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The Effect of the FIFA 11+ on Injury Prevention and Performance in Football: A Systematic Review with Meta-Analysis

Theodosis Vlachas and Eleftherios Paraskevopoulos *

Department of Physiotherapy, Aegean College, 10564 Athens, Greece
* Correspondence: e.paraskevopoulos@aegeancollege.gr; Tel.: +30-21-0321-1228

Abstract: Football is characterized as a contact sport that increases the risk of injury. For the reduction of injuries, health care providers created a warm-up program that is called the FIFA11+. This is a 20 min warm-up program that has the goal of preventing injuries. This literature review investigated the effects of FIFA11+ on injury prevention and performance in football players. A systematic search was performed in three scientific databases (Pubmed, Scopus, and Physiotherapy Evidence Database (PEDro)) and one search engine (Google Scholar) from inception to June 2022. Relevant studies published in the English language were extracted, evaluated, and independently rated for methodological quality (PEDro scale). Overall, 10 randomized controlled trials were analyzed and their outcomes are discussed. Through the analysis of the studies, it was observed that the groups which performed the FIFA 11+ warm-up program had fewer incidents of injuries. In addition, the athletes of these groups increased their performance, especially in balance, proprioception, and strength of hamstrings. After the analysis, the results and limitations of the randomized controlled trials are discussed. Finally, this review suggests the inclusion of the FIFA 11+ in training sessions, and future recommendations are provided for the next trials for the maximization of their reliability.

Keywords: FIFA 11+; injury prevention; performance; football

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1. Introduction

Football is the most widely played sport around the world, with both men and women participating in football games both professionally and at amateur level. It is characterized as a contact sport that increases the risk of injury [1]. The FIFA 11+ injury prevention program was developed in 2006 to address this matter, under the leadership of the FIFA Medical Assessment and Research Centre and in collaboration with the Oslo Sports Trauma Research Center and the Santa Monica Orthopaedic and Sports Medicine Center [2]. Furthermore, more studies have examined the effectiveness of the FIFA 11+ for sports performance improvement with promising results [3].

This program comprises of three parts which are running exercises, the strength, plyometrics, and balance exercises, and finally, it is completed with running exercises again. In the first part, there are six exercises that last 8 min. The first exercise is running ahead, the second one is running with a hip out, and the third with a hip in. The fourth exercise is circling running partner and the fifth is with shoulder contact for a proper landing. Finally, the sixth phase of part 1 is quick running forwards and backwards [4].

The second part is categorized into three levels for each exercise, and every level increases the difficulty of each one. The first exercise is the static bench, the progression of which is with alternate legs and one leg lifted and held. The second exercise is the static sideway bench, which progresses with the raising and lowering of the hip and, finally, with a leg lift. The third one is the Nordic exercise for the hamstrings at the beginner, intermediate and advanced levels. The fourth exercise is the single-leg stance: the first level is performed by holding a ball, the second level by throwing a ball with a partner, and

the third level with each athlete testing the partner by pushing him in different directions. The fifth exercise is the squats. In the beginning, these are performed with toe raises; in the second level, he/she performs walking lunges; and in the third level, he/she performs single-leg squats. The last exercise of part 2 is jumping. In the beginning, the athlete performs vertical jumps, and he/she progresses to lateral jumps, and finally progresses to box jumps. This second part lasts 10 min. Finally, there is the third part of the running exercises which lasts 2 min and includes three exercises. The first one is running across the pitch, the second is running with high bounding steps, and the last one is running in changing directions [4].

The FIFA 11+ may reduce the injury rates in football players, but also provide an opportunity for coaches to match the training and match load variables in order to have similar intensity, duration, frequency, and recovery periods [5]. Furthermore, in weekly macrocycles with high loading (i.e., competitive seasons) where injury most often occurs, injury prevention programs are highly important [5]. It is well-accepted that training load varies based on age group, training day, inter-week, and playing position [6,7].

Previous research studies have examined the effectiveness of the FIFA 11+ as an injury prevention program for football players [8–10]. In addition, one systematic review has also examined the effectiveness of the FIFA 11+ for improving sports performance [11]. However, since the publication of the aforementioned systematic reviews, more studies have been published. Thus, an updated systematic review on the effectiveness of the FIFA 11+ for injury prevention and sport performance is needed. This systematic review aims to investigate the efficacy of the FIFA 11+ warm-up program for injury prevention in football players regardless of gender. In addition, this study aims to examine the impact of this program on the performance of athletes. Performance is related to the muscle strength, sprint speed, jump height, balance, and proprioception of footballers. The overall aim of this review is to examine whether the teams should include the FIFA 11+ program in their training sessions or not. The practical applications of this review are highly important, since football carries a significant risk of injuries, especially in the lower limbs. These injuries are mainly related to modifiable factors, which corroborates with the critical role played by warm-up programs. Accordingly, these programs should be easily applicable and involve all players, which is consistent with the proposal of the FIFA 11+ program [10].

