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A Meta-Analysis of Meta-Analyses of the Effectiveness of FIFA Injury Prevention Programmes in Soccer

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ABSTRACT

FIFA has a Medical and Research Centre (F-MARC) which has designed a comprehensive programme targeting muscle strength, kinaesthetic awareness, and neuromuscular control during static and dynamic movements to decrease injury risk for soccer players. A number of meta-analyses now exist on how effective FIFA's programmes to prevent and reduce injury actually are, with various degrees of injury reduction reported. This research aimed to carry out a systematic review and to meta analyse the existing meta-analyses so that a conclusion can be drawn on how effective the injury programmes are. Relevant studies were identified by searching five databases for the period January 1990 till 1 July 2018. Results of each meta-analysis were combined together using risk ratios (RR) in a summary meta-analysis. QUOROM checklist and AMSTAR 2 assessment were used to assess the quality of reporting and methodology in the meta-analyses. Four meta-analyses met the inclusion criteria covering fifteen primary studies. All four meta-analyses scored quite highly on QUOROM, but two were rated by AMSTAR 2 as moderate quality and two were found to be of critically low quality. An overall risk reduction of 34% [RR= 0.66 (0.60 – 0.73)] for all injuries and a reduction of 29% [RR= 0.71 (0.63 – 0.81)] for injuries to the lower limbs were revealed by this meta-analysis of meta-analyses. Combining every previous meta-analysis into a single source in this paper produced decisive evidence that the risk of injuries while playing soccer is reduced as a result of FIFA's injury prevention programmes.

KEYWORDS: F-MARC, FIFA, FIFA 11, FIFA 11+, The 11+, Injury Prevention, Warm-up, Soccer.

1 INTRODUCTION

Sports injuries are costly. There is the financial burden of costs related to surgery and rehabilitation. There is also a personal cost to the athlete involved related to inability to participate in sport – something that may well have a negative effect on well-being and health.[1,2] It is for these reasons that recent years have seen programmes to prevent injury through sport become a major focus of sports medicine's interest.[3] FIFA (The Fédération Internationale de Football Association) has its Medical and Research Centre (F-MARC); America has its Santa Monica Orthopaedic and Sports Medicine Research Foundation (SMSMF) and Norway has the Oslo Sports Trauma Research Centre (OSTRC). These three institutions worked together to develop the F-MARC, FIFA 11, and FIFA 11+ soccer player injury prevention programmes.[3,4] The programmes comprise exercises divided into three main modules: running and active stretching; core and leg strengthening; and high-speed planting and cutting. What these programmes set out to do is to bring about neuromuscular system improvements by combining training in technique and balance with neuromuscular training exercises including strengthening and plyometrics with a view to eliminating injury.[3,5]

A number of studies in a number of countries have taken place to assess how well the FIFA programmes work. Countries involved include Canada,[6] Germany,[7] Nigeria,[8] Norway,[9] and the USA[10,11] but, so far as we have been able to ascertain, no systematic review has taken place to meta analyse the meta-analyses in order to provide an overall view of how effectively FIFA programmes prevent injury. This is in spite of the fact that different studies have reported different levels of effectiveness for the programmes. Hence this meta-analysis intended to provide information that was of high quality and readily accessible. It is not possible to draw conclusions or make recommendations until the quality of the reviews being better analysed has been assessed and so this study's purposes were: 1) to systematically review meta-analyses that were carried out to assess the effectiveness of FIFA programmes to reduce the risk of injury and 2) to summarise to what degree injuries had actually been reduced.

2 MATERIAL AND METHODS

2.1 Protocol and registration

This meta-analysis was conducted using PRISMA (Preferred Reporting Items for Systematic Reviews and Meta-Analyses) guidelines[12] and was registered in PROSPERO

(CRD42018097291).

2.2 Search methods

The literature was systematically searched using five databases: MEDLINE (via Ovid), PubMed, Embase, CINAHL (Cumulative Index to Nursing and Allied Health literature) and Cochrane Central Register of Controlled Trials (CENTRAL) looking for the search terms: (F-MARC) OR (FIFA) OR (FIFA 11) OR (FIFA 11+) OR ("The 11+") OR ("warm-up program") OR (Warm-Up Exercise) OR ("Injury prevention program") OR (neuromuscular training) OR (Soccer/ football warm up program) OR ("Injury prevention") AND (Athletes) OR ("soccer player") OR ("Football player") AND (sport injuries) OR (Athletic Injuries). The search in the case of each database was for the period January 1990 till 1 July 2018 and the types of study to be found were restricted to review with meta-analyses.

2.3 Eligibility criteria

The criteria for inclusion of a study were: that it should be a meta-analysis of RCTs (randomised controlled trials) or prospective cohort studies carried out to evaluate how effective FIFA's programmes to prevent injury were and that it should be written in English. The criteria for exclusion of the study were: that it was a systematic review that did not pool data and did not carry out meta-analysis; that it was a narrative review; that it reviewed an injury programme that was either general or was concerned with sports injuries but did not deal specifically with a FIFA programme; or that it was concerned only with individual components of training programmes such as dosage or particular exercises or that it dealt with only one sport.

2.4 Study selection

Two reviewers (MAA and WSA) independently screened articles' titles and abstracts to assess whether they were eligible under the criteria for inclusion and exclusion. Every reference retrieved was entered into Endnote software (Version X7; Thomson Reuters) after which duplicates were removed. A manual search was carried out on the reference lists of every meta-analysis that met the criteria for inclusion to make sure that no relevant study was missed. Where abstracts contain insufficient data to say whether the criteria for inclusion and exclusion were met, the whole text was screened. The final decision on inclusion was only taken after careful assessment of every meta-analysis that met either set of criteria and any disagreements between the two independent reviewers were resolved in a consensus meeting with a third reviewer (HA).

2.5 Data extraction

Data extracted from each study that was included was as follows: the primary author; the journal in which the study had been published; the year in which the study had been published; the search range of years of studies that were included in the meta-analysis; and how many primary studies were included in the meta-analysis. Each meta-analysis was also screened to establish why the meta-analysis had been repeated and how many previous meta-analyses could have been cited compared with the number that actually were cited. The dates the primary studies included in the meta-analyses had been published were recorded along with the size of the sample, the population from which it was drawn, the results of the meta-analysis including mean difference and standardised mean difference pertaining to the risk ratio (RR), the confidence intervals (CI), the p value, the degree of heterogeneity, and the intervention type and comparison.

2.6 Assessment of comprehensiveness of reporting

How comprehensive reporting had been in the meta-analyses included in this study was assessed by reference to the QUOROM checklist (Quality of Reporting of Meta-analyses).[13] QUOROM has eighteen items, and one point is added to the assessment for each of those eighteen items were more than 50% of the criteria have been met.

2.7 Assessment of methodological quality

AMSTAR (Assessment of Multiple Systematic Reviews) was used to assess the internal validity of meta-analyses included in this study.[14] AMSTAR measures the quality of both reporting and methodology in a systematic review. It showed good reliability and validity,[15-17] with a kappa value of 0.7 for agreement on individual items and an interclass coefficient of correlation of 0.84.[17] Version 2 of AMSTAR, which was the one used, the new version of AMSTAR (v.2) assess both RCTs and non-RCTs and broadly assesses a review's quality, finds its flaws, and highlights poor reviewing conduct that can cause less confidence to be placed in a review's findings.[18] The QUOROM and AMSTAR 2 checklists for all reviews included in this study were completed by two reviewers (MAA and HA) who discussed the differences in order to reach a consensus.

2.8 Degree of primary study overlap

Overlap in primary studies included in reviews can be measured by CCA (Corrected Covered Area) developed by Pieper et al.[19] It works by 'dividing the frequency of repeated

occurrences of the index publication in other reviews by the product of index publications and reviews, and this product is reduced by the number of index publications.' Overlap is categorised as one of: slight overlap (0-5), moderate overlap (6-10), high overlap (11-15) and very high overlap (>15).

