intervention programme also requires taking the choice of primary outcome in a study into account. We used the

results in terms of the primary outcome in the included studies to describe the effect of an intervention, because there may be insufficient statistical power for conclusions based on the secondary outcomes. However, some studies [30, 31] only reported a preventive effect in terms of secondary outcomes. Finally, the mean IRR of the six included studies (19 % reduction) should be interpreted with care. By calculating this score the methodological quality of the included studies is not taken into account. Besides this, the calculation is not based on a meta-analysis. Ideally, relative weights should be given to each included study before calculating the overall IRR.

5 Conclusion

The calculated IRRs for the studies included in our review indicate that there is conflicting evidence for the effectiveness of exercise-based programmes to prevent soccer injuries. There is thus a need for more high-quality studies investigating the best type and intensity of exercises in a generic training programme (for a specific population in terms of sex, level of play and age), in order to reduce the incidence of injuries in soccer effectively.

Acknowledgments No sources of funding were used for the preparation of this review. The authors have no conflicts of interest that are directly relevant to the content of this review.

Reference

1. FIFA big count 2006. Zurich: FIFA, 2007.
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(3):165–80.
4. Reilly T, Gilbourne D. Science and football: a review of applied research in the football codes. J Sports Sci. 2003;21(9):693–705.
5. Schmikli SL, Backx FJ, Kemler HJ, et al. National survey on sports injuries in The Netherlands: target populations for sports injury prevention programs. Clin J Sport Med. 2009;19(2):101–6.
6. Ekstrand J, Hagglund M, Walden M. Injury incidence and injury patterns in professional football: the UEFA injury study. Br J Sports Med. 2011;45(7):553–8.
7. Inklaar H. Soccer injuries. I: incidence and severity. Sports Med. 1994;18(1):55–73.
8. Mickel TJ, Bottoni CR, Tsuji G, et al. Prophylactic bracing versus taping for the prevention of ankle sprains in high school athletes: a prospective, randomized trial. J Foot Ankle Surg. 2006;45(6):360–5.
9. Mohammadi F. Comparison of 3 preventive methods to reduce the recurrence of ankle inversion sprains in male soccer players. Am J Sports Med. 2007;35(6):922–6.
10. Waldén M, Atroshi I, Magnusson H, et al. Prevention of acute knee injuries in adolescent female football players: cluster randomised controlled trial. BMJ. 2012;344:e3042.
11. Junge A, Dvorak J. Soccer injuries: a review on incidence and prevention. Sports Med. 2004;34(13):929–38.
12. Dvorak J, Junge A, Chomiak J, et al. Risk factor analysis for injuries in football players. Possibilities for a prevention program. Am J Sports Med. 2000;28(5 Suppl):S69–74.
13. Bir CA, Cassatta SJ, Janda DH. An analysis and comparison of soccer shin guards. Clin J Sport Med. 1995;5(2):95–9.
14. Hawkins RD, Fuller CW. A prospective epidemiological study of injuries in four English professional football clubs. Br J Sports Med. 1999;33(3):196–203.
15. Ekstrand J, Gillquist J. The avoidability of soccer injuries. Int J Sports Med. 1983;4(2):124–8.
16. Ekstrand J, Gillquist J, Liljedahl SO. Prevention of soccer injuries. Supervision by doctor and physiotherapist. Am J Sports Med. 1983;11(3):116–20.
17. Arnason A, Andersen TE, Holme I, et al. Prevention of hamstring strains in elite soccer: an intervention study. Scand J Med Sci Sports. 2008;18(1):40–8.
18. Askling C, Karlsson J, Thorstensson A. Hamstring injury occurrence in elite soccer players after preseason strength training with eccentric overload. Scand J Med Sci Sports. 2003;13(4):244–50.
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(11):2296–303.
20. Alentorn-Geli E, Myer GD, Silvers HJ, et al. Prevention of noncontact anterior cruciate ligament injuries in soccer players. Part 2: a review of prevention programs aimed to modify risk factors and to reduce injury rates. Knee Surg Sports Traumatol Arthrosc. 2009;17(8):859–79.
21. Grindstaff TL, Hammill RR, Tuzson AE, et al. Neuromuscular control training programs and noncontact anterior cruciate ligament injury rates in female athletes: a numbers-needed-to-treat analysis. J Athl Train. 2006;41(4):450–6.
22. Kiani A, Hellquist E, Ahlqvist K, et al. Prevention of soccer-related knee injuries in teenaged girls. Arch Intern Med. 2010;170(1):43–9.
23. Mandelbaum BR, Silvers HJ, Watanabe DS, et al. Effectiveness of a neuromuscular and proprioceptive training program in preventing anterior cruciate ligament injuries in female athletes: 2-year follow-up. Am J Sports Med. 2005;33(7):1003–10.
24. Sherrington C, Herbert RD, Maher CG, et al. PEDro. A database of randomized trials and systematic reviews in physiotherapy. Man Ther. 2000;5(4):223–6.
25. Maher CG, Sherrington C, Herbert RD, et al. Reliability of the PEDro scale for rating quality of randomized controlled trials. Phys Ther. 2003;83(8):713–21.
26. Lievense AM, Bierma-Zeinstra SM, Verhagen AP, et al. Influence of obesity on the development of osteoarthritis of the hip: a systematic review. Rheumatology (Oxford). 2002;41(10):1155–62.
27. Van Peppen RP, Kwakkel G, Wood-Dauphinee S, et al. The impact of physical therapy on functional outcomes after stroke: what's the evidence? Clin Rehabil. 2004;18(8):833–62.
28. Emery CA, Meeuwisse WH. The effectiveness of a neuromuscular prevention strategy to reduce injuries in youth soccer: a cluster-randomised controlled trial. Br J Sports Med. 2010;44(8):555–62.
29. Heidt RS Jr, Sweeterman LM, Carlonas RL, et al. Avoidance of soccer injuries with preseason conditioning. Am J Sports Med. 2000;28(5):659–62.
30. Junge A, Rosch D, Peterson L, et al. Prevention of soccer injuries: a prospective intervention study in youth amateur players. Am J Sports Med. 2002;30(5):652–9.
31. Soligard T, Myklebust G, Steffen K, et al. Comprehensive warm-up programme to prevent injuries in young female footballers: cluster randomised controlled trial. BMJ. 2008;337:a2469.

32. Söderman K, Werner S, Pietila T, et al. Balance board training: prevention of traumatic injuries of the lower extremities in female soccer players? A prospective randomized intervention study. Knee Surg Sports Traumatol Arthrosc. 2000;8(6):356–63.
33. Steffen K, Myklebust G, Olsen OE, et al. Preventing injuries in female youth football: a cluster-randomized controlled trial. Scand J Med Sci Sports. 2008;18(5):605–14.
34. Fuller CW, Ekstrand J, Junge A, et al. Consensus statement on injury definitions and data collection procedures in studies of football (soccer) injuries. Clin J Sport Med. 2006;16(2):97–106.
35. Benjaminse A, Gokeler A, Fleisig GS, et al. What is the true evidence for gender-related differences during plant and cut maneuvers? A systematic review. Knee Surg Sports Traumatol Arthrosc. 2011;19(1):42–54.
36. Vescovi JD, VanHeest JL. Effects of an anterior cruciate ligament injury prevention program on performance in adolescent female soccer players. Scand J Med Sci Sports. 2010;20(3):394–402.
37. Waldén M, Hagglund M, Werner J, et al. The epidemiology of anterior cruciate ligament injury in football (soccer): a review of the literature from a gender-related perspective. Knee Surg Sports Traumatol Arthrosc. 2011;19(1):3–10.
38. Sadoghi P, von Keudell A, Vavken P. Effectiveness of anterior cruciate ligament injury prevention training programs. J Bone Joint Surg Am. 2012;94(9):769–76.
39. Soligard T, Nilstad A, Steffen K, et al. Compliance with a comprehensive warm-up programme to prevent injuries in youth football. Br J Sports Med. 2010;44(11):787–93.
40. Finch C. A new framework for research leading to sports injury prevention. J Sci Med Sport. 2006;9(1–2):3–9.
41. Verhagen EA, Van Stralen MM, Van Mechelen W. Behaviour, the key factor for sports injury prevention. Sports Med. 2010;40(11):899–906.
42. Caraffa A, Cerulli G, Projetti M, et al. Prevention of anterior cruciate ligament injuries in soccer: a prospective controlled study of proprioceptive training. Knee Surg Sports Traumatol Arthrosc. 1996;4(1):19–21.
43. Gilchrist J, Mandelbaum BR, Melancon H, et al. A randomized controlled trial to prevent noncontact anterior cruciate ligament injury in female collegiate soccer players. Am J Sports Med. 2008;36(8):1476–83.
44. Hewett TE, Lindenfeld TN, Riccobene JV, et al. The effect of neuromuscular training on the incidence of knee injury in female athletes: a prospective study. Am J Sports Med. 1999;27(6):699–706.
45. 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(6):1052–60.
46. Pfeiffer RP, Shea KG, Roberts D, et al. Lack of effect of a knee ligament injury prevention program on the incidence of noncontact anterior cruciate ligament injury. J Bone Joint Surg Am. 2006;88(8):1769–74.
47. Dvorak J, Junge A, Derman W, et al. Injuries and illnesses of football players during the 2010 FIFA World Cup. Br J Sports Med. 2011;45(8):626–30.
48. Hoff GL, Martin TA. Outdoor and indoor soccer: injuries among youth players. Am J Sports Med. 1986;14(3):231–3.
49. Emery CA, Meeuwisse WH. Risk factors for injury in indoor compared with outdoor adolescent soccer. Am J Sports Med. 2006;34(10):1636–42.