Effects of functional correction training on injury risk of athletes - a systematic review and meta-analysis (#53313)

First submission

Guidance from your Editor

Please submit by **20 Nov 2020** for the benefit of the authors (and your $200 publishing discount) .

Structure and Criteria
Please read the 'Structure and Criteria' page for general guidance.

Custom checks
Make sure you include the custom checks shown below, in your review.

Raw data check
Review the raw data.

Image check
Check that figures and images have not been inappropriately manipulated.

Privacy reminder: If uploading an annotated PDF, remove identifiable information to remain anonymous.

Files

Download and review all files from the materials page.

10 Figure file(s)
5 Table file(s)
1 Raw data file(s)
1 Other file(s)

Custom checks

Systematic review or meta analysis

- Have you checked our policies?
- Is the topic of the study relevant and meaningful?
- Are the results robust and believable?

Structure and Criteria

Structure your review

The review form is divided into 5 sections. Please consider these when composing your review:

1. **BASIC REPORTING**
2. **EXPERIMENTAL DESIGN**
3. **VALIDITY OF THE FINDINGS**
4. General comments
5. Confidential notes to the editor

You can also annotate this PDF and upload it as part of your review

When ready submit online.

Editorial Criteria

Use these criteria points to structure your review. The full detailed editorial criteria is on your guidance page.

BASIC REPORTING

- Clear, unambiguous, professional English language used throughout.
- Intro & background to show context. Literature well referenced & relevant.
- Structure conforms to PeerJ standards, discipline norm, or improved for clarity.
- Figures are relevant, high quality, well labelled & described.
- Raw data supplied (see PeerJ policy).

EXPERIMENTAL DESIGN

- Original primary research within Scope of the journal.
- Research question well defined, relevant & meaningful. It is stated how the research fills an identified knowledge gap.
- Rigorous investigation performed to a high technical & ethical standard.
- Methods described with sufficient detail & information to replicate.

VALIDITY OF THE FINDINGS

- Impact and novelty not assessed. Negative/inconclusive results accepted. *Meaningful* replication encouraged where rationale & benefit to literature is clearly stated.
- All underlying data have been provided; they are robust, statistically sound, & controlled.
- Speculation is welcome, but should be identified as such.
- Conclusions are well stated, linked to original research question & limited to supporting results.

Standout reviewing tips

The best reviewers use these techniques

Tip	*Example*
Support criticisms with evidence from the text or from other sources	*Smith et al (J of Methodology, 2005, V3, pp 123) have shown that the analysis you use in Lines 241-250 is not the most appropriate for this situation. Please explain why you used this method.*
Give specific suggestions on how to improve the manuscript	*Your introduction needs more detail. I suggest that you improve the description at lines 57- 86 to provide more justification for your study (specifically, you should expand upon the knowledge gap being filled).*
Comment on language and grammar issues	*The English language should be improved to ensure that an international audience can clearly understand your text. Some examples where the language could be improved include lines 23, 77, 121, 128 – the current phrasing makes comprehension difficult.*
Organize by importance of the issues, and number your points	*1. Your most important issue* *2. The next most important item* *3. …* *4. The least important points*
Please provide constructive criticism, and avoid personal opinions	*I thank you for providing the raw data, however your supplemental files need more descriptive metadata identifiers to be useful to future readers. Although your results are compelling, the data analysis should be improved in the following ways: AA, BB, CC*
Comment on strengths (as well as weaknesses) of the manuscript	*I commend the authors for their extensive data set, compiled over many years of detailed fieldwork. In addition, the manuscript is clearly written in professional, unambiguous language. If there is a weakness, it is in the statistical analysis (as I have noted above) which should be improved upon before Acceptance.*

Effects of functional correction training on injury risk of athletes - a systematic review and meta-analysis

Junxia Chen Corresp., 1 , **Chunhe Zhang** 1 , **Sheng Chen** 1 , **Yuhua Zhao** 1

1 Physical Education College, Hubei University., Wuhan, Hubei Province, China

Corresponding Author: Junxia Chen
Email address: 775100275@qq.com

Background. This systematic review and meta-analysis of non-randomized clinical trials aimed to explore functional correction training after the use of Functional Movement Screen (FMS™) and the effects of training on the injuries of athletes.

Methods. Twenty-four articles published from January 1997 to September 2020 were retrieved from PubMed, CENTRAL, Scopus, ProQuest, Web of Science, EBSCOhost, SPORTDiscus, Embase, WanFang and CNKI. The inclusion criteria for the selected studies were as follows: randomized and non-randomized controlled trials, studies with functional correction training screened by FMS™ as the independent variable, and studies with the athletes' injury risk as the dependent variable. Data conditions included the sample size, mean, standard deviation, total FMS™ scores, number of injuries, and asymmetry movement patterns after intervention in the experimental and control groups. Exclusion criteria were as follows: conference abstracts, cross-sectional studies, papers with retrospective study design; and papers on non-athletes. **Results**. The injury risk ratio of athletes after functional correction training was 0.3932 (95% confidence interval [CI], 0.2386-0.6482; Z=-3.57; P=0.0003; I^2=0.0%). It was found that functional correction training could reduce the injury risk by 60% in the experimental groups as compared with the control groups. The influence of functional correction training on the athletes' total FMS™ scores was 1.7165 (95% CI, 1.4999-1.9330; Z=15.53; P<0.0001; I^2 =2.6%), indicating effective improvement of athletes' functional patterns. **Conclusion.** Grade B evidence indicates that functional correction training based on FMS™ could improve athletes' functional patterns , and Grade D evidence indicates that could reduce sports injury risks of athletes, The true effect is likely to be different from the estimate of effect, Further studies are needed to explore the influence of functional correction training on the injury risks of athletes. Protocol registration: CRD42019145287.

Effects of Functional Correction Training on Injury Risk of Athletes - A Systematic Review and Meta-analysis

Junxia Chen[1],Sheng Chen[2],Chunhe Zhang[3],Yuhua Zhao[4]

[1] Physical Education College of Hubei University. No. 368, Youyi Avenue , Wuchang District, Wuhan, Hubei Province, P. R. China, 430062

[2] Physical Education College of Hubei University. No. 368, Youyi Avenue , Wuchang District, Wuhan, Hubei Province, P. R. China, 430062

[3] Physical Education College of Hubei University. No. 368, Youyi Avenue , Wuchang District, Wuhan, Hubei Province, P. R. China, 430062

[4] Physical Education College of Hubei University. No. 368, Youyi Avenue , Wuchang District, Wuhan, Hubei Province, P. R. China, 430062

Corresponding Author:

Junxia Chen[1]

Physical Education College of Hubei University. No. 368, Youyi Avenue , Wuchang District,

Wuhan, Hubei Province, P. R. China, 430062

Email address: 775100275@qq.com

Effects of Functional Correction Training on the Injury Risk of Athletes: A Systematic Review and Meta-analysis

9-10 2 notes:

Abstract

11 Jakub Baron

Background. This systematic review and meta-analysis of non-randomized clinical trials aimed to explore functional correction training after the use of Functional Movement Screen (FMS™) and the effects of training on the injuries of athletes.

Methods. Twenty-four articles published from January 1997 to September 2020 were retrieved from PubMed, CENTRAL, Scopus, ProQuest, Web of Science, EBSCOhost, SPORTDiscus, Embase, WanFang and CNKI. The inclusion criteria for the selected studies were as follows: randomized and non-randomized controlled trials, studies with functional correction

12 Jakub Baron

training screened by FMS™ as the independent variable, and studies with the athletes' injury risk as the dependent variable. Data conditions included the sample size, mean, standard deviation, total FMS™ scores, number of injuries, and asymmetry movement patterns after intervention in the experimental and control groups. Exclusion criteria were as follows: conference abstracts, cross-sectional studies, papers with retrospective study design; and papers on non-athletes.

Results. The injury risk ratio of athletes after functional correction training was 0.3932 (95% confidence interval [CI], 0.2386-0.6482; Z=-3.57; P=0.0003; I^2=0.0%). It was found that functional correction training could reduce the injury risk by 60% in the experimental groups as compared with the control groups. The influence of functional correction training on the athletes' total FMS™ scores was 1.7165 (95% CI, 1.4999-1.9330; Z=15.53; P<0.0001; I^2 =2.6%), indicating effective improvement of athletes' functional patterns.

13 Jakub Baron

Conclusion. Grade B evidence indicates that functional correction training based on FMS™ could improve athletes' functional patterns, and Grade D evidence indicates that it could reduce

sports injury risks of athletes, The true effect is likely to be different from the estimate of effect, Therefore, further studies are needed to explore the influence of functional correction training on the injury risks of athletes.

Protocol registration: CRD42019145287.

Introduction

The mechanisms of sports injuries are complex and multifactorial, with many potential inherent risk factors increasing the injury risk. Functional Movement Screening (FMS™) has been used to evaluate the basic sports patterns of athletes and to recognize potential sports injury risks (Cook, Burton & Hoogenboom, 2006a; Cook, Burton, & Hoogenboom, 2006b). Functional correction training recognizes athletes' motor dysfunction, left and right muscle function asymmetries, and pain during exercise through FMS™. It formulates personalized correction exercises, guided by professional coaches, to stimulate the core muscles of the human body, increases strength, establishes body symmetry, and achieves balance between mobility and stability. Therefore, it can optimize functional patterns and reduces the risk of potential sports injuries (Cook, 2011; Cook, et al., 2014). This approach is intriguing to practitioners in sports disciplines and sports medicine.

One randomized controlled trial reported that performing function-based exercise after the patient receives anterior cruciate ligament reconstruction can significantly improve the function and movement of the knee joint (Chao et al., 2018). Several non-randomized controlled trials for firefighters have shown that personalized corrective exercises can improve FMS™ scores （Basar, 2017; Jafari, Zolaktaf & Ghasemi, 2019). A series of studies by Frost et al. reported that whether the FMS™ training program is effective and requires consideration of various factors, such as the number and type of participants, the scoring method (paper or video), the feedback provided during the test, coach supervision (Frost et al., 2012, 2015a, 2015b, 2015c). The studies indicated that the FMS™, whether graded qualitatively using composite or task scores, or quantitatively via kinematic analyses, may not be a viable tool to assess performers' movement behaviors (Frost et al. 2017). Another study of functional corrective exercise program did not improve the functional exercise of firefighters or the quality of measures (David J. Cornell, 2016). Therefore, the effect of functional correction training after FMS™ of firefighters or general population was unclear.

Some non-randomized controlled studies for athletes' functional correction training (Kiesel et al., 2011, 2014; Robert et al., 2019; Campa et al., 2018; Reila et al., 2019; Kovac et al., 2018) showed that it could improve their FMS™ scores as well as could reduce asymmetry in functional patterns. Moreover, other three studies (Xuhua et al., 2015; Dinc et al., 2017; Hui et al., 2019) reported that athletes had significantly improved FMS™ scores and had reduced sports injuries. The training effect of athletes' functional correction after FMS™ seemed to be effective, but the above-mentioned studies had a small sample size, some studies had no control group, and lacked a strict randomized control design. Therefore, the finding needs to be verified through comprehensive evidence.

The summarized results of systematic reviews and meta-analyses of the total FMS™ score of a mixed population to predict the sports injury risk are contradictory because they do not support the predictive validity of FMS™ or its use as an injury prediction tool (Dorrel et al., 2015; Moran et al., 2017). The association of an FMS™ score ⩽14 with an increased risk of injury is unclear (Manuel et al., 2019); However, other authors reported that the probability of injury for high-risk participants was 2.74 times (or 51%) higher than that for low-risk participants (Bonazza et al., 2016; Bunn, Rodrigues & Bezerra da Silva, 2019); Grade C evidence has indicated that the Selective Functional Movement Assessment contributes to the functional evaluation of dancers (Fauntroy et al., 2018). Only one study (Moore et al. 2019) pertaining to FMS™ and sports injuries of athletes considered the total scores and asymmetry of the FMS™ to be more useful for evaluating the injury risk of older athletes; therefore, there is no consistent conclusion regarding this.

Some reviews that have analyzed the effects of functional correction training reported that the plan was effective and improved the limitations of exercise patterns (Lindsay et al., 2015, Kraus et al., 2014). To the best of our knowledge, since there is no meta-analysis or systematic review of this topic, it is impossible to clearly establish the impact of functional correction training on sports injuries of athletes. Therefore, the main purpose of this review was to explore the impact of functional correction training after FMS™ screening on the injury risk of athletes. The secondary purpose was to determine whether functional correction training after FMS™ screening could increase total FMS™ scores and could reduce the incidence of asymmetry in movement patterns of athletes.

Materials and Methods

Agreement and registration

The systematic review and meta-analysis were performed in accordance with the preferred reporting items for systematic reviews and meta-analyses, and the Cochrane Collaboration Handbook was followed while conducting the research (DerSimonian & Kacker, 2007; Moher, Liberati, Tetzlaff, & Altman, 2009). Since this systematic review did not include individual patient data; therefore, ethical approval was not required. The research has been registered in PROSPERO (Registration no. CRD42019145287).

Inclusion and exclusion criteria

Articles were included only if the independent variable was functional correction training after FMS™ and if the dependent variable was the sports injury risk of athletes. Data indicators were sample size, mean, standard deviation, total FMS™ scores, number of athletes with sports injuries, and functional pattern asymmetry after intervention of the experimental and control groups. A functional correction plan was used as the intervention for the experimental group, and conventional training was used for the control group. Exclusion criteria were conference abstracts, cross-sectional and retrospective study designs, and studies on non-athletes.

Article sources, retrieval, and selection

Two authors (Chen) and (Zhao) independently executed search strategies, Disagreements were solved through consensus and by discussion with a reference author (Zhang). Ten electronic databases were searched for full text published between January 1997 and September 2020, these databases were PubMed, CENTRAL, Scopus, ProQuest, Web of Science, EBSCOhost, SPORTDiscus, Embase, Wanfang and the CNKI databases. The following search terms and MeSH terms were used: functional movement screen OR fms* OR functional movement screen* AND injury* OR injury prediction OR injury risk OR injury prevention screening OR athletic injuries [MeSH] AND functional training OR functional correction training OR corrective exercise training AND sport* OR athlete*OR player. Articles written in Chinese were limited to full text. The key words "FMS™, functional training and athletes" were entered in Chinese, and the results were obtained. Additionally, the references of the selected articles were searched manually to obtain other potentially related studies. Table 1 shows the systematic search strategy.

Data extraction and collection procedure

All duplicates were removed before two investigators independently screened the titles and abstracts for eligibility. Two investigators independently assessed the full text of the remaining articles for eligibility. Results provided by each investigator were compared after each stage, and any discrepancies were resolved by discussion. The following data were extracted from the original reports: authors, year, and publication; country; sample characteristics (sample size, age, sex); functional correction training program; conventional training program; and main results (average value, standard deviation), total FMS™ scores, number of athletes with sports injuries, and functional movement asymmetry after intervention in the experimental group and the control group.

In this study, injuries of skeletal muscles, joints, bones, and tendons (i.e., the sports system) were defined as sports injuries, and were included in main outcomes that directly indicate whether our intervention test reduces risk of sports injuries. Other additional outcomes were total FMS™ score and functional movement asymmetry. Of these, left and right muscle function asymmetries through FMS™ were defined as functional movement asymmetry, and the Functional Movement Screening (FMS™) comprises seven basic movements: deep squat, hurdle step, in-line lunge, shoulder mobility, active straight leg raise, trunk stability push-up, and rotary stability. The maximum comprehensive FMS score was 21. Both these demonstrate could improvement to functional patterns, thereby indicators indirectly reducing the risk of sports injuries.

Quality evaluation

The risk of bias in non-randomized studies was assessed in a manner similar to that used for randomized trials, as recommended by the Cochrane Collaboration Handbook for bias assessment of non-randomized studies (Higgins &Green, 2011). Two researchers (Chen and Zhao) were asked to independently evaluate the quality of articles according to 11 factors of the PEDro quality score scales (PEDro, https://www.pedro.org.au). The Spearman rank correlation coefficient was calculated to determine inter-rater reliability of the two researchers (Spearman's rho = 0.779), and a strong level of agreement was found.

The systematic error of the 15 articles was assessed using Cochrane's risk of bias tool (RevMan; Review Manager, 2020). The same researchers (Chen and Zhao) independently scored each trial for the risk of bias. In the case of disagreement, a third researcher (Zhang) assessed the questionable item, and agreement was sought by consensus. Each study was graded for the following domains: random sequence generation, allocation concealment, blinding of participants and personnel, blinding of outcome assessment, incomplete outcome data, selective reporting, and other bias. Domains were rated as low if the risk of bias for this item was low or as high if the risk of bias for this item was high. In the case of insufficient reported information or information that made an interpretation questionable and thus unclear, the risk of bias for this item was rated as unclear.

Effect index and data aggregation method

Meta-analyses were performed with R3.3.2, Depending on the heterogeneity, either the random effects method or the fixed-effects method was used (DerSimonian & Kacker, 2007). The risk ratio (RR) was used to combine the athletes' sports injuries and functional patterns asymmetry after the intervention. The mean difference (MD) was used to combine the athletes' total FMS™ scores. The 95% confidence interval (CI) was also used. The effect sizes of the results were evaluated as follows: large effect size, >0.8; medium effect size, 0.5-0.79; and small effect size, 0.00-0.49 (Higgins and Green, 2011). Heterogeneity of results across studies was evaluated using the I^2 statistic as follows: might not be important, 0-40%; moderate heterogeneity, 30-60%; substantial heterogeneity, 50-90%; and considerable heterogeneity, 75-100% (Higgins & Thompson, 2002). Additionally, the adopted significance level was $P \leq 0.05$. Publication bias was tested by Egger's linear regression (Sterne, Egger & Smith, 2001). Finally, a sensitivity analysis was performed.

Level of evidence

The quality of the evidence associated with the meta-analysis results was assessed using the

Grading of Recommendations Assessment, Development and Evaluation approach (GRADE) (Guyatt et al., 2011a; Guyatt et al., 2011b; Guyatt et al., 2011c; Guyatt, Oxman & Montori et al., 2011d; GRADEpro GDT, 2020).

Results

Study selection

Among the 696 articles identified in the initial literature search, we included 102 articles as 594 articles were excluded after removing duplicates and after reading titles and abstracts.

Further screening was conducted according to the aforementioned inclusion criteria and quality assessment. Discrepancy was resolved through third-party mediation. Finally, 24articles that met the inclusion criteria were included in the systematic review, and 12 were selected for this meta-analysis. None of the studies was a randomized controlled trial. Fig 1 shows the systematic search strategy and selection process.

Study characteristics

The study included 538 participants (adolescent and adult athletes; men and women); out of these, 258 comprised the experimental group and 280 comprised the control group. Detailed information regarding the training status is found in Table 2. The age of the participants ranged from 9.6 to 26.5 years; the average age of the experimental group and control group was 18.56±4.17 years and 19.04±4.92 years, respectively. The shortest experiment time was 6 weeks and the longest was 20 weeks. The average experiment time was 9.33±4.32 weeks. The shortest intervention frequency was twice per week, and the maximum was six times per week. The average intervention frequency was 3.42±1.39 weeks. Finally, the shortest duration of each lesson was 15 minutes, the longest was 60 minutes, and the average was 36.36±16.75 minutes.

The publication period of the studies that were included was between January 1997 and September 2020. The sports involved in the research were baseball (Song et al., 2014), table tennis (Kangkang et al., 2016), volleyball (Xuhua et al., 2015), free kicking (Bodden, Needham & Chockalingam, 2015), basketball (Klusemann et al., 2012; Hui and Baoai, 2019), soccer (Dinc et al., 2017; Campa, Spiga & Toselli, 2018; Riela & Bertollo, 2019; Schneider et al., 2019), tennis (Yildiz, Pinar & Gelen, 2019), netball (Kovac, 2018), and wrestling (Bayati et al., 2019). Moreover, three studies were not included in the meta-analysis. One did not include data regarding the total FMS™ scores and sports injury but data regarding the strength and flexibility of the athletes were included (Song et al., 2014). Two other studies had single-group sample sizes fewer than 10 people, and the quality assessment scores were very low (the PEDro quality scale score for physical therapy was only 4 points) (Kim et al., 2014; Armstrong et al., 2019). Furthermore, some studies used a single-group pre-test design method to perform functional correction training for athletes and the results showed that they had a positive impact on their FMS™ scores, asymmetric events, and sports injuries (Kiesel, et al., 2011; Jim et al.,, 2015; Toma et al.,2017; Ali et al.,2019; Brende et al., 2018; Jakub et al., 2019; Bethany et al.,2019 ; Bayrakdar et al., 2020). Such studies did not meet the inclusion criteria and were excluded.

The standard functional correction procedure does not require special or expensive equipment; instead, it uses elastic bands, medicine balls, and foam rollers. It includes self-managed trigger point therapy, self-based and partner-based stretching exercises for the major muscle groups, and strength, stability, and flexibility exercises. In 12 studies, after FMS™ screening, the researchers developed a functional correction training program (including personalized correction training) as an intervention. Some of these studies used mixed interventions (Klusemann et al., 2012; Bayati et al., 2019). One study did not report whether the intervention plan was supervised or was known by coaches or researchers (Dinc et al., 2017). Two studies (Dinc et al.,2017 and Bayati et al.,2019) did not provide any FMS™ assessor qualification information or reliability tests. All experimental groups performed functional correction and conventional training or warm-up activities; and the control groups performed either conventional training or warm-up activities. Two non-randomized trials (Xuhua et al., 2015; Hui et al., 2019) used scoring thresholds to attempted to divide the subjects into high-risk group (FMS™ $\leqslant$14) and low-risk group (FMS™ $\geqslant$14) before the test and interventions (Kiesel, Plisky & Voight, 2007), All four trials met the inclusion criteria after evaluation by the researchers.

After FMS™, the numbers of athletes in the experimental and control groups with sports injuries and pattern asymmetry during the intervention period were reported (Xuhua et al., 2015; Hui & Baoai, 2019; Dinc et al., 2017; Bodden et al., 2015; Campa et al., 2018; Kangkang et al., 2016). Research performed by Dinc et al., 2017 did not report the number of people with sports injuries; instead, selection of injuries causing the inability to perform athletic activities for more than 3 weeks was calculated.

Research bias

The risk of bias was analyzed, and high risk was associated with the blinding procedures. (Figs 2 and 3). Participant blinding was only described in one study (Campa et al., 2018). Four studies mentioned random grouping; however, they did not provide any specific methods. Blinding of the outcome assessors was performed in two studies (Campa et al., 2018, ; Riela & Bertollo, 2019). The outcome evaluators of the other four studies were not blinded because repeated measurement reliability, inter-rater reliability, and high-precision professional electronic instruments were used to record data that the measurement of the outcome may not have been affected by unblinding (Song et al., 2014; Kim et al., 2014; Klusemann et al., 2012; Yildiz, Pinar & Gelen, 2019). The selection bias ratings remained unclear due to either insufficient or unclear information. A low risk of bias attributable to the blinding of outcome assessment, reporting, and other bias was observed throughout the studies.

We selected the PEDro physical therapy quality scale to evaluate article quality and the primary difference between randomized and non-randomized trials (Table 3). Some studies included athletes who were randomly divided into groups in a blinded manner (Bobben et al., 2015; Kovac et al., 2018; Campa et al., 2018; Riela & Bertollo, 2019). Some studies did not conduct random grouping of athletes; therefore, there was no score for this item. In some studies, the coaches, raters, and participants were not blinded; therefore, scores were not obtained for questions related to those items. Among the 15 studies, the average score was 5.5 with the overall quality of the literature being average.

Result integration

We verified the effects of functional correction training on sports injuries of athletes based on the sports injury RR, total FMS™ score, and functional pattern asymmetry. There was no heterogeneity in the hazard ratio of the influence of functional correction training on athletes' sports injuries (RR, 0.3932; 95% CI, 0.2386-0.6482; Z=-3.57; P=0.0003; I^2=0.0%) (Fig 4); therefore, the fixed-effects model was used to combine the effect sizes. The incidence of sports injuries in the experimental group was lower than that of the control group, and the injury risk in the experimental group decreased by 60%.

The effect sizes were combined to measure the influence of functional correction training on the total FMS™ scores (MD, 1.7165; 95% CI, 1.4999-1.9330; Z=15.53; P<0.0001; I^2=2.6%) (Fig 5). Because there was low heterogeneity, the fixed-effects model was used to combine the effect sizes. According to Cohen's interpretation standard, all results had large effect sizes with significant differences as compared with those of the control group and the functional patterns of athletes were optimized.

The hazard ratio of the influence of functional correction training on the pattern of asymmetry of athletes showed large heterogeneity (RR, 0.446; 95% CI, 0.1323-1.5033; Z=-1.3; P=0.1928; I^2=65.2%) (Fig 6). Therefore, the randomized effects model was used to combine the effects; no significant difference was observed when compared with the control group. One study considered that age during playing sports can explain heterogeneity in the prospective prediction of injury risk by FMS™ (Moore et al., 2019) and reported that asymmetry determined by FMS™ is more useful for evaluating the injury risk of senior athletes. Another study included young soccer players 15.89±0.53 years (Campa et al. 2018), and two studies included adult free combat athletes (Bodden et al., 2015) and a national table tennis team (Kangkang et al., 2016); the incidence rates of model asymmetry for the adults were lower than that of the young soccer players. Therefore, our research results are in line with their results. However, because only three cases were included in the sample, a subgroup analysis to determine the source of heterogeneity was impossible. Additionally, the total FMS™ score was not necessarily better, and attempting to reach a score of 21 was not the goal. Instead, it was important to identify asymmetries (Cook et al., 2014b). Further studies are needed to explore the influence of functional correction training on the model asymmetry of athletes.

The sports injuries are complex. A variety of factors can lead to sports injuries; however, strength and flexibility are the main contributing factors. One study of functional correction training after FMS™ for 62 elite male high school baseball players showed improvements in their strength and flexibility (Song et al., 2014), thus indicating that increased strength and flexibility of young athletes may reduce the potential for injury. This result may also imply that functional correction training after FMS™ reduces the risk of sports injury.

Publication bias and sensitivity analysis

The publication bias associated with the influence of functional correction training on athletes' total FMS™ scores was not significant (Egger's linear regression, t=-0.096147; df=11; P=0.9251>0.05) (Fig. S1). The sensitivity analysis indicated that the hazard ratios for athletic injuries and total FMS™ scores after functional correction training were consistent with those without stratification, with very robust results (Fig .S2,S3,S4). The results of the sensitivity analysis of athletes' asymmetry were slightly different than those before stratification and were not sufficiently stable.

Level of evidence

The included studies were non-randomized controlled trials, and the level of evidence using GRADE instruments was low (Tables 4 and 5). Among them, the outcome was a very low level evidence of the injury risk ratio and asymmetry model of the athlete the other outcome was a moderate level evidence of the total FMS™ scores of athletes.

Discussion

This review explored the influence of functional correction training based on FMS™ on the sports injury risk of athletes. The results showed that the injury risk of the experimental group was reduced by 60% after functional correction training, and the effect on the total scores of FMS™ was large, and significantly different from that of the control group. Results of the sensitivity analysis were very robust, and the possibility of publication bias influencing the athletes' total FMS™ scores was very low.

A previous review had no consistent conclusion regarding the total FMS™ score and the risk of subsequent injuries for athletes and mixed populations (Dorrel et al., 2015; Moran et al., 2017; Bonazza et al., 2016; Bunn et al., 2019; Moore et al., 2019). This review summarized functional correction training after FMS™ with the RR for athletes' injuries, total FMS™ scores, and asymmetry as well as provided standardized evidence, and clarified that functional correction training after FMS™ can effectively enhanced the functional patterns of athletes.

Functional correction training was found to be effective because of its pertinence and comprehensiveness. Using FMS™, athletes can discover weak links and perform correction by focusing on their trunk pillar strength, joint flexibility, and stability to ensure effectiveness. Intervention training includes dynamic stretching, core stability training, resistance strength training, and combined training involving fast stretching, flexibility, and dexterity training. Considering the various muscle modes of the limb and trunk muscles, the emphasis is placed on the quality of action, breathing coordination, and muscle proprioception training. It can improve the imbalance of the muscle groups and the energy transmission effect of the body's kinetic chain (Cook et al., 2011; Cook et al., 2014a; Cook et al., 2014b). Therefore, after functional correction training, the athletes' total FMS™ scores and their functional patterns were enhanced, their strength and flexibility (Song et al., 2014) were improved, which could effectively reduce the sports injury risk.

To the best of our knowledge, this was the first study to evaluate the impact of functional correction training after FMS™ on athletes' sports injury risk by including non-randomized controlled trials. Grade B evidence indicates that functional correction training based on FMS™ could improve athletes' functional patterns and Grade D evidence indicates that reduce sports injury risks of athletes. The evidence found in this review is reliable and had certain significance for evidence-based clinical practice.

Strengths and limitations

This review has some limitations. First, although we searched nine online databases, some relevant literature might have been overlooked. Second, its methodological limitations should be considered, such as the small sample sizes evaluated within the retained studies, no differentiation among sports, allocation concealment, and evaluator blindness, which might have caused overestimation of the effects of the intervention. Third, because the sample sizes used to determine the sports injury risk and model asymmetry were fewer than 10, the publication bias test was not completed. Fourth, some studies did not define whether the coaches supervised or corrected the training quality or whether joint intervention was used. Fifth, FMS™ was limited by its inability to test a single construct from a composite set of scores, the total FMS™ score of our study was only used to show whether the functional model could be improved. Finally, our findings should be carefully interpreted.

Conclusions

Grade B evidence indicates that functional correction training based on FMS™ could improve athletes' functional patterns, and Grade D evidence indicates that it could reduce sports injury risks of athletes, The true effect is likely to be different from the estimate of effect, Therefore, further studies are needed to explore the influence of functional correction training on the injury risks of athletes.

Acknowledgements

We would like to thank Professor Li Shuping, Professor Huang Zhijian, and Professor Yu

Lianghua for their guidance and suggestions in the process of writing the paper. We would also like to thank Editage for their editing work for this article.

References

Akan Bayrakdar, Hilal Kılın, Boz .2020. The effect of functional movement screen and lower extremity training on hamstring/quadriceps ratio in football players. PHYSICAL EDUCATION OF STUDENTS .2: 80-85. doi:10.15561/20755279.2020.0202

Armstrong K, McDevitt B, Baumann K, O'Reilly L, Ramos Y, Reyes C. 2019. Movement capability changes in collegiate basketball players following a corrective exercise programme. https://digitalcommons.linfield.edu/cgi/viewcontent.cgi?article=1431&context=symposium

Baron J, Bieniec A, Swinarew AS, Gabryś T, Stanula A. 2019. Effect of 12-week functional training intervention on the speed of young footballers. *International Journal of Environmental Research and Public Health* 17:160. DOI: 10.3390/ijerph17010160.

Bayati R, Shamsi Majelan A, Mirzaei B, Barbas I. 2019. The effect of 12 weeks of wrestling+ warm-up program on functional movement screen scores in cadet wrestlers. *Annals of Applied Sport Science* 7: 39-47. DOI: 10.29252/aassjournal.7.1.39

Bodden JG, Needham RA, Chockalingam N. 2015. The effect of an intervention program on functional movement screen test scores in mixed martial arts athletes. *The Journal of Strength & Conditioning Research* 29:219-225. DOI: 10.1519/JSC.0b013e3182a480bf

Bonazza NA, Smuin D, Onks CA, Silvis ML, Dhawan A. 2017. Reliability, validity, and injury predictive value of the functional movement screen: a systematic review and meta-analysis.

The American Journal of Sports Medicine 45:725-732. DOI: 10.1177/0363546516641937

Boucher BK, Rich AJ, Gobert D, Gardner B, Metzner P, King C, Buse M. 2018. The effectiveness of a functional movement assessment and 4-week exercise training program for female high school athletes. *Journal of Strength and Conditioning Research*. DOI: 10.1519/JSC.0000000000002549

Basar MJ. 2017. The influence of corrective exercises on functional movement screen and physical fitness performance in Army ROTC Cadets. *Theses and Dissertations*. 652. https://ir.library.illinoisstate.edu/etd/652

Campa F, Spiga F, Toselli S. 2019. The effect of a 20-week corrective exercise program on functional movement patterns in youth elite male soccer players. *Journal of Sport Rehabilitation* 28:746-751. DOI: 10.1123/jsr.2018-0039

Chao WC, Shih JC, Chen KC, Wu CL, Wu NY, Lo CS. 2018. The effect of functional movement training after anterior cruciate ligament reconstruction: a randomized controlled trial. *Journal of Sports Rehabilitation* 27:541-545. DOI: 10.1123/jsr.2017-0022.

Cook G, Burton L, Hoogenboom B. 2006a. Pre-participation screening: the use of fundamental movements as an assessment of function - part 1. *North American Journal of Sports Physical Therapy* 1:62-72.

Cook G, Burton L, Hoogenboom B. 2006b. Pre-participation screening: the use of fundamental movements as an assessment of function - part 2. *North American Journal of Sports Physical Therapy,* 1:132-139.

Cook G, Burton L, Hoogenboom BJ, Voight M. 2014. Functional movement screening: the use of fundamental movements as an assessment of function-part 1. *International Journal of Sports Physical Therapy* 9:396-409

Cook G, Burton L, Hoogenboom BJ, Voight M. 2014. Functional movement screening: the use of fundamental movements as an assessment of function-part 2. *International Journal of Sports Physical Therapy* 9:549-563.

Cook G. Movement: Functional Movement Systems. Screening—Assessment—Corrective Strategies. Bucuresti, Romania: Lotus Publishing; 2011

Chapman RF, Laymon AS, Arnold T. 2014. Functional movement scores and longitudinal performance outcomes in elite track and field athletes. *International Journal of Sports Physiology Performance* 9:203-211. DOI: 10.1123/ijspp.2012-0329

DerSimonian R, Kacker R. 2007. Random-effects model for meta-analysis of clinical trials: an update. *Contemporary Clinical Trials* 28:105-114. DOI: 10.1016/j.cct.2006.04.004

Dinc E, Kilinc BE, Bulat M, Erten YT, Bayraktar B. 2017. Effects of special exercise programs on functional movement screen scores and injury prevention in preprofessional young football players. *Journal of Exercise Rehabilitation* 13:535-540. DOI: 10.12965/jer.1735068.534

Dorrel BS, Long T, Shaffer S, Myer GD. 2015. Evaluation of the functional movement screen as an injury prediction tool among active adult populations: a systematic review and meta-analysis. *Sports Health* 7:532-537. DOI: 10.1177/1941738115607445

Fauntroy V, Fyock M, Hansen-Honeycutt J, Nolton E, Ambegaonkar JP. 2019. Using the selective functional movement assessment for the evaluation of dancers' functional limitations and dysfunctions: a critically appraised topic. *Journal of Sports Rehabilitation* 1-6. DOI: 10.1123/jsr.2018-0054

Frost DM, Beach TAC, Callaghan JP, McGill SM. 2012. Using the functional movement screen to evaluate the effectiveness of training. *Journal of Strength and Conditioning Research* 26:1620e1630. DOI: 10.1519/JSC.0b013e318234ec59

Frost DM, Beach TAC, Callaghan JP, McGill SM. 2015a. Exercise-based performance enhancement and injury prevention for firefighters: Contrasting the fitness- and movement-related adaptations to two training methodologies. *Journal of Strength and Conditioning Research* 29:2441e2459. DOI: 10.1519/JSC.0000000000000923

Frost DM, Beach TAC, Callaghan JP, McGill SM. 2015b. FMSTM scores change with performers' knowledge of the grading criteria- are whole-body movement screens capturing "dysfunction"? *Journal of Strength and Conditioning Research* 29:3037-3044. DOI: 10.1097/JSC.0000000000000211.

Frost DM, Beach TAC, Campbell TL, Callaghan JP, McGill SM. 2015c. An appraisal of the Functional Movement Screen grading criteria -Is the composite score sensitive to risky movement behavior? *Physical Therapy in Sport* 16:324-330. DOI: 0.1016/j.ptsp.2015.02.001.

Frost DM, Beach TA, McGill SM, Callaghan JP. 2015d. A proposed method to detect kinematic differences between and within individuals. *Journal of Electromyography and Kinesiology* 25:479-487. DOI: 10.1016/j.jelekin.2015.02.012

Frost DM, Beach TAC, McGill SM, Callaghan JP. 2015e. The predictive value of general movement tasks in assessing occupational task performance. *Work* 52:11-18. doi:

10.3233/WOR-141902

Frost DM, Beach TA, Campbell TL, Callaghan JP, McGill SM. 2017. Can the Functional Movement Screen™ be used to capture changes in spine and knee motion control following 12 weeks of training? *Physical Therapy in Sports* 23:50-57. DOI: 10.1016/j.ptsp.2016.06.003

Garbenytė-Apolinskienė T, Šiupšinskas L, Salatkaitė S, Gudas R, Radvila R. 2018. The effect of integrated training program on functional movements patterns, dynamic stability, biomechanics, and muscle strength of lower limbs in elite young basketball players. *Sport Sciences for Health* 14:245-250. DOI: 10.1007/s11332-017-0409-y

Guyatt GH, Oxman AD, Kunz R, Brozek J, Alonso-Coello P, Rind D, Devereaux PJ, Montori VM, Freyschuss B, Vist G, Jaeschke R, Williams Jr JW, Murad MH, Sinclair D, Falck-Ytter Y, Meerpohl J, Whittington C, Thorlund K, Andrews J, Schünemann HJ. 2011a. GRADE guidelines 6. Rating the quality of evidence--imprecision. *Journal of Clinical Epidemiology* 64:1283–1293. https://doi.org/10.1016/j.jclinepi.2011.01.012

Guyatt GH, Oxman AD, Kunz R, Woodcock J, Brozek J, Helfand M, Alonso-Coello P, Glasziou P, Jaeschke R, Akl EA, Norris S, Vist G, Dahm P, Shukla VK, Higgins J, Falck-Ytter Y, Schünemann HJ; GRADE Working Group. 2011b. GRADE guidelines: 7. Rating the quality of evidence--inconsistency. *Journal of Clinical Epidemiology* 64:1294-1302. https://doi.org/10.1016/j.jclinepi.2011.03.017

Guyatt GH, Oxman AD, Kunz R, Woodcock J, Brozek J, Helfand M, Alonso-Coello P, Falck-Ytter Y, Jaeschke R, Vist G, Akl EA, Post PN, Norris S, Meerpohl J, Shukla VK, Nasser M, Schünemann HJ, GRADE Working Group. (2011c). GRADE guidelines: 8. Rating the quality of evidence--indirectness. *Journal of Clinical Epidemiology* 64:1303-1310. DOI: 10.1016/j.jclinepi.2011.04.014

Guyatt GH, Oxman AD, Montori V, Vist G, Kunz R, Brozek J, Alonso-Coello P, Djulbegovic B, Atkins D, Falck-Ytter Y, Williams JW Jr, Meerpohl J, Norris SL, Akl EA, Schünemann HJ. 2011d. GRADE guidelines: 5. Rating the quality of evidence--publication bias. *Journal of Clinical Epidemiology* 64:1277–1282. DOI: 10.1016/j.jclinepi.2011.01.011

GRADEpro GDT. Online computer program. *Available at https://gradepro.org/.2020.8.30.*

Higgins JP, Green S. 2011. *Cochrane Handbook for Systematic Reviews of Interventions*, version 5.1.0. 2011 [updated March 2011]. The Cochrane Collaboration. *Available at https:/handbook.cochrane.org.*

Higgins JP, Thompson SG. 2002. Quantifying heterogeneity in a meta-analysis. *Statistics in Medicine* 21:1539-1558. DOI: 10.1002/sim.1186

Huebner BJ, Plisky PJ, Kiesel KB, Schwartzkopf-Phifer K. 2019. Can injury risk category be changed in athletes? An analysis of an injury prevention system. *International Journal of Sports Physical Therapy* 14:127.

Hui L, Baoai W. 2019. Functional movement screen and rehabilitation training of basketb all player. *Sport Science Research* 40:81-85.

Jafari M, Zolaktaf V, Ghasemi G. 2019. Functional movement screen composite scores in firefighters: effects of corrective exercise training. *Journal of Sports Rehabilitation* 1-5. DOI: 10.1123/jsr.2018-0080

Kangkang Z, Zhuhang H. 2016. The application research of the top level table tennis athlete in the functional movement screen test. D. Phil. Thesis, Beijing Sport University.

Kiesel K, Plisky PJ, Voight ML. 2007. Can serious injury in professional football be predicted by a preseason functional movement screen? *North American Journal of Sports Physical Therapy* 2:147-158.

Kiesel K, Plisky P, Butler R. 2011. Functional movement test scores improve following a standardized off-season intervention program in professional football players. *Scandinavian Journal of Medicine & Science in Sports* 21:287-292. DOI: 10.1111/j.1600-0838.2009.01038.x

Kiesel KB, Butler RJ, Plisky PJ. 2014. Prediction of injury by limited and asymmetrical fundamental movement patterns in American football players. *Journal of Sports Rehabilitation* 23:88-94. DOI: 10.1123/jsr.2012-0130

Kim H, Lee Y, Shin I, Kim K, Moon J. 2014. Effects of 8 weeks' specific physical training on the rotator cuff muscle strength and technique of javelin throwers. *Journal of Physical Therapy Science* 26:1553-1556. DOI: 10.1589/jpts.26.1553

Klusemann MJ, Pyne DB, Fay TS, Drinkwater EJ. 2012. Online video-based resistance training improves the physical capacity of junior basketball athletes. *The Journal of Strength & Conditioning Research* 26:2677-2684. DOI: 10.1519/JSC.0b013e318241b021

Kovac D. 2018. The effect of a six-week functional movement intervention on dynamic knee stability and physical performance in female netball players. Diss. Stellenbosch: Stellenbosch University.

Kraus K, Schütz E, Taylor WR, Doyscher R. 2014. Efficacy of the functional movement screen: a review. *Journal of Strength & Conditioning Research* 28:3571-3584. DOI: 10.1519/JSC.0000000000000556

Jin-Wook Lee , Seok-Am Zhang1, Jang-Kyu Lee. 2015. Effects of combined training on the FMS score in woman rugby national players. *Journal of the Korean Society of Industry-Academia Technology* 11:7439-7446. DOI: 10.5762/KAIS.2015.16.11.7439

Moher D, Liberati A, Tetzlaff J, Altman D. 2009. Preferred reporting items for systematic reviews and Meta-analyses: the PRISMA statement. *PLoS Medicine* 6:e1000097. DOI: 10.1371/journal.pmed.1000097

Moore E, Chalmers S, Milanese S, Fuller JT. 2019. Factors influencing the relationship between the functional movement screen and injury risk in sporting populations: a systematic review and meta-analysis. *Sports Medicine* 49:1449-1463. DOI: 10.1007/s40279-019-01126-5

Moran RW, Schneiders AG, Mason J, Sullivan SJ. 2017. Do Functional Movement Screen (FMS™™) composite scores predict subsequent injury? A systematic review with meta-analysis. *British Journal of Sports Medicine* 51:1661-1669. DOI: 10.1136/bjsports-2016-096938

Minthorn LM, Fayson SD, Stobierski LM, Welch CE, Anderson BE. 2015. The Functional Movement Screen's ability to detect changes in movement patterns after a training intervention. *Journal of Sports Rehabilitation* 24:322-326. doi:10.1123/jsr.2013-0146

PEDro. *Available at: https://www.pedro.org.au/english/downloads/pedro-scale/*

Riela LA, Bertollo M. 2019. The effectiveness of eight weeks of a movement-based program on functional movement patterns in male professional soccer players. *Journal of Physical*

Education and Sport 19:1976-1983. DOI:10.7752/jpes.2019.s5294

Rippetoe M, Kilgore L, Bradford SE. 2013. *Practical Programming for Strength Training*, 3rd edition. Wichita Falls, TX: Aasgaard Company.

Review Manager. 2020. RevMan computer program, version 5.4. The Cochrane Collaboration. *Available at: https://www.cochrane.org/zh-hans/join-cochrane.*

Schneider J, Wiegand Y, Braumann KM, Wollesen B. 2019. Functional and motor deficits in youth soccer athletes–an explorative, quasi-experimental study. *Deutsche Zeitschrift für Sportmedizin* 70:14-20.

Song HS, Woo SS, So WY, Kim KJ, Lee J, Kim JY. 2014. Effects of 16-week functional movement screen training program on strength and flexibility of elite high school baseball players. *Journal of Exercise Rehabilitation* 10:124-130. DOI: 10.12965/jer.140101

Sorenson EA. 2009. Functional movement screen as a predictor of injury in high school basketball athletes. D. Phil. Thesis, University of Oregon.

Santos Bunn P, Rodrigues AI, da Silva EB. 2019. The association between the functional movement screen outcome and the incidence of musculoskeletal injuries: a systematic review with meta-analysis. *Physical Therapy in Sport* 35:146-158. 10.1016/j.ptsp.2018.11.011

Sterne JA, Egger M, Smith GD. 2001. Investigating and dealing with publication and other biases in meta-analysis. *BMJ* 323:101-105. DOI: 10.1136/bmj.323.7304.101

Tejani AS, Middleton EF, Huang M, Dimeff RJ. 2019. Implementing a standardized interventional exercise regimen to improve functional movements in female collegiate athletes. *International Journal of Sports Physical Therapy* 14:117.

Trinidad-Fernandez M, Gonzalez-Sanchez M, Cuesta-Vargas AI. 2019. Is a low Functional Movement Screen score (≤14/21) associated with injuries in sport? A systematic review and meta-analysis. *BMJ Open Sport & Exercise Medicine* 5:e000501. DOI: 10.1136/bmjsem-2018-000501

Tejani AS, Middleton EF, Huang M, Dimeff RJ. 2019. Implementing a standardized interventional exercise regimen to improve functional movements in female collegiate athletes. *International Journal of Sports Physical Therapy* 14:117-126.

Xuhua Z, Ye T. 2015. The Experimental Study of Intervention on the Prevention and Treatment of Sports Injury and Improvement of Athletic Performance by Functional Movement Screen (FMS™) and Rehabilitation Training Volleyball Players. D. Phil. Thesis, Shanghai Institute of Physical Education.

Yildiz S, Pinar S, Gelen, E. 2019. Effects of 8-week functional vs. traditional training on athletic performance and functional movement on prepubertal tennis players. *The Journal of Strength & Conditioning Research* 33:651-661. DOI: 10.1519/JSC.0000000000002956

Figure 1

Flow diagram of the study selection process

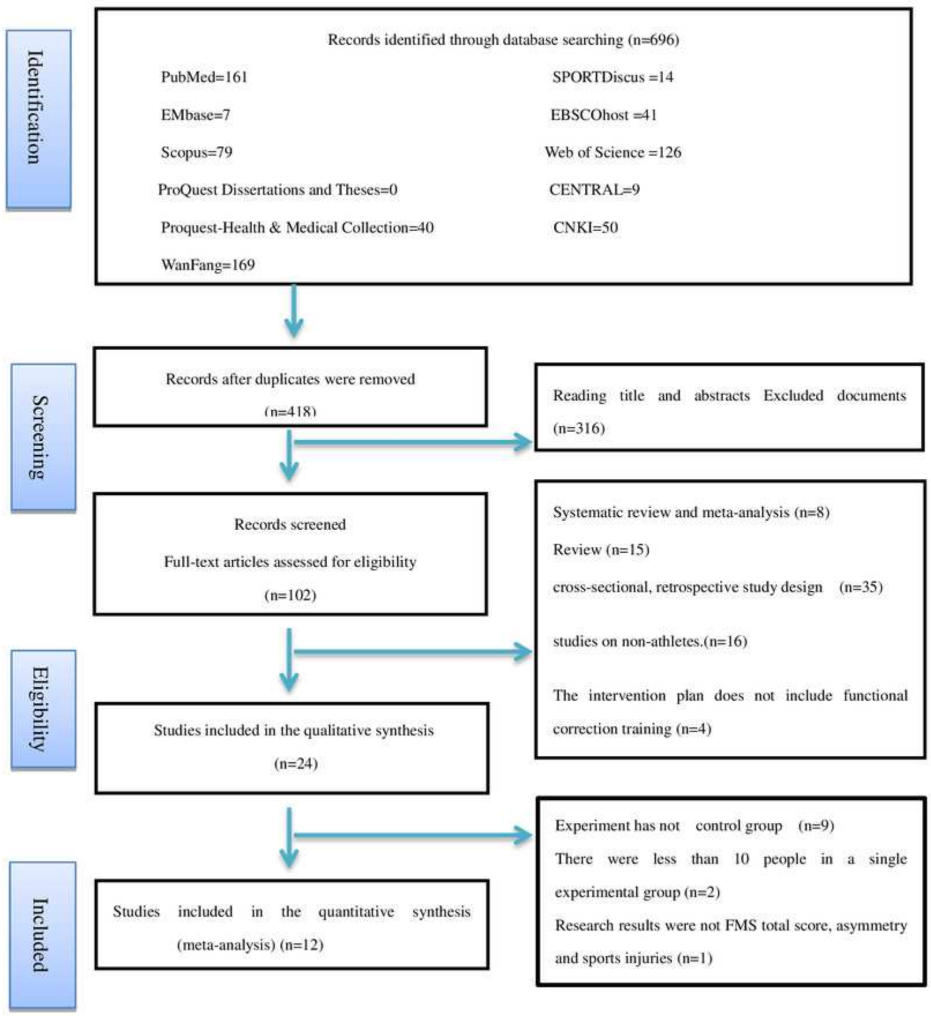
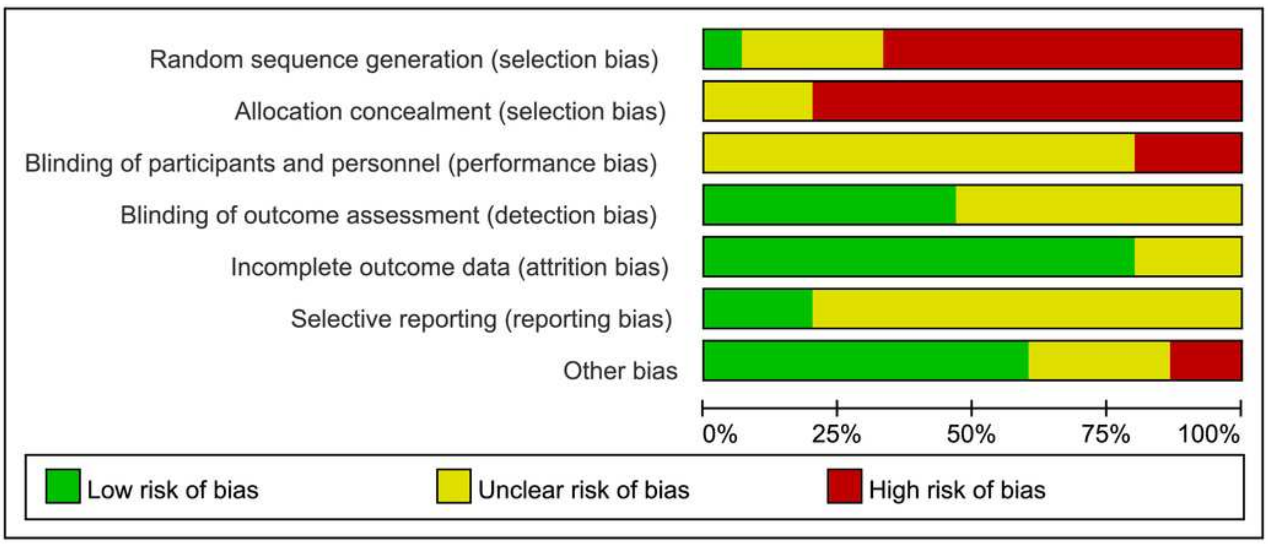

Identification
Records identified through database searching (n=696)
PubMed=161
SPORTDiscus =14
EMbase=7
EBSCOhost =41
Scopus=79
Web of Science =126
ProQuest Dissertations and Theses=0
CENTRAL=9
Proquest-Health & Medical Collection=40
CNKI=50
WanFang=169
Screening
Records after duplicates were removed (n=418)
Reading title and abstracts Excluded documents (n=316)
Records screened
Full-text articles assessed for eligibility (n=102)
Systematic review and meta-analysis (n=8)
Review (n=15)
cross-sectional, retrospective study design (n=35)
studies on non-athletes.(n=16)
The intervention plan does not include functional correction training (n=4)
Eligibility
Studies included in the qualitative synthesis (n=24)
Experiment has not control group (n=9)
There were less than 10 people in a single experimental group (n=2)
Research results were not FMS total score, asymmetry and sports injuries (n=1)
Included
Studies included in the quantitative synthesis (meta-analysis) (n=12)

Figure 2

Assessment of bias risk for included studies (Risk of bias graph)



Random sequence generation (selection bias)
Allocation concealment (selection bias)
Blinding of participants and personnel (performance bias)
Blinding of outcome assessment (detection bias)
Incomplete outcome data (attrition bias)
Selective reporting (reporting bias)
Other bias
0%
25%
50%
75%
100%
Low risk of bias
Unclear risk of bias
High risk of bias

Figure 3

Assessment of bias risk for included studies (Risk of bias summary)

(A)Each study was graded for the following domains: random sequence generation, allocation concealment, blinding of participants and personnel, blinding of outcome assessment, incomplete outcome data, selective reporting, and other bias.

(B) Domains were rated as low if the risk of bias for this item was low or as high if the risk of bias for this item was high.

(C)In the case of insufficient reported information or information that made an interpretation questionable and thus unclear, the risk of bias for this item was rated as unclear.

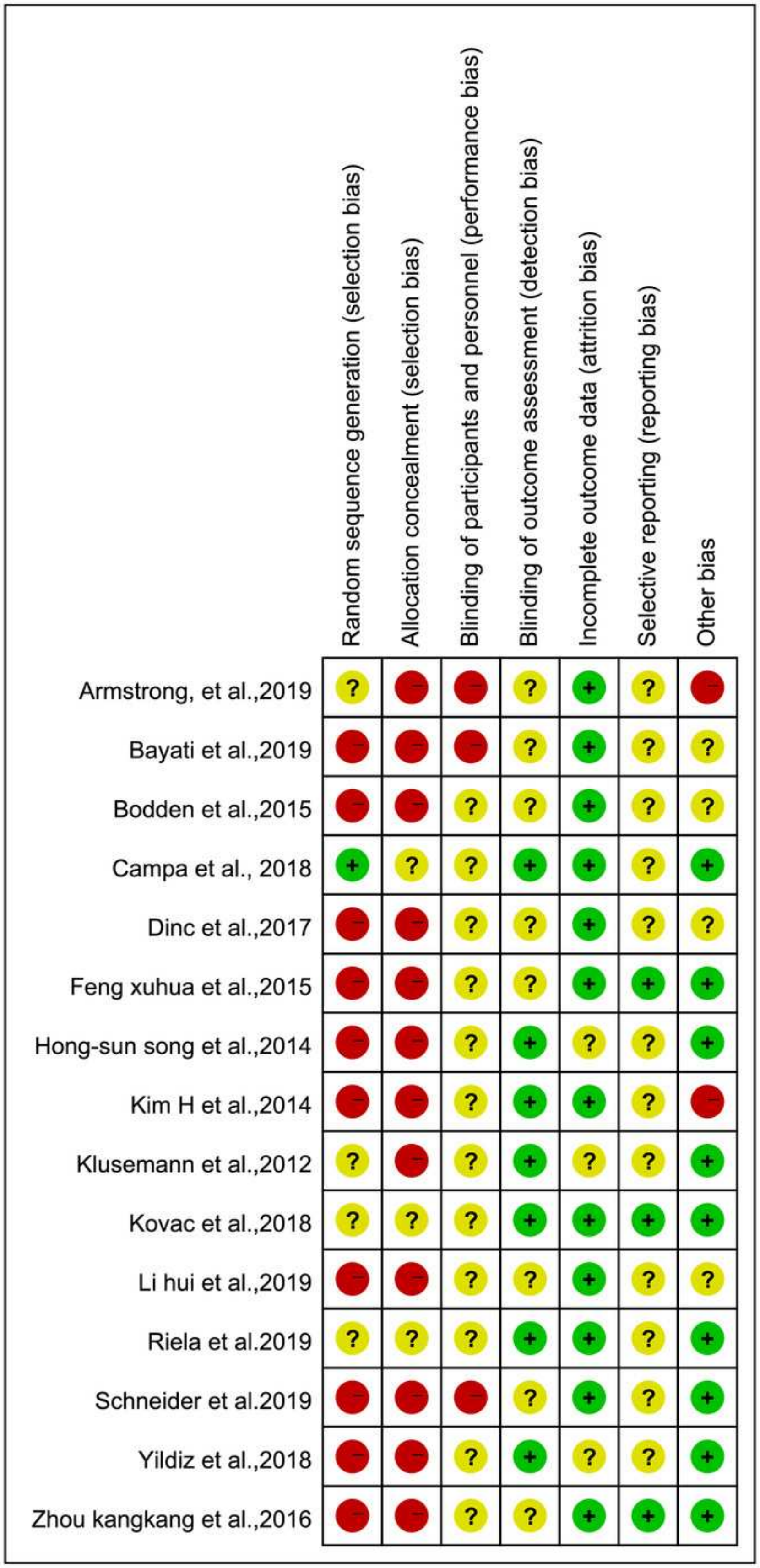

Random sequence generation (selection bias)
Allocation concealment (selection bias)
Blinding of participants and personnel (performance bias)
Blinding of outcome assessment (detection bias)
Incomplete outcome data (attrition bias)
Selective reporting (reporting bias)
Other bias
Armstrong, et al.,2019
Bayati et al.,2019
Bodden et al.,2015
Campa et al., 2018
Dinc et al.,2017
Feng xuhua et al.,2015
Hong-sun song et al.,2014
Kim H et al.,2014
Klusemann et al.,2012
Kovac et al.,2018
Li hui et al.,2019
Riela et al.2019
Schneider et al.2019
Yildiz et al.,2018
Zhou kangkang et al.,2016

Figure 4

Forest plot of the sports injury of athletes

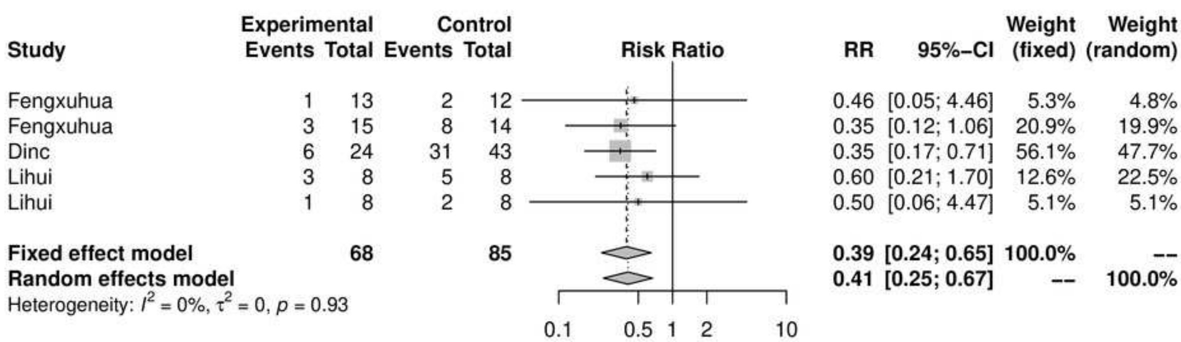


Figure 5

Forest plot of the effect size of the athletes' total FMS™ score

40
12.11.2020
Jakub Baron

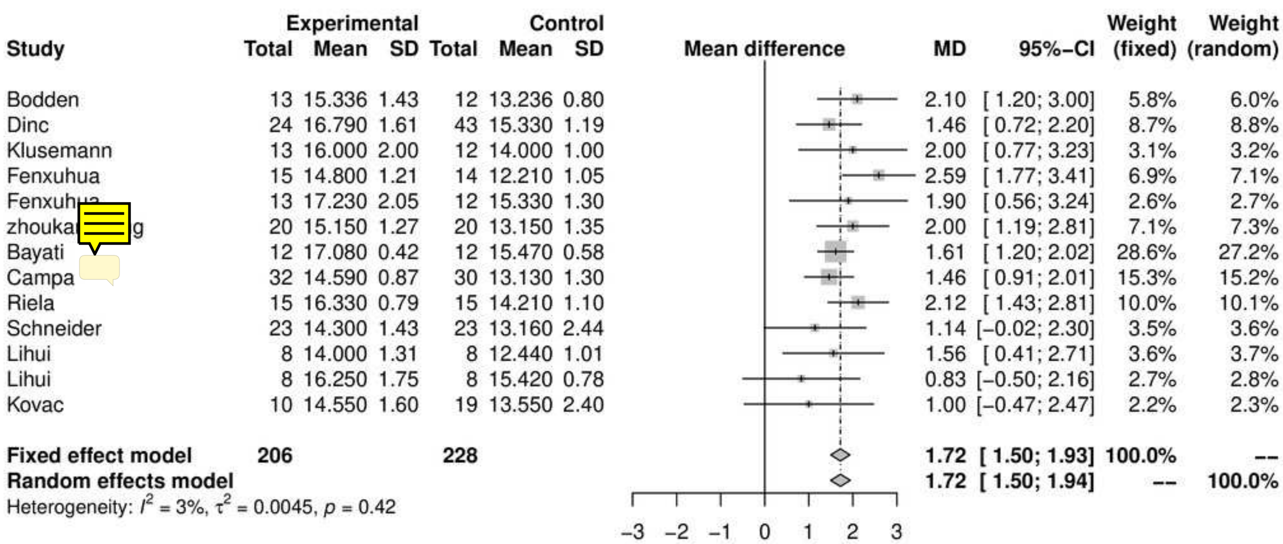


Figure 6

Forest plot of the athletes’ asymmetry functional patterns

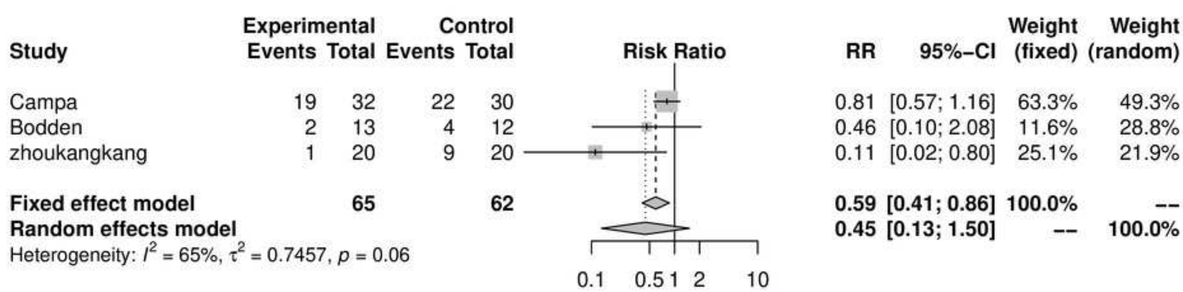


Table 1(on next page)

Search history.

1 **Table S1 search strategy**

PubMed	**up to September 2020**
Search: (((((functional movement screen) OR (fms*)) OR (functional movement screen*)) AND (((((injury*) OR (injury prediction)) OR (injury risk)) OR (injury prevention screening)) OR (Athletic injuries[MeSH]))) AND ((functional training) OR (corrective exercise training) OR(functional correction training))) AND ((sport*) OR (athlet*)OR(player)) Filters: Free full text, Full text, from 1997 – 2020	
Scopus	**up to September 2020**
TITLE-ABS-KEY ("functional movement screen") OR ("fms* ") OR ("functional movement screen* ") AND ("injury*") OR ("injury prediction") OR ("injury risk") OR ("injury prevention screening") OR ("Athletic injuries exp") AND ("functional training") OR ("corrective exercise training") OR(“functional correction training”) AND ("sport*") OR ("athlet*") OR (“player”)	
EMbase	**up to September 2020**
1 "functional movement screen" or "fms* af" or "functional movement screen* ".af. 2 "injury*" or "injury prediction" or "injury risk" or "injury prevention screening" or "Athletic inj uries exp".af. 3 "functional training" or "corrective exercise training" or "functional correction training".af. 4 "sport*" or "athlet*" or "player".af. 5 "functional movement screen" or "fms* af" or "functional movement screen* af "and "injury*" or "injury prediction" or "injury risk" or "injury prevention screening" or "Athletic injuries exp" and "functional training" or "corrective exercise training" or "functional correction training" and "sport*" or "athlet*" or "player". af.	
Web-sicence	**up to September 2020**
# 5 #4 AND #3 AND #2 AND #1 # 4 TS=(sport*) OR TS= (athlet*) OR TS=(player) # 3 TS=(functional training) OR TS= (corrective exercise training) OR TS=(functional correction training)	

2 TS=(injury*) OR TS= (injury prediction) OR TS=(injury risk) OR TS= (injury prevention screening) OR TS= (Athletic injuries[MeSH]) # 1 TS=(functional movement screen) OR TS= (fms*) OR TS= (functional movement screen*)
EBSOhost up to September 2020
S1 ((functional movement screen) OR (fms*)) OR (functional movement screen*) S2 ((((injury*) OR (injury prediction)) OR (injury risk)) OR (injury prevention screening)) OR (Athletic injuries[MeSH]) S3 (functional training) OR (corrective exercise training) OR (functional corrective training) S4 (sport*) OR (athlet*) OR (player) S5(((((functional movement screen) OR (fms*)) OR (functional movement screen*)) AND (((((injury*) OR (injury prediction)) OR (injury risk)) OR (injury prevention screening)) OR (Athletic injuries[MeSH]))) AND (((functional training) OR (corrective exercise training) OR (functional correction training)))) AND (((sport*) OR (athlet*) OR (player))
CENTRAL up to September 2020 **ProQuest-** Dissertations & Theses **Proquest-Health & Medical Collection**
1 "functional movement screen" OR "fms*"OR "functional movement screen" 2 "injury*" OR "injury prediction" OR "injury risk" OR "injury prevention screening" OR "Athletic injuries[MeSH]" 3 "functional training" OR "corrective exercise training" OR "functional corrective training" 4 "sport*" OR "athlet*" OR "player" 5 "functional movement screen"OR"fms* " OR"functional movement screen* "AND"injury*" OR"injury prediction" OR "injury risk" OR "injury prevention screening" OR "Athletic injuries[MeSH] " AND "functional training" OR "corrective exercise training" OR "functional correction training" AND "sport*" OR"athlet*" OR "player"
SPORTDiscus **up to September 2020**
S1 ((functional movement screen) OR (fms*)) OR (functional movement screen*)

S2 ((((injury*) OR (injury prediction)) OR (injury risk)) OR (injury prevention screening)) OR (Athletic injuries[MeSH]) S3 (functional training) OR (corrective exercise training) OR (functional corrective training) S4 (sport*) OR (athlet*) OR (player) S5(((((functional movement screen) OR (fms*)) OR (functional movement screen*)) AND (((((injury*) OR (injury prediction)) OR (injury risk)) OR (injury prevention screening)) OR (Athletic injuries[MeSH]))) AND (((functional training) OR (corrective exercise training) OR (functional correction training)))) AND (((sport*) OR (athlet*) OR (player)	
CNKI	**up to September 2020**
	FMS, functional training, athletes
WANFANG	**up to September 2020** FMS, functional training, athletes

2

Table 2(on next page)

Base line characteristics of included studies

(A) EG = experimental group, CG = next step. (B) Amstrong's research results only provide histograms and lack data.

1

41
12.11.2020
Jakub Baron

References	sports	n ,gender	Age mean (SD)	Experimental group Intervention	Dose	n ,gender	Age mean (SD)	control group Intervention	Dose	Outcomes Measurement item Results between groups
Bodden et al.,2015 United Kingdom	martial arts	12,males	24.31±4.46	corrective exercise program Certified coach implementation	frequency/s,? 4times /w 8weeks	12,males	24.13 ±4.46	routine training	8weeks	FMS™ scores :EG 15.34±1.43 CG 13.24±0.8 Asymmetry Number of patients Total number EG 2 13 CG 4 12
Klusemann et al.,2012 Australia;	basketball	13, Males and females	14.6±1 15±1	Strength, stability and jumping (including functional training) of upper and lower limbs with bare hands or instruments Coach supervision	frequency/s,60 min 2times /w 6weeks	13, Males and females	14.6±1 15±1	Daily training without resistance	6weeks	FMS™ scores :EG 16±2 CG 14±1 20-m sprint :EG 3.56±0.21 CG 3.50±0.22 Vertical jump : EG 46±6 CG 44±9
Campa et al., 2018 Italy	soccer	32, males	15.93±0.4	corrective exercise program Professional trainer guidance	2times /w 20weeks	30, males	15．81±0.63	routine training	20 weeks	FMS™ scores :EG 14.59±0.87 CG 13.13±1.3 Asymmetry Number of patients Total number EG 19 32 CG 22 30
Yildiz et al.,2018 Turkey	tennis	10 males	9.6±0.7	Functional training (for problems such as muscle imbalance) Coach supervision	3times /w 8weeks	10,males	9.6±0.7	routine training	8weeks	FMS™ scores : EG 19.3±0.8 CG 10.3±1.6 10-m acceleration: EG 4.44±0.20 CG 3.64±0.3 Counte movement jump: EG 28.9±1.90 CG 22.4±3.6
Riela et al.2019 Italy	soccer	15,males	23.8±4.6	Warm up (functional correction training) Professional trainer guidance	3times /w 8weeks	15,males	24.78±4.6	Regular warm up	8weeks	FMS™ scores EG 16.33±0.79 CG 14.21±1.1
Bayati et al.,2019 Guilan	Wrestling	12 ?	16.16±0.7	Wrestling+" injury prevention program Coach supervision	3times /w 12weeks	12 ?	16.41±0.79	Regular warm up	12weeks	FMS™ scores ： EG 17.08±0.42 CG 15.47±0.58

References	**sports**	**n ,gender**	**Age mean (SD)**	**Experimental group Intervention**	**Dose**	**n ,gender**	**Age mean (SD)**	**control group Intervention**	**Dose**	**Outcomes Measurement item Results between groups**
Dinc et al.,2017 Turkey	Soccer	24,males	16.13±0.38	corrective exercise program	2times /w 12weeks	43 , males	16.42±0.24	routine training	12weeks	FMS™ scores : EG 16.79±1.61 CG 15.33±1.19 Sports injury (injury stop > 3 weeks) Number of patients Total number EG 6 24 CG 31 43
Hong-sun song et al.,2014 Korea	baseball	31,males	17±1.06	FMS training program	3times /w 16weeks	31,males	16.62±0.94	routine training	16weeks	Strength (Back Muscle Strength) : EG 144.93±20.67 CG 137.74±20.5 Strength squat（1RM）: EG 161.08±35.06 CG 129.68±26.82
Schneider et al.2019 Germany	soccer	23,males	11.87±0.87	individualized multimodal training intervention on warm up Coach supervision	2times /w 12weeks	22,males	10.84±1.18	regular soccer practice	12weeks	FMS™ scores : EG 14.30±143 CG 13.16±2.44
Zhou kangkang et al.,2016 China	Table Tennis	20, Males and females	?	Pre class function plan × 4 + personalized correction training × 1 (supervised by author and fitness coach)	5times /w 6weeks	20, Males and females	?	routine training	6weeks	FMS™ scores : EG 15.15±1.27 CG 13.15±1.35 Asymmetry Number of patients Total number EG 1 20 CG 9 20
Li hui et al.,2019 China	Basketball	High-risk 8,males Low risk 8,males	21.75±1.28 21.50±0.76	Dynamic stretching and personalized correction training	6times /w 8weeks	High-risk 8,males Low risk 8,males	21.78±1.48 21.71±1.49	routine training	8weeks	FMS™ scores（ High-risk group）: EG 14.00±1.31 CG 12.44±1.01 （ Low risk group）:EG 16.25±1.75 CG 15.42±0.78 High-risk Number of patients Total number EG 3 8 CG 5 8 Low-risk

										EG 1 8 CG 2 8
Kovac et al.,2018 South Africa	Netball	10,females	20±1.5	corrective exercise program instructed and supervised by the researcher.	3times/ 6weeks	19,females	19.8±1.5	routine training	6weeks	FMS™ scores : EG 14.55±1.6 CG 13.55±2.4 Drop vertical jump: EG 2.155±0.95 CG 1.9±0.86
References	**sports**	**n ,gender**	**Age mean (SD)**	**Experimental group Intervention**	**Dose**	**n ,gender**	**Age mean (SD)**	**control group Intervention**	**Dose**	**Outcomes Measurement item Results between groups**
Armstrong, al.,2019 USA	basket ball	6,males	20.04±1.4	corrective exercise program	4times /w 4weeks	7,males	20.04±1.4	pre-practice dynamic warm-up	4times/w 4weeks	
Feng xuhua et al.,2015 China	Volley ball	High-risk 15,females Low risk 13,females	20.92±3.26 21.47±3.16	Rehabilitation physical training (correction training)	6times / 6weeks	High-risk 14,females Low risk 12,females	21.56±3.58 21.20±3.32	routine training	6weeks	FMS™ scores（ High-risk group ） EG 14.80±1.21 CG 12.21±1.05 （ Low risk group ）: EG 17.23±2.05 CG 15.33±1.30 High-risk Number of patients Total number EG 3 15 CG 8 14 Low-risk EG 1 13 CG 2 12 squat（ High-risk ）:EG 115±12.11 CG 112±18.78 （low-risk） :EG 118±6.15 CG 115±18.7
Kim H et al.,2014 Korea	Javelin	4,males 2,females	males 22±1.15 females 22±1.41	Weight , Javelin specific, core,FMS training Performed by researchers	?/8weeks	2,males 2,females	males 26±4.24 females 26.5±1.41	routine training	8weeks	Difference CG-EG FMS score (points) ： CG 0.30 ±1.07 EG-1.03±1.37 throwing performances：CG 9.6±1.10 EG5.8±2.64

Table 3(on next page)

Results of quality assessment of included studies using the PEDro quality scales

The purpose of the PEDro scale is to help the users of the PEDro database rapidly identify which of the known or suspected randomised clinical trials (ie RCTs or CCTs) archived on the PEDro database are likely to be internally valid (criteria 2-9), and could have sufficient statistical information to make their results interpretable (criteria 10-11). An additional criterion (criterion 1) that relates to the external validity (or “generalisability” or “applicability” of the trial) has been retained so that the Delphi list is complete, but this criterion will not be used to calculate the PEDro score reported on the PEDro web site.

Author	1	2	3	4	5	6	7	8	9	10	11	scale	PEDro Scoring item
Dinc	Y	N	N	Y	N	N	N	Y	Y	Y	Y	5	1. eligibility criteria were specified
Bodden	Y	N	N	Y	N	N	?	Y	Y	Y	Y	5	2. subjects were randomly allocated to groups
Campa	Y	Y	N	Y	N	N	Y	Y	Y	Y	Y	7	3. allocation was concealed
Kovac	Y	Y	N	Y	N	N	N	Y	Y	Y	Y	6	4. the groups were similar at baseline regarding the most important prognostic indicators
Riela	Y	Y	?	Y	N	N	Y	Y	Y	Y	Y	7	5. there was blinding of all subjects
Hong Sun	Y	N	N	Y	N	N	N	Y	Y	Y	Y	5	6. there was blinding of all therapists who administered the therapy
Schneider	Y	N	N	Y	N	N	?	Y	Y	Y	Y	5	7. there was blinding of all assessors who measured at least one key outcome
Feng xuhua	Y	N	N	Y	N	N	?	Y	Y	Y	Y	5	8. measures of at least one key outcome were obtained from more than 85% of the subjects initially allocated to groups
Zhou angkang	Y	N	N	Y	N	N	N	Y	Y	Y	Y	5	9. all subjects for whom outcome measures were available received the treatment or control condition as allocated or, where this was not the case, data for at least one key outcome was analyses by “intention to treat
Klusemann	Y	Y	N	Y	N	N	?	N	Y	Y	Y	5	10. the results of between-group statistical comparisons are reported for at least one key outcome
Bayati	Y	N	N	Y	N	N	?	Y	Y	Y	Y	5	11. the study provides both point measures and measures of variability for at least one key outcome
Yildiz	Y	N	?	Y	N	N	?	Y	Y	Y	Y	5	
Li hui	Y	N	N	Y	N	N	N	Y	Y	Y	Y	5	
Kim H	Y	N	N	?	N	N	N	Y	Y	Y	Y	4	
Armstrong	Y	Y	N	?	N	N	N	Y	Y	N	Y	4	

Table 4(on next page)

Summary of findings table

Effect of Functional Correction Training on Injury Risk of Athletes: A Systematic Review and Meta-analysis

Patient or population: athletes **Setting**: sports injury
Intervention: functional correction training **Comparison**: conventional training

Outcomes	Anticipated absolute effects* (95% CI)		Relative effect (95% CI)	№ of participants (studies)	Certainty of the evidence (GRADE)	Comments
	Risk with conventional training	**Risk with functional correction training**				
sports injury risk of athletes (injury risk) follow up: mean 6-12 weeks	**Study population**		**RR 0.3932** (0.2386 to 0.6482)	153 (5 observational studies)	⊕◯◯◯ VERY LOW [a,b,c,d]	The incidence of sports injuries in the experimental group was lower than that in the control group and injury risk in the experimental group decreased by 60%.
	565 per 1,000	**222 per 1,000** (135 to 366)				
	0 per 1,000	**0 per 1,000** (0 to 0)				
New outcome (model asymmetry of athletes) assessed with: Functional movement screen follow up: mean 6-20 weeks	**Study population**		**RR 0.4460** (0.1323 to 1.5033)	127 (3 observational studies)	⊕◯◯◯ VERY LOW [c,d,e,f]	
	565 per 1,000	**252 per 1,000** (75 to 849)				
	Moderate					
	0 per 1,000	**0 per 1,000** (0 to 0)				

43
12.11.2020
Jakub Baron

Effect of Functional Correction Training on Injury Risk of Athletes: A Systematic Review and Meta-analysis

Patient or population: athletes **Setting**: sports injury
Intervention: functional correction training **Comparison**: conventional training

Outcomes	Anticipated absolute effects* (95% CI)		Relative effect (95% CI)	№ of participants (studies)	Certainty of the evidence (GRADE)	Comments
	Risk with conventional training	**Risk with functional correction training**				
Total FMS score of athlete assessed with: FunctionalMovement Screen Scale from: 0 to 21 follow up: range 6 weeks to 20 weeks	The mean total FMS score of athlete was **13.89** MD	MD **1.7165 MD higher** (1.4999 higher to 1.9333 higher)	-	434 (13 observational studies)	⊕⊕⊕◯ MODERATE [g,h]	Functional corrective training based on FMS could improve athletes functional patterns

***The risk in the intervention group** (and its 95% confidence interval) is based on the assumed risk in the comparison group and the **relative effect** of the intervention (and its 95% CI).

CI: Confidence interval; **RR:** Risk ratio; **MD:** Mean difference

GRADE Working Group grades of evidence

High certainty: We are very confident that the true effect lies close to that of the estimate of the effect

Moderate certainty: We are moderately confident in the effect estimate: The true effect is likely to be close to the estimate of the effect, but there is a possibility that it is substantially different

Low certainty: Our confidence in the effect estimate is limited: The true effect may be substantially different from the estimate of the effect

Very low certainty: We have very little confidence in the effect estimate: The true effect is likely to be substantially different from the estimate of effect

Explanations

a. All included studies were not randomized

b. Researchers may have different definition of sports injury\ies

c. Sample size was small. According to the graph in the GRADE guidelines: 6. Rating the quality of evidence---imprecision, set RRR=30%,both injury risk ratio and asymmetry movement patterns of athletes that event rate of the control group was 0.56, at least 500-1000 samples were required.

d. because the sample sizes used to determine the sports injury risk and model asymmetry were fewer than 10, the publication bias test was not completed.

e. Only one study implemented randomization

f. The hazard ratio of the influence of functional correction training on the pattern of asymmetry of athletes had large heterogeneity (RR, 0.446; 95% CI, 0.1323-1.5033; z = -1.3; P = 0.1928; I2 = 65.2%)

g. 66% subjects were not randomly allocated to group.

h. The influence of functional correction training on the athletes' total FMS™ scores was 1.7165 (95% CI, 1.4999-1.9330; Z=15.53; P<0.0001; I^2 =2.6%), Confidence interval exceeds 1.

Table 5(on next page)

GRADE evidence profile

Author(s): Chen Junxia;Chen Sheng ;Zhang Chunhe;Zhao Yuhua

Question: Explore functional correction training after the use of Functional Movement Screen (FMS™) and the effects of training on the injuries of athletes.

Setting: sports injury **Bibliography**:

Certainty assessment							№ of patients		Effect		Certainty	Importance
№ of studies	Study design	Risk of bias	Inconsistency	Indirectness	Imprecision	Other considerations	functional correction training	conventional training	Relative (95% CI)	Absolute (95% CI)		
sports injury risk of athletes (follow up: mean 6-12 weeks)												
5	observational studies	serious [a,b]	not serious	not serious	serious [c]	publication bias strongly suspected strong association all plausible residual confounding would reduce the demonstrated effect [d]	14/68 (20.6%)	48/85 (56.5%) 0.0%	**RR 0.3932** (0.2386 to 0.6482)	**343 fewer per 1,000** (from 430 fewer to 199 fewer) **0 fewer per 1,000** (from 0 fewer to 0 fewer)	⨁◯◯◯ VERY LOW	CRITICAL
New outcome (follow up: mean 6-20 weeks; assessed with: Functional movement screen)												
3	observational studies	very serious [e]	serious [f]	not serious	serious [c]	publication bias strongly suspected all plausible residual	22/65 (33.8%)	35/62 (56.5%)	**RR 0.4460** (0.1323 to 1.5033)	**313 fewer per 1,000** (from 490 fewer to 284 more)	⨁◯◯◯ VERY LOW	CRITICAL

Certainty assessment							№ of patients		Effect		Certainty	Importance
№ of studies	Study design	Risk of bias	Inconsistency	Indirectness	Imprecision	Other considerations	functional correction training	conventional training	Relative (95% CI)	Absolute (95% CI)		
						confounding would reduce the demonstrated effect [d]		0.0%		**0 fewer per 1,000** (from 0 fewer to 0 fewer)		
Total FMS score of athlete (follow up: range 6 weeks to 20 weeks; assessed with: Functional Movement Screen; Scale from: 0 to 21)												
13	observational studies	serious [g]	not serious	not serious	serious [h]	very strong association all plausible residual confounding would reduce the demonstrated effect	206	228	-	MD **1.7165 MD higher** (1.4999 higher to 1.9333 higher)	⊕⊕⊕◯ MODERATE	IMPORTANT

CI: Confidence interval; **RR:** Risk ratio; **MD:** Mean difference

Explanations

a. All included studies were not randomized

b. Researchers may have different definition of sports injury\ies

c. Sample size was small. According to the graph in the GRADE guidelines: 6. Rating the quality of evidence---imprecision, set RRR=30%,both injury risk ratio and asymmetry movement patterns of athletes that event rate of the control group was 0.56, at least 500-1000 samples were required.

d. because the sample sizes used to determine the sports injury risk and model asymmetry were fewer than 10, the publication bias test was not completed

e. Only one study implemented randomization

f. The hazard ratio of the influence of functional correction training on the pattern of asymmetry of athletes had large heterogeneity (RR, 0.446; 95% CI, 0.1323-1.5033; z = -1.3; P = 0.1928; I2 = 65.2%)

g. 66% subjects were not randomly allocated to group.

h. The influence of functional correction training on the athletes' total FMS™ scores was 1.7165 (95% CI, 1.4999-1.9330; Z=15.53; P<0.0001; I^2 =2.6%), Confidence interval exceeds 1.

Effects of functional correction training on injury risk of athletes - a systematic review and meta-analysis Structure and Criteria

Custom, Criteria

01 Jakub Baron Page 4

9/11/2020 13:30

The editorial text should be corrected, ie the subtitle abstract should be added. Sub-headings should be left-left and start on a new line with no gaps between sub-headings

02 Jakub Baron Page 4

9/11/2020 13:28

03 Jakub Baron Page 4

9/11/2020 13:39

According to PeerJ publication standars. Instead of Methods,there should be used form "Methodology".

04 Jakub Baron Page 4

9/11/2020 13:39

05 Jakub Baron Page 5

9/11/2020 13:17

In my opinion and according to PeerJ publication standards, the format should be changed a bit so line 1-22 page should be removed.

06 Jakub Baron Page 5

9/11/2020 13:17

07 Jakub Baron Page 6

9/11/2020 13:25

There are so many introducing pages and titles, authors should decide to chose proper form.

08 Jakub Baron Page 6

9/11/2020 13:09

09 Jakub Baron Page 7

9/11/2020 13:25

I recomend authors to to consider linking the start page to this one (lines 41-65) or rearranging the page layout. Because it seems to be the same as the starting page.

10 Jakub Baron Page 7

9/11/2020 13:25

11 Jakub Baron Page 7

9/11/2020 13:35

12 Jakub Baron Page 7

9/11/2020 13:36

13 Jakub Baron Page 7

9/11/2020 13:36

14 Jakub Baron Page 9

9/11/2020 13:37

I think that full name used in abstract is enough. Short name here should be applied.

15 Jakub Baron Page 9

9/11/2020 13:36

16 Jakub Baron Page 9

9/11/2020 13:50

The sentence concerning injuries in sport, quoted in verse 92, for the understanding of the concept by international audiences should be developed and explained a little more

17 Jakub Baron Page 9

9/11/2020 13:49

18 Jakub Baron Page 10

9/11/2020 13:55

Highlited reference cannot be found in reference list.

19 Jakub Baron Page 10

9/11/2020 13:55

20 Jakub Baron Page 10

9/11/2020 14:00

The authors say that FMS could not be a good tool to assess injury risk. This sentence contradicts what the authors claim in the introduction, which refers to the positive use of FMS

21 Jakub Baron Page 10

9/11/2020 13:59

I think this sentence (lines 121-122) should be further explained.

22 Jakub Baron Page 10

9/11/2020 13:58

23 Jakub Baron Page 10

9/11/2020 13:59

In my opinion for better understanding of readers, before saying about scores, there should be explanation how to score in FMS or what <14 points mean.

24 Jakub Baron Page 11

9/11/2020 14:02

For ease of understanding by readers, the Selective Functional Movement Assessment name should be further explained.

25 Jakub Baron Page 11

9/11/2020 14:01

26 Jakub Baron Page 12

12/11/2020 13:22

27 Jakub Baron Page 12

9/11/2020 14:33

The authors claim that publications containing studies with non-athletes were omitted from the study. And yet they mention them earlier in the publication.I think this sentense should be modified or explained more.

28 Jakub Baron Page 12

9/11/2020 14:32

29 Jakub Baron Page 13

9/11/2020 14:47

I think, that those information should be highlighted at the beggining of the introduction, that people can understand what is FMS.

30 Jakub Baron Page 13

9/11/2020 14:46

31 Jakub Baron Page 17

9/11/2020 15:15

I cannot find this reference in your list. Please check the correctness of the citation.

32 Jakub Baron Page 17

9/11/2020 15:15

33 Jakub Baron Page 18

9/11/2020 15:16

This sentence should be explained further (line 274).

34 Jakub Baron Page 18

9/11/2020 15:16

35 Jakub Baron Page 18

9/11/2020 15:23

36 Jakub Baron Page 25

12/11/2020 12:40

Few journals written with small letter, some of them with big. It should be fixed.

37 Jakub Baron Page 25

12/11/2020 12:40

38 Jakub Baron Page 27

12/11/2020 12:37

I noticed diffrent font color.

39 Jakub Baron Page 27

12/11/2020 12:37

40 Jakub Baron Page 42

9/11/2020 16:07

I think that years should be included near the authors

41 Jakub Baron Page 49

9/11/2020 16:09

table need to be edited, unclear (same titles with no examples) and need more editorial changes

42 Jakub Baron Page 53

9/11/2020 16:09

Year should be included

43 Jakub Baron

9/11/2020 16:14

It would be great if there will be comment as well