2.9 Data pooling

Combination of included meta-analyses' results was achieved with a summary meta-analysis model for RR with 95% CI. Where a review reported a RR, that result was accepted. Where a review reported an odds ratio, that data was converted to a RR on the basis of the primary data in the review. Subgroup analysis was conducted to distinguish between the effectiveness of FIFA 11 and FIFA 11+ injury prevention programmes. The meta-analysis was conducted using RevMan 5.3 software.

3 RESULTS

3.1 Study selection

The electronic database search provided an initial 842 studies. Manual search of relevant journals and reference lists provided no studies. 376 duplicates were removed from the 842, leaving 466 articles from which a title and abstract screening removed 400 as not relevant. The full text of all remaining sixty-six articles was downloaded to be assessed in detail; fifty of these were excluded in the detailed assessment and four meta-analyses were included in the review.[5,20-22] Figure 1 shows how the search and exclusion were executed.

3.2 Characteristics of included studies

Table 1 gives the details of the included meta-analyses' characteristics. All were published between 2015 and 2017; each was published in a different journal; there were between six and eleven studies in the included meta-analyses. There was only one case in which a previously published meta-analysis[5] was cited in a meta-analysis.[21] Grounds for a repeated meta-analysis included such things as different criteria for inclusion and different methods for analysing data.

All of the meta-analyses included in this study had used MEDLINE/PubMed in their search of the literature. Three out of four had also used[5,20,21] Embase, Cochrane Library and CINAHL (Table 2). The use of other databases varied, but no meta-analysis had searched fewer than four electronic databases. In total, fifteen primary studies had been used in the reviews and the meta-analyses had made use of not less than six and not more than eleven

(Table 3). Primary studies were not included in any consistent way. A meta-analysis by Al Attar et al.[5] published in 2015 included 9 primary studies. A meta-analysis by Neto et al.[20] published in 2016 included 11 primary studies. The two meta-analyses published in 2017 each included only six studies.[21,22] Only three out of fifteen primary studies were cited in all four meta-analyses: Soligard et al.,[9] Steffen et al.,[23] and Owoeye et al.[8]. The overlap between included primary studies was very high, yielding a CCA score of 37.7%.

3.3 Reporting and methodological quality assessment

QUOROM checklist scores between reviews were fairly high, ranging between fourteen and eighteen (considered as satisfactory reporting overall). AMSTAR 2 rated two studies as being of moderate quality[5,21] and two as critically low in quality.[20,22] None of the included meta-analyses addressed the possible impact on meta-analysis results of risk of bias in an individual study (Table 4) and most failed to carry out adequate investigation of publication bias[5,20,21] while only two of the four considered risk of bias in the individual studies when they interpreted and discussed the review's results.[5,21]

3.4 Study results and summary meta-analysis

The majority of meta-analyses produced results favourable to FIFA's programme of intervention to prevent injuries (Table 5). Every review calculated RR, but the mean difference and standardised mean difference, which make it possible to gauge the overall scale of the FIFA programme's effect, were calculated in only one review.[20] Every review included primary studies in the meta-analysis and estimated the overall reduction in the injury rate but three of the four also divided the results on the basis of different clusters.[5,20,21]

Every meta-analysis found that the overall injury rate was significantly reduced with actual reductions ranging between 23% and 31% in a controlled comparison of the FIFA 11 and 11+ programmes (Table 5), but few of the plots from sub-analysis showed any results that were not significant. In the case of FIFA 11, the overall rate of injuries was not reduced significantly in comparison with the control.[5,21] Nor did the FIFA programmes, when compared with the control group, show any significant reduction in overall injury rates suffered by females[5]. There was no significant improvement in running sprint or jump height compared with the control[20]. The summary of the meta analyses meta-analysis showed the FIFA programme to give an overall reduction in the risk of all injuries of 34% reduction [RR= 0.66 (0.60 – 0.73); I^2= 84%] (Figure 2) and a 29% reduction [RR= 0.71 (0.63 – 0.81); I^2= 80%] as well as reductions for injuries to the lower limb (Figure 3).

4 DISCUSSION

This study was carried out to provide a systematic accumulation of evidence from a number of meta-analyses to provide one single, up-to-date, accessible database to show the effectiveness of FIFA programmes for injury prevention. Four meta-analyses were included in the review[5,20-22] and the results indicated that the risk of all injuries had been reduced by 34% overall and the risk of lower limb injuries by 29% as a result of FIFA's (11 and 11+) prevention programme. These reductions are important, or clinically significant, and confirm that benefit accrues from the FIFA programmes. A very important part of the FIFA 11+ programme is the NH (Nordic Hamstring) exercise, and meta-analysis showed that, when NH exercises were included in programmes to prevent injury, soccer players experienced a reduction in the number of hamstring injuries (IRR=0.49, 95% CI: 0.29-0.83, p=0.008). Teams whose programmes for the prevention of injury included NH exercises experienced up to a 51% long-term fall in rates of hamstring injury when compared with teams that had no programmes to prevent injury.[24] A survey by Al Attar et al.[25] found that only half of coaches in Australia and 70% of coaches in Saudi Arabia had in their own regimens exercise components taken from FIFA's 11+ programme. FIFA 11+ was designed as a warming up programme before the start of a soccer training session and the reason for developing dynamic warm-ups was so that neuromuscular activities could be performed in a state of non-fatigue as well as to promote good technique and optimal motor planning. It is, though, also possible that muscle strength may be improved when neuromuscular exercises are performed in a fatigued condition.[26]

The study by Al Attar et al [27,28] was the first RCT to research how much benefit was obtained from using the FIFA 11+ programme before and after training as a way of avoiding injury to Australian amateur soccer players. These programmes are based on FIFA's 11+ programme and the results indicated that injury rates can be reduced in the long term by more than 70% by the introduction of pre-and post-training warm up and warm down routines in comparison with teams who have no such programmes. Two studies conducted by Steffen et al., showed that compliance is also important using a comparison between the 52%[23] compliance with FIFA 11 and the 85%[6] compliance with FIFA 11+. FIFA 11's lower number of weekly sessions is a significant limiting factor and Steffen et al.[6] demonstrated an inverse association between the degree of compliance and the risk of injury (IRR = 0.32, 95% CI 0.11 to 0.95).

Results also reflect on the reliability of conclusions drawn by each of the individual meta-analyses and the need to summarise the meta-analyses in a single overall analysis. That was

the goal of this study, and it is the study's product. This work will have profound applications not just for coaches and other medical staff but also for sporting organisations, because reducing the number of injuries leads to improved performance and reduction in costs of treatment. Evidence from this study, in addition to reducing economic, social and individual costs of injury, may also lead to a reduction in chronic non-communicable diseases. In either case, the overall effect is likely to be a reduction in burdens on the healthcare system.

4.1 Limitations

Limitations to this analysis include the fact that a number of primary studies have been included in more than one meta-analysis so that the studies that appear in a number of reviews may have greater effect on the results.[19] Earlier published studies appear in more meta-analyses and are therefore likely to be overrepresented. When the internal validity of the included meta-analyses was tested, AMSTAR v.2 gave two of them a quality rating of critically low.

5 PERSPECTIVES

There has been no systematic review before this one of meta-analyses of FIFA programmes designed to prevent injury with the object of combining them into a single report. Overall, our finding is that such programmes can cut the risk of all injuries by 34% and the risk of injuries to the lower limb by 29% over the long term and in comparison with teams not engaging in FIFA programmes for injury prevention. The FIFA programmes are very effective in reducing both overall and lower extremity injury and the data support the development and introduction of programmes specific to a particular sport.

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TABLES

TABLE 1 Main characteristics of included studies, number of meta-analyses cited compared with number that could be cited

Authors	Journal	Publication date (month/year)	Range of years of included studies	Primary studies (n)	Included RCTs (n)	Meta-analyses possible to cite (n)	Meta-analyses cited (n)
Al Attar et al.[5]	Sports Medicine	09/2015	1985 – 2015	9	6	0	0
Neto et al.[20]	Clinical Rehabilitation	11/2016	NA – 2016	11	11	1	0
Thorborg et al.[21]	British Journal of Sports Medicine	01/2017	2004 – 2016	6	6	1	1
Sadigursky et al.[22]	BMC Sports Science, Medicine and Rehabilitation	11/2017	2006 – 2016	6	6	3	0

RCT randomized controlled trial

TABLE 2 Search databases used by each included meta-analysis

Primary study	Al Attar et al.[5]	Neto et al.[20]	Thorborg et al.[21]	Sadigursky et al.[22]
Medline/PubMed	+	+	+	+
Embase	+	+	+	
Cochrane Library	+	+	+	
CINAHL	+	+	+	
AMED	+			
SPORTDiscus	+		+	
Web of Science	+		+	
AusSportMed	+			
PEDro		+		
SciELO		+		+
LILACS				+
ScienceDirect				+

TABLE 3 Citation matrix of primary studies included in each meta-analysis

Primary study	Al Attar et al.[5]	Neto et al.[20]	Thorborg et al.[21]	Sadigursky et al.[22]
Junge et al.[29] (2002)	+			
Soligard et al.[9] (2008)	+	+	+	+
Steffen et al.[23] (2008a)	+	+	+	+
Steffen et al.[30] (2008b)		+		
Kilding et al.[31] (2008)		+		
Gatterer et al.[32] (2012)	+			
van Beijsterveldt et al.[33] (2012)	+	+	+	
Deneshjoo et al.[34] (2012a)		+		
Deneshjoo et al.[35] (2012b)		+		
Grooms et al.[10] (2013)	+			
Steffen et al.[6] (2013)	+	+		+
Impellizzeri et al.[36] (2013)		+		
Hammes et al.[7] (2014)	+		+	+
Owoeye et al.[8] (2014)	+	+	+	+
Silvers-Granelli et al.[11] (2015)		+	+	+

TABLE 4 AMSTAR 2 assessment and QUOROM checklist for included meta-analyses

AMSTAR 2 Items	Al Attar et al.[5]	Neto et al.[20]	Thorborg et al.[21]	Sadigursky et al.[22]
Did the research questions and inclusion criteria for the review include the components of PICO?	Yes	Yes	Yes	Yes
Did the report of the review contain an explicit statement that the review methods were established prior to the conduct of the review and did the report justify any significant deviations from the protocol?	Yes	Yes	Yes	Yes
Did the review authors explain their selection of the study designs for inclusion in the review?	Yes	Yes	Yes	Yes
Did the review authors use a comprehensive literature search strategy?	Partial Yes	No	Partial Yes	Partial Yes
Did the review authors perform study selection in duplicate?	Yes	Yes	Yes	No
Did the review authors perform data extraction in duplicate?	Yes	Yes	Yes	No
Did the review authors provide a list of excluded studies and justify the exclusions?	No	No	Yes	No
Did the review authors describe the included studies in adequate detail?	Partial Yes	Partial Yes	Partial Yes	Yes
Did the review authors use a satisfactory technique for assessing the risk of bias (RoB) in individual studies that were included in the review?	Yes	Yes	Yes	No
Did the review authors report on the sources of funding for the studies included in the review?	No	No	No	No
If meta-analysis was performed did the review authors use appropriate methods for statistical combination of results?	Yes	Yes	Yes	Yes
If meta-analysis was performed, did the review authors assess the potential impact of RoB in individual studies on the results of the meta-analysis or other evidence synthesis?	No	No	No	No
Did the review authors account for RoB in individual studies when interpreting/ discussing the results of the review?	Yes	No	Yes	No
Did the review authors provide a satisfactory explanation for, and discussion of, any heterogeneity observed in the results of the review?	No	No	Yes	Yes
If they performed quantitative synthesis did the review authors carry out an adequate investigation of publication bias (small study bias) and discuss its likely impact on the results of the review?	No	No	No	Yes

Did the review authors report any potential sources of conflict of interest, including any funding they received for conducting the review?	Yes	Yes	Yes	Yes
AMSTAR 2 quality level	Moderate	Critically low	Moderate	Critically low
QUOROM score	15	17	18	14

TABLE 5 Main results of the included meta-analyses

Study	Population	Intervention group (n)	Control group (n)	Meta-analysis results	Direction of findings
Al Attar et al.[5]	Both gender	2932	2549	RR 0.771; 95% CI 0.647–0.918, p = 0.003* RR 0.762; 95% CI 0.621–0.935, p = 0.009* RR 0.654; 95% CI 0.537–0.798, p< 0.001* RR 0.923; 95% CI 0.786–1.083, p= 0.327 RR 0.612; 95% CI 0.475–0.788, p< 0.001* RR 0.961; 95% CI 0.776–1.191, p= 0.717 RR 0.818; 95% CI 0.603–1.110, p= 0.197 RR 0.705; 95% CI 0.534–0.929, p= 0.013*	F-MARC intervention reduced overall injury by 23% compared to control. F-MARC intervention reduced lower extremity injury by 24% compared to control. FIFA 11+ intervention reduced overall injury by 35% compared to control. FIFA 11 intervention did not significantly reduce the overall injury compared to control. FIFA 11+ intervention reduced lower extremity injury by 39% compared to control. FIFA 11 intervention did not significantly reduce lower extremity injury compared to control. F-MARC intervention did not significantly reduce overall injury in female compared to control. F-MARC intervention significantly reduced overall injury by 30% in male compared to control.
Neto et al.[20]	Both gender	2489	2067	RR 0.69; 95% CI 0.49–0.98, p= 0.04, I^2 84%* MD 2.68; 95% CI 0.44–4.92, p= 0.02, I^2 77%* SMD -0.36; 95% CI -0.70 – -0.02, p= 0.04, I^2 0%* SMD 0.25; 95% CI -0.08 – 0.59, p= 0.14, I^2 0% SMD -0.24; 95% CI -0.58 – 0.10, p= 0.17, I^2 0%	FIFA injury prevention program significantly reduced the risk of injury by 31% compared to control. FIFA significantly enhanced dynamic balance compared to control. FIFA significantly improved agility compared to control.

					FIFA did not significantly improve jump height compared to control. FIFA did not significantly improve running sprint compared to control.
Thorborg et al.[21]	Both gender	3384	3180	IRR 0.75; 95% CI 0.57–0.98, p= 0.04, I^2 68.9%* IRR 0.99; 95% CI 0.80–1.23, p= 0.94, I^2 0% IRR 0.61; 95% CI 0.48–0.77, p< 0.001, I^2 25.5%* IRR 0.40; 95% CI 0.19–0.84, p= 0.02, I^2 0%* IRR 0.59; 95% CI 0.35–0.97, p= 0.04, I^2 0%* IRR 0.52; 95% CI 0.38–0.72, p< 0.001, I^2 0%* IRR 0.68; 95% CI 0.48–0.97, p= 0.04, I^2 27.1%*	FIFA injury prevention programs (FIFA 11 and FIFA 11+) group reduced overall injury by 25% compared to control group. FIFA 11 did not significantly reduce injury rates compared to control. FIFA 11+ significantly reduced injury rates compared to control. FIFA 11+ injury prevention program reduced hamstring injuries compared to control group. FIFA 11+ injury prevention program reduced hip and groin injuries compared to control group. FIFA 11+ injury prevention program reduced knee injuries compared to control group. FIFA 11+ injury prevention program reduced ankle injuries compared to control group.
Sadigursky et al.[22]	Both gender	3307	3037	RR 0.70; 95% CI 0.52–0.93, p=0.01, I^2 91%*	FIFA 11+ injury prevention programs group reduced overall injury by 30% compared to control group.

RR risk ratio, MD mean difference, SMD standardised mean difference, F-MARC FIFA Medical and Research Centre, FIFA Fédération Internationale de Football Association, IRR incidence rate ratio.

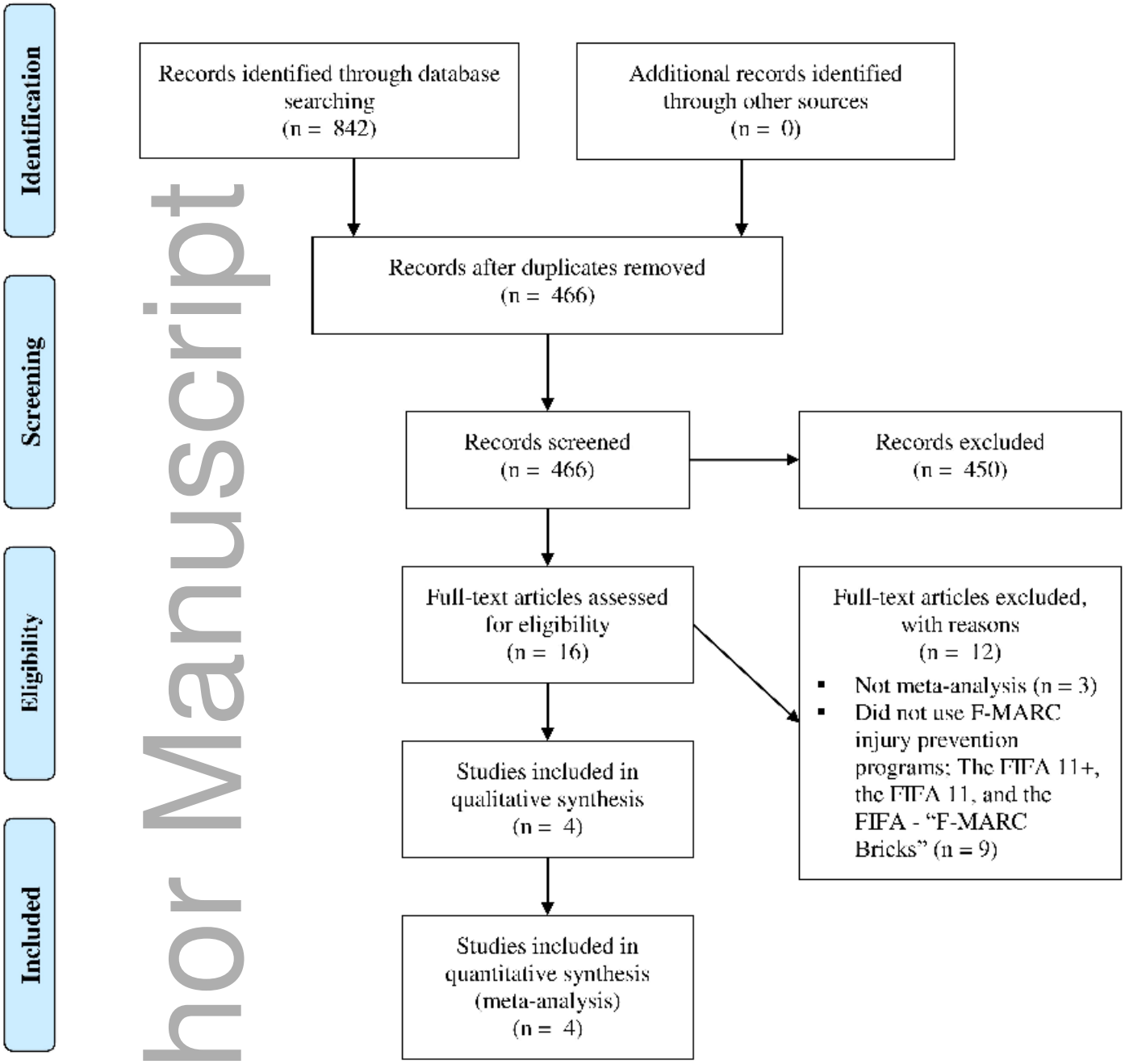
*Significant results at P<0.05

FIGURES LEGENDS

FIGURE 1 PRISMA flow diagram of the search strategy and study selection

FIGURE 2 Meta-analysis of the meta-analyses of FIFA injury prevention programmes versus control interventions on overall injury risk ratio

FIGURE 3 Meta-analysis of the meta-analyses of FIFA injury prevention programmes versus control interventions on lower limb injury risk ratio



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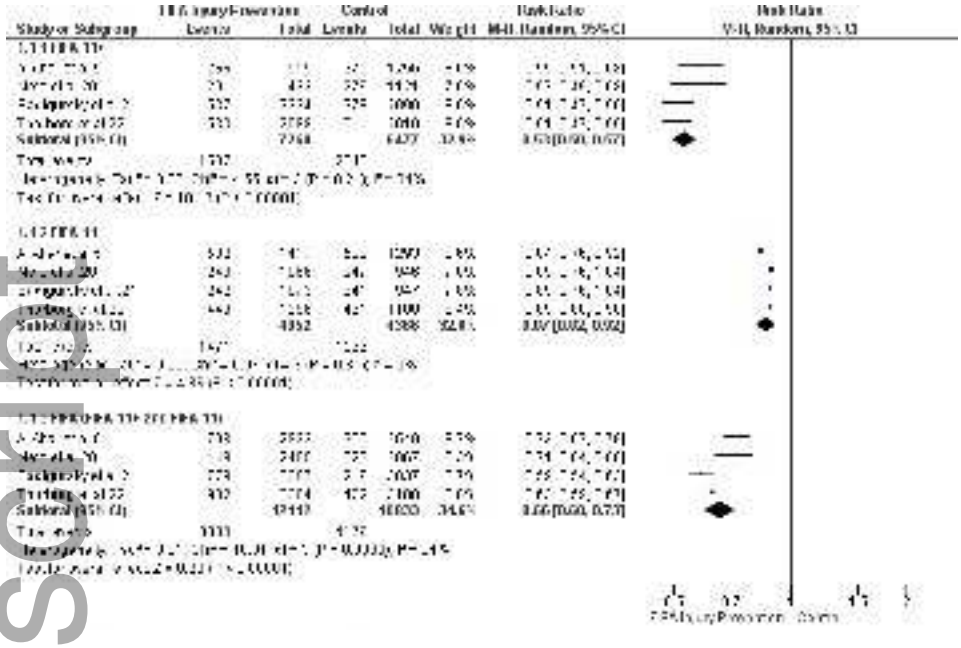

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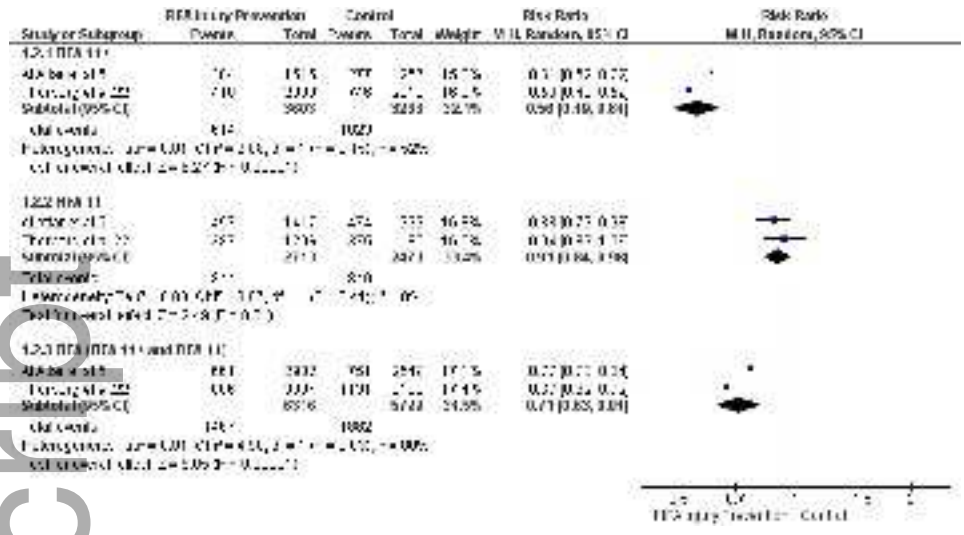

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