2. Materials and Methods

This literature review was conducted through the research of randomized controlled trials (RCTs). The international databases of PubMed, Scopus, SPORTDiscus, and PEDro were used for the needs of this research. One search engine (Google Scholar) was also used during the search process. The keywords that were used for the search were "FIFA 11+ in football", "FIFA 11+ AND injury prevention", "FIFA 11+ AND performance". The studies were screened for eligibility by title, abstract, and full text. The search and inclusion of the articles were performed using the PICOS framework. The PICOS acronym is composed of 'P', which describes the participants; 'I', which describes the intervention that is analyzed; 'C', which means the comparison between the groups that are investigated; 'O', which is about the outcome measures of the study; and 'S', which is about the study design which describes the articles' type that is used for this literature review [12].

2.1. Participants

Studies were included if they recruited footballers, men or women, professionals or amateurs. To be included, studies were required to fulfil the following criteria: (1) the full-text paper published in a peer-reviewed journal was available; (2) the study contained original data from a randomized controlled or a cluster-randomized trial; (3) the preventive effect of FIFA 11 or the FIFA 11+ prevention program was evaluated; (4) only football players were included; and (5) football injury was an outcome. Studies that investigated population in different sports were excluded. In addition, case-scenarios, case reports, and cohort studies were excluded.

2.2. Intervention

Articles which investigated the effects of the FIFA 11+ warm-up program in footballers were considered eligible for this literature review. Studies which investigated the effects of the FIFA 11+ warm-up program against a conventional warm-up program were included in this review. In addition, articles that compared the FIFA 11+ against another special warm-up program were considered eligible for this review.

2.3. Comparison Groups

Studies that compared FIFA 11+ against a conventional warm-up program were considered eligible. In addition, studies that compared FIFA 11+ against a special warm-up program were included in this review, but the group of interest was the one which performed the FIFA 11+. In addition, articles which investigated the effect of the FIFA 11+ warm-up program and another special warm-up program against a conventional warm-up program were considered eligible, but the group of interest was the one which performed the FIFA 11+.

2.4. Outcome Measures

Studies were included in this literature review if they analyzed at least one of the following outcome measures at the baseline and the final follow-up assessment: (1) the injury incidence rates of the groups and (2) the efficacy of the program on the functional performance of the athletes.

2.5. Study Design

The articles that were used in this literature review were randomized controlled trials (RCTs) only. In addition, only studies written in the English language were included. Articles of different languages were excluded. Finally, the studies that were used were published from 2006, because in this year, FIFA, with the support of PEP (Prevent Injury and Enhance Performance), launched the warm-up program FIFA 11+ [13].

2.6. Quality Assessment

The quality assessment of the studies was performed according to the PEDro scale. This scale is conducted by 11 items related to the validity of the studies. The first item is the external validity, but it is not counted in the final score. The second item is about the random allocation of the subjects. This procedure ensures that the treatment and control groups are comparable. The third item is about allocation concealment, which means that the person who determined if a subject was included in the trial was unaware in which group he would be allocated. The fourth item is about the baseline comparability. This criterion is important because huge discrepancies between the groups can affect the randomization of the trial's procedure. The items 5, 6, and 7 are about the blinding of all subjects, therapists, and assessors, which increases the reliability of the study. Item 8 is about the population that was measured for at least one key outcome. These measures need to reach the 85% of the subjects of the groups, because this will reduce the risk of bias. Item 9 refers to the intention-to-treat analysis, which means that the subjects of each group receive the treatment as planned. Through this procedure, the risk of bias is reduced. Item 10 refers to the comparison of the statistics between the groups for at least one key outcome and item 11 is about the point measures and the measures of variability of at least one key outcome that the study provides. Points for each item are awarded only when a criterion is clearly satisfied. The final score of the PEDro scale could range from 0 to 10, where 0 refers to low quality and 10 to high quality [14]. Based on previous studies, articles that are awarded with $6\geq$ of total score on the PEDro scale were classified as trials with high quality of methodology [15]. It should be noted that both the authors evaluated the methodological quality. However, all of the included studies were found in the PEDro database and the authors maintained their scores. Thus, inter-rater agreement

for assessments of methodological quality was not needed in this study, since quality assessment had been already conducted using PEDro.

2.7. Data Extraction

The titles and abstracts of the extracted studies were evaluated by one reviewer (EP). When the abstract did not contain adequate information, the entire article was examined. Data on the year of publication, participant demographics type, number of sessions, length of each intervention, outcome follow-up, and results of each included study were extracted by two reviewers (EP and TV) according to PRISMA (Preferred Reporting Items for Systematic Reviews and Meta-Analyses) [16].

2.8. Meta-Analysis

A meta-analysis was performed using the Mantel–Haenszel method to provide a pooled risk ratio (RR), using a fixed effects model, 95% CI threshold, and inverse variance weighting only for the studies that evaluated the risk of injury. The pooled RR describes the relationship between scapular dyskinesis and shoulder injury risk, where a value equal to 1 indicates no change in risk and values. The values 1 or −1 indicate increased or decreased injury risk, respectively [17]. The meta-analysis was performed using RevMan Version 5 (Cochrane).

3. Results

The articles that were identified from this search were 30 for 'FIFA 11+ and injury prevention', and another 30 for 'FIFA 11+ and performance'. After reading the titles and abstracts of the articles, 27 studies were found as potentially eligible for this literature review. The full texts of these studies were carefully analyzed and 10 articles were finally included for the evaluation of the FIFA 11+. The process of the studies' eligibility is quoted in the flowchart (Figure 1).

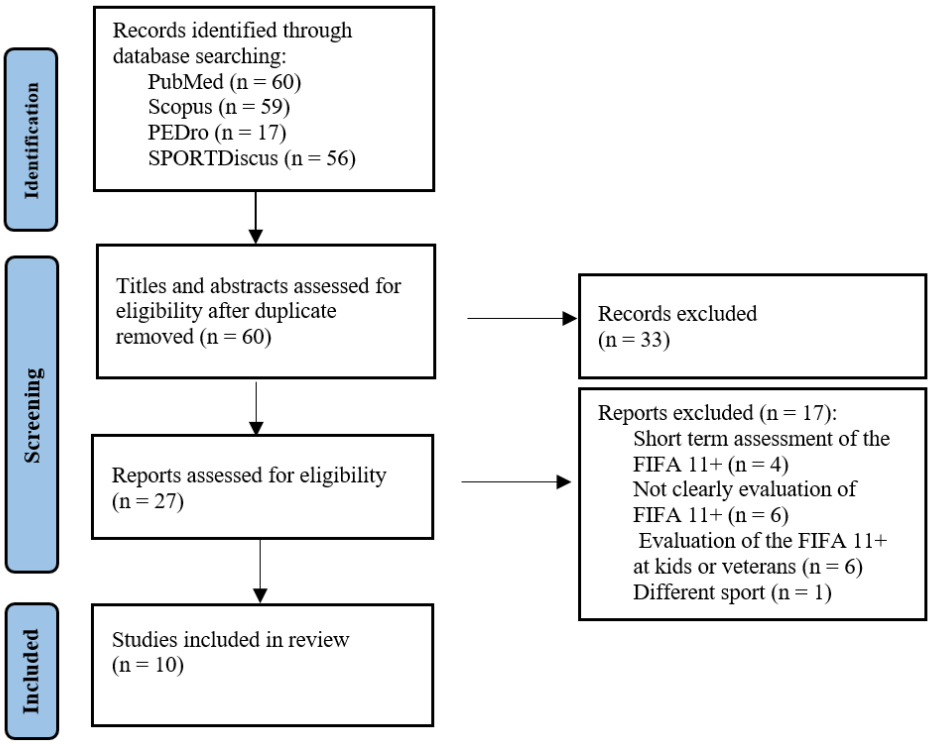


Figure 1. PRISMA flowchart showing the selection procedure for the studies in this systematic review.

On average, the methodological quality score of all included studies rated with the PEDro scale was 5.6/10 (Table 1). Interestingly, five studies [4,9,18–20] were considered as high-quality studies based on the PEDro scale.

Table 1. Methodological quality of the included studies assessed with the PEDro scale.

Studies	1	2	3	4	5	6	7	8	9	10	11	Overall
Soligard et al., 2008 [9]	Y	Y	N	Y	N	N	Y	Y	Y	Y	Y	7/10
Owoeye et al., 2014 [21]	Y	N	N	Y	N	N	N	Y	Y	Y	Y	5/10
Akbari et al., 2019 [18]	Y	Y	N	Y	N	N	N	Y	Y	Y	Y	6/10
Silvers-Granneli et al., 2017 [2]	Y	Y	N	N	N	N	N	Y	N	Y	Y	4/10
Silvers-Granneli et al., 2015 [4]	Y	Y	Y	Y	N	N	N	Y	N	Y	Y	6/10
Nuhu et al.,2021 [20]	Y	Y	Y	N	N	N	Y	Y	Y	Y	Y	7/10
Impellizzeri et al., 2013 [19]	Y	Y	N	Y	N	N	Y	Y	N	Y	Y	6/10
Nawed et al., 2018 [22]	N	Y	Y	Y	N	N	N	N	N	Y	Y	5/10
Daneshjoo et al., 2012 [23]	Y	Y	N	Y	N	N	Y	N	N	Y	Y	5/10
Ayala et al., 2017 [24]	Y	N	N	Y	N	N	N	Y	Y	Y	Y	5/10

Y: Yes; N: No. 1. Eligibility criteria; 2. Random allocation; 3. Concealed allocation; 4. Baseline comparability; 5. Blinding of individuals; 6. Blinding of therapists; 7. Blinding of assessors; 8. Adequate follow-up; 9. Intention-to-treat analysis; 10. Between-group comparisons; 11. Point estimates and variability. Item 1 (Eligibility criteria) does not contribute to the total score.

3.1. Characteristics of the Studies

The studies that were included in the review included participants aged 13–25 years (Table 2). The studies predominantly recruited male athletes, except for one study that recruited female athletes only [9]. Study participants were primarily recruited from football. All studies had conducted an a priori sample size calculation to attain a power level of at least 80% at a significance level of 0.05 for their primary outcome measure.

Table 2. Characteristics of the studies included.

STUDIES	SAMPLE	INTERVENTIONS	PERIOD	RESULTS
Silvers-Granneli et al., 2017 [2]	IG = 675 players CG = 850 players Gender: Male Age: 18–25	IG: FIFA 11+ CG: Conventional warm-up	3 times/week for 1 season	Total injuries: IG = 285 CG = 665 Knee injuries: IG = 34 CG = 102 Mechanism of ACL: IG = 3 CG = 16
Silvers-Granneli et al., 2015 [4]	IG = 675 players CG = 850 players Gender: Male Age: 18–25	IG: FIFA 11+ CG: Conventional warm-up	3 times/week for 1 season	Total injuries: IG = 285 CG = 665 Ankle injuries: IG = 59 CG = 115 Knee injuries: IG = 34 CG = 102 Hamstring injuries: IG = 16 CG = 55
Soligard et al., 2008 [9]	IG = 1055 players CG = 837 Gender: Female Age: 13–17	IG: FIFA 11+ CG: Conventional warm-up	3 times/week for 8 months	Total injuries: IG = 135 CG = 166 Acute injuries: IG = 112 CG = 130 Overuse injuries: IG = 27 CG = 48
Nuhu et al., 2021 [20]	IG = 309 players CG = 317 players Gender: Male Mean age: 20	IG: FIFA 11+ CG: Conventional warm-up	3 times/week for 7 months	Total injuries: IG = 168 CG = 252 Overuse: IG = 8 CG = 15 Trauma: IG = 160 CG = 191 Severity: Minimal → IG > CG Mild → IG < CG Moderate → IG < CG Severe → IG < CG
Owoeye et al., 2014 [21]	IG = 212 players CG = 204 players Gender: Male Mean age: 17.50	IG: FIFA 11+ CG: Conventional warm-up	3 times/week for 6 months	Total injuries: IG = 36 CG = 94 Overuse injuries: IG = 2 CG = 14 Acute injuries: IG = 34 CG = 80 Severity: Minimal → IG < CG Mild → IG < CG Moderate → IG < CG Severe → IG > CG (No significant difference)
Akbari et al., 2019 [18]	IG = 12 players CG = 12 players Gender: Male Mean age: 16.79	IG: FIFA 11+ CG: Conventional warm-up	3 times/week for 8 weeks	**LESS Score** Landing patterns: IG: High-risk → −2.93 Low-risk → −1.3 CG: High-risk → 0 Low-risk → +0.2

Table 2. *Cont.*

STUDIES	SAMPLE	INTERVENTIONS	PERIOD	RESULTS
Daneshjoo et al., 2012 [23]	Group A = 12 players Group B = 12 players Group C = 12 players Gender: Male Age: 17–20	Group A: FIFA 11+ Group B: HarmoKnee Group C: Conventional warm-up	3 times/week for 2 months	**Proprioception: Biodex Isokinetic Dynamometer 30°, 45°, 60°** Proprioception error: Group A: 45° → ↓2.8% 60° → ↓ 1.7% Group B: 45° → ↓ 3% 60° → ↓ 2.1% Group C: no significant improvement **Dynamic Balance: Star Excursion Balance Test (SEBT)** Dynamic Balance: Group A: ↑ 12.4% Group B: ↑ 17.6% Group C: no significant improvement **Static Balance: Stork stand balance test** Static Balance (eyes open): Group A: ↑ 10.9% Group B: ↑ 6.1% Group C: no significant improvement **(eyes closed):** Group A: ↑ 12.4% Group B: ↑ 17.6% Group C: no significant improvement
Impellizzeri et al., 2013 [19]	IG = 42 players CG = 39 players Gender: Male Mean age: 23.5	IG: FIFA 11+ CG: Conventional warm-up	3 times/week for 9 weeks	**Time to stabilization: Jump landing task** Significant Improvements: Time to stabilization: −2.8% for IG Core stability: −8.9% for IG **Concentric/Eccentric strength of flexors/extensors: Cybex NORM isokinetic dynamometer** Concentric strength of flexors: IG: ↑ 3.2% Eccentric strength of flexors: IG: ↑ 3.8%
Ayala et al., 2017 [24]	Group A: CG = 11 players FIFA 11+ = 10 players Group B: CG = 10 players HarmoKnee = 10 players Gender: Male Mean age: 16.8	CG: Conventional warm-up	3 times/week for 4 weeks	**Dynamic Postural Control: Y-balance test** Significant improvements: Group A (in favor of the FIFA 11+ players): Dynamic Postural Control: anterior ↑ 2.5%, posteromedial ↑ 7.2% Single-legged-hop limb symmetry: ↑ 8.3% Sprint speed: 10 m → −8.4% 20 m →−1.8% Vertical jump: ↑ 9.1% **Sprint speed 10 m/20 m: Beam photocell gates** Group B (in favor of HarmoKnee players): Sprint speed: 10 m → −2.7% 20 m →−2.9% **Vertical drop Jump: Contact platform (Ergojump)** Vertical jump: ↑ 9.7%
Nawed et al., 2018 [22]	IG = 29 players CG = 28 players Gender: Male Mean age: 20.63	IG: FIFA 11+ CG: Conventional warm-up	5 times/week for 12 weeks	**Leg power: Vertical Jump Test** IG → Significant improvements: leg power → Vertical Jump Test: ↑ 4.67% **Sprint speed: 20 m. sprint run test** Sprint speed → 20 m. sprint run test: −0.38 s.

IG: Intervention group; CG: Control group; ROM: Range of Motion; ↓: Decrease; ↑: Increase.

3.2. Injury Prevention

There are five articles in this literature review that investigated the impact of the FIFA 11+ warm-up program on injury prevention in football. The Silvers-Granneli [2] randomized controlled trial investigated the efficacy of the FIFA 11+ warm-up program on anterior cruciate ligament (ACL) injuries. They collected the players of 61 male teams from Division I and Division II. The total number of professional athletes was 1525, in the range of 18–25 years old, and they were separated into two groups. The first group was the intervention group, which comprised 675 footballers, and the second group was the control group, which comprised the other 850 players. The intervention group performed the FIFA 11+ three times per week for one season, while the control group kept performing

the conventional warm-up. By the end of the trial, significant differences were observed in the comparison between the groups, in favor of the FIFA 11+ players. They recorded 950 injuries in total. The 665 injuries were in the control group and the 285 injuries in the intervention group. Of the 665 and 285 injuries, 102 and 34 were in the knee joint, respectively. Furthermore, the 16 injuries of the 102 were anterior cruciate ligament injuries and 3 of the 34 were in anterior cruciate ligament. Another observation is that most ACL injuries were caused by non-contact mechanisms: 10 and 3, respectively.

The other articles investigated the impact of the FIFA 11+ in injury prevention in total. However, two of them also examined the differences between the severity of the injuries. The Silvers-Granneli [4] randomized controlled trial in 2015 had the same population, intervention, and period as the 2017 Silvers-Granneli [2] study in 2017. By the end of the trial, significant differences between the groups were observed. The total number of injuries was less in the FIFA 11+ group. The intervention group had 285 injuries and the control group had 665. Most injuries were observed in the ankle joint, at 174. From the total, 115 injuries were in the control group, and the rest were in the intervention group. In addition, greater differences were recorded for knee and hamstring injuries. For knee injuries, 102 were in the control group and 34 in the FIFA 11+ athletes, and for hamstrings injuries, 55 were in the conventional warm-up players and 16 in the intervention group. The randomized controlled trial by Soligard et al. [9] collected 1892 female amateur youth players, 13–17 years old, from 125 clubs in Norway. They were separated into two groups. The first group was the intervention group, which had 1055 footballers, and the second group was the control group, which had 837 athletes. The intervention group performed the FIFA 11+ warm-up program three times per week for 8 months, while the control group performed the conventional warm-up. By the end of the trial, significant differences were observed in favor of the FIFA 11+ footballers. The total number of injuries was 135 for the intervention group and 166 for the control group. In addition, 112 of the 135 injuries were acute, while 27 were due to overuse for the FIFA 11+ group. For the control group, 130 of the 166 were acute, while 48 were due to overuse. In addition, most injuries were recorded on the ankle and knee joints for both groups.

The pooled data from the meta-analysis revealed 2751 injuries from a total of 5984 players (Figure 2). The pooled RR (0.57; 95% CI, 0. 45–0.60; $p < 0.01$) indicated that FIFA11+ is associated with a significant reduction in lower limb injuries in football players.

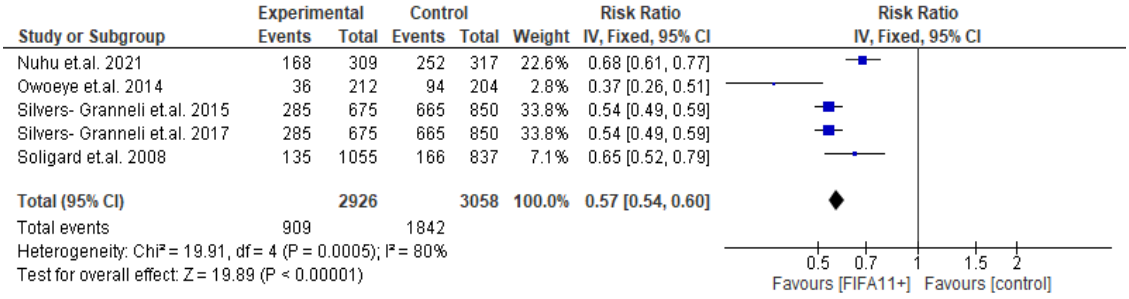


Figure 2. Forest plot for the Mantel–Haenszel (M-H) meta-analysis of the included studies to produce a pooled risk ratio. The analysis was performed using RevMan Version 5.0, with a fixed-effects model, inverse variance weighting, and 95% CI threshold [2,4,9,20,21].

3.3. Severity

The next two studies, from Nuhu et al. [20] and Owoeye et al. [21], also investigated the severity of the injury. The categorization of the severity was conducted as minimal (1–3 days), mild (4–7 days), moderate (8–28 days), and severe (>29 days) (Nuhu et al. [20]). The study of Nuhu et al. [20] collected 626 male professional footballers. The mean age of these athletes was 20. These players were separated into two groups. In this study, 309 footballers were in the intervention group, and 317 in the control. The intervention group performed the FIFA 11+ warm-up program three times per week for 7 months,

while the control group kept performing the conventional warm-up. Significant differences were recorded between the group's results by the end of the trial. The total number of injuries for the intervention group was 168, 8 of which were due to overuse and 160 caused by trauma. The overall number of injuries for the control group were 252, of which 15 were due to overuse and 191 were caused by trauma. Most injuries were observed on the knee and ankle joints and in the form of thigh and groin lesions. The categorization of the injuries based on severity showed that minimal injuries were increased among the FIFA 11+ players, with 44 against 40 of the control group. There were 63 mild injuries in the intervention group, while there were 69 in the other group. The number of moderate injuries was fewer among the FIFA 11+ athletes than the control group, with 52 against 113, and there were 9 severe injuries in the intervention group but 30 in the conventional warm-up players. The randomized controlled trial by Owoeye et al. [21] collected 416 male amateur players in 20 teams, aged over 14 years old. They separated them into two groups. The first group was the intervention group, and the second group was the control group. They comprised 212 and 204 players, respectively. The intervention group performed the FIFA 11+ warm-up program three times per week for 6 months and the control group performed the conventional warm-up program. Significant differences were recorded in the between-group comparison by the end of the trial. The total number of injuries was 36 for the FIFA 11+ players, in which 34 of them were caused by acute trauma and 2 were caused by overuse. Most injuries were observed on the ankle and knee joints and the biggest difference between the groups were observed in thigh and ankle injuries. The categorization of the injuries based on severity showed that the number of minimal injuries was fewer in the intervention group than the control group, at 7 and 23, respectively. The number of mild injuries was 7 in the FIFA 11+ players, while in the conventional warm-up players, there were 27. The number of moderate injuries was fewer in the intervention group than the control group, at 14 and 33, respectively, and the number of severe injuries was seven in the FIFA 11+ athletes and nine in the conventional warm-up group. This shows that there were more severe injuries in the control group.

3.4. Performance

The next five articles investigated the effect of the FIFA 11+ program on the performance of the athletes. Three of these studies compared the results of the FIFA 11+ against the conventional warm-up of each team. The other two studies compared the effectiveness of the FIFA 11+ and the HarmoKnee warm-up program against the conventional warm-up program of each team. In addition, differences were recorded between the FIFA 11+ and the HarmoKnee warm-up program groups. The first of those three articles that compared the results of FIFA 11+ against the conventional warm-up of each team was the study by Akbari et al. [18], a randomized controlled trial which investigated the effect of the FIFA 11+ on the landing patterns of the footballers. This study collected 24 under-19 players from a professional team. Landing technique was measured by the Landing Error Scoring System (LESS) score. Pre-training measures were used to determine the risk group placement of the athletes, depending on the score that they achieved. Footballers with a LESS score of $\geq$5 were classified as high-risk and players with a LESS score of <5 were classified as low-risk. Then, the athletes were randomly allocated into two groups. The first group was the intervention group and comprised 12 athletes. The second group was the control group which comprised the other 12 footballers. The intervention group performed the FIFA 11+ warm-up program three times per week for 8 weeks, while the control group performed the conventional warm-up of the team. The results showed significant differences in high-risk athletes of the FIFA 11+ group, with a mean reduction of 2.93 on the LESS score. The reduction in the low-risk athletes of the FIFA 11+ group was lower, with a reduction of approximately 1.3 on the LESS score. For the control group, the high-risk footballers showed no difference in LESS score, while the scores of the low-risk players increased slightly, by approximately 0.2. The second of the three articles was the randomized controlled trial by Impellizzeri et al. [19]. This study collected 81 male amateur footballers with a mean age of

23.5 years old. These players were divided in two groups. The first group was the intervention group, which performed the FIFA 11+ warm-up three times per week for 9 weeks. The other group was the control group, which performed the conventional warm-up program. A total of 42 players were assigned to the intervention group, and 39 were assigned to the control group. The primary outcome of this study was to measure the time to stabilization, which was conducted by the jump landing task and strength of the flexors, concentric and eccentric, which was measured using a Cybex NORM isokinetic dynamometer. The secondary outcome was to measure the concentric and eccentric strength of the extensors, which were also measured using a Cybex NORM isokinetic dynamometer. In addition, measuring dynamic balance was one of the secondary outcomes, which was conducted by the SEBT test. In addition, core stability was measured through the unstable sitting posture test and sprint speed over 10 and 20 m, in which time was recorded using a photocell system (Microgate, Polifemo, Bolzano, Italy). Finally, other secondary outcomes were the measurement of agility, which was measured through the agility *t*-test, and vertical jumps, which were recorded on a force platform (Quattrojump, Kistler, Switzerland). By the end of the trial, significant improvements were observed in favor of the FIFA 11+ players. Time to stabilization was reduced by 2.8% in the jump landing task score and core instability was reduced by 8.9% in the unstable sitting posture test score. In addition, the concentric strength of the flexors increased by 3.2, and the eccentric flexors' strength also increased, by about 3.8%. The third article that compared only the FIFA 11+ against the conventional warm-up of the team was from Nawed et al. [22]. This study collected 57 male amateur footballers with a mean age of 20.63. The population was divided into two groups. The first group was the intervention group, to which 29 players were assigned and performed the FIFA 11+ warm-up program five times per week for 12 weeks. The second group was the control group, in which players performed the conventional warm-up. The control group comprised 28 athletes. The performance responses that this study investigated were leg power, which was measured by the vertical jump test; sprint speed, which was measured by the 20 m sprint run test; and agility, which was measured by the agility *t*-test and Illinois agility run test. By the end of the trial, significant improvements were observed in favor of the FIFA 11+ players in leg power and sprint speed. The vertical jump test score was increased by 4.67 cm and the 20 m sprint run test was decreased by 0.38 s.

The last two articles, in addition to the FIFA 11+ warm-up program, included the HarmoKnee warm-up program in their investigation. The first of these studies is the randomized controlled trial by Daneshjoo et al. [23]. This trial collected 36 male under-21 professional footballers who were 17–20 years old. The players separated into three groups. The first group comprised 12 players who performed the FIFA 11+ warm-up program three times per week for 2 months; the second group also comprised 12 players, who performed the HarmoKnee warm-up program three times per week for 2 months; and finally, the third group, comprising the remaining 12 athletes, was the control group, whose members performed the conventional warm-up. This study investigated proprioception error through the use of a Biodex isokinetic dynamometer at 30°, 45°, and 60°. In addition, they examined dynamic balance using the SEBT test and static balance, which was measured using the Stork stand balance test. Proprioception error was decreased by 2.8% at 45° for the first group, and for the second group by 3%. Error at 30° showed no significant improvement for any group. In addition, the control group showed no improvement in proprioception error. Dynamic balance showed significant improvement in both the FIFA 11+ and HarmoKnee groups. For the FIFA 11+ athletes, the SEBT test score increased by 12.4%, and for the HarmoKnee players by 17.6%. No significant improvements were observed in the control group. In addition, static balance showed great improvements in the first and second group. In the first group, the score of the Stork stand balance test increased by 10.9% in the open-eyes trial and by 12.4% in the closed-eyes trial. In the second group, the score increased by 6.1% in the open-eyes trial and by 17.6% in the closed-eyes trial. The other study which included the HarmoKnee warm-up program was the randomized controlled trial of Ayala et al. [24]. This study collected 41 male youth amateur footballers,

with a mean age 16.8 years old. The athletes were separated into two groups: group A, which comprised 21 players; and group B, which comprised 20 players. Each group was further separated into two other groups. Group A's members were divided into those who performed the conventional warm-up (n = 11) and into those who performed the FIFA 11+ warm-up program (n = 10). Group B's members were divided into those who performed the conventional warm-up (n =10) and into those who performed the HarmoKnee warm-up program (n = 10). The FIFA 11+ players and the HarmoKnee players performed the warm-up program three times per week for 4 weeks. The performance response that this study investigated was dynamic postural control, which was measured using the Y-balance test. In addition, they investigated the range of motion of the hip using the passive SLR, the range of motion of the knee using the modified Thomas test, and the range of motion of the ankle, which was measured by the weight-bearing lunge with knee extended test. In addition, they investigated the single-legged-hop limb symmetry through the single-hop for distance test and the triple-hop for distance test and the sprint speed over 10 m and 20 m in which time was recorded using beam photocell gates. Finally, they assessed the vertical drop jump using a contact platform (Ergojump) and agility using the Illinois agility test. By the end of the trial, in group A, significant improvements were observed in favor of FIFA 11+ players. Firstly, dynamic postural control increased by 12.5% in the anterior and by 7.2% in the posteromedial. In addition, the single-legged-hop limb symmetry score increased by 8.3%. Furthermore, sprint speed time over 10 m decreased by 8.4%, and over 20 m by 1.8%. Finally, the vertical drop jump score increased by 9.1%. For group B, significant improvements were observed in favor of HarmoKnee players. The time of the sprint speed over 10 m decreased by 2.7%, and over 20 m by 2.9%. Finally, the vertical drop jump score increased by 9.7%.

4. Discussion

The outcomes of the studies on FIFA 11+ demonstrated that this warm-up program can reduce the incidence of injuries in football players. In general, the athletes who performed the FIFA 11+ had fewer injuries than the athletes who performed the conventional warm-up. In addition, the greatest reduction was observed in knee, ankle, and thigh injuries, which are the most commonly injured areas in football. Knee injuries are common in sports that involve numerous abrupt shifts in support such as football [25]. Furthermore, the sports with greater incidence in ankle injuries are those that require abrupt changes in support such us football. In these sports, hamstring injuries are the most commonly injured areas, including in football, since contusions and repeated actions with sprints and maximum accelerations and decelerations occur very often. In addition, great reductions were also observed in acute and overuse injuries [9,20,21]. Finally, two studies investigated the effectiveness of the FIFA 11+ in comparison with the severity of the injuries. Both studies agreed that the FIFA 11+ warm-up program showed significant improvements in mild and moderate injuries, but they disagreed regarding minimal and severe injuries. One study provided evidence that there were more instances of minimal injuries in players who performed the FIFA 11+ compared to the athletes who performed the conventional warm-up program, while the other study provided the opposite results. In addition, one study provided evidence that there were more instances of severe injuries among footballers who performed the FIFA 11+ compared to the players who performed the conventional warm-up, while the other study provided the opposite results [20,21].

The outcomes of the studies showed that the FIFA 11+ showed significant improvements in many aspects of the athletes' performance. Firstly, through the investigation of the studies, we observed great increases in balance, landing patterns, and time to stabilization [18,19,22–24]. In addition, there was a reduction in proprioception errors and an increase in vertical jumps [22–24]. In addition, significant improvements were observed in the knee flexors, strength, and core stability of the athletes [19]. Finally, two studies also included in their investigation the effect of the HarmoKnee program. Through the comparison of these studies, it was observed that both warm-up programs had better

outcomes than the conventional warm-up. In addition, there were some categories that both programs showed improvements. Those were sprint speed, vertical jump, and dynamic and static balance. In the first three categories, the HarmoKnee players showed slightly better results, while for static balance, the FIFA 11+ players showed slightly better outcomes. However, the footballers who performed the FIFA 11+ also showed significant improvements in single-legged-hop limb symmetry and dynamic postural control, while the footballers who performed the HarmoKnee program showed no improvements in these areas [23,24].

After reading the results of the randomized controlled trials, one interpretation of the outcomes could be that injury prevention and performance are closely related. Firstly, the increase in core stability produces significant improvements in balance, which leads to improved lower limb and trunk biomechanics. In turn, these altered biomechanical patterns could lead to the prevention of injuries through the improvement of the landing patterns [26]. In addition, studies have shown that proprioception and neuromuscular training programs were effective in knee and ankle injuries which, as discussed above, are very common in football [27,28]. In addition, the increase in the hamstring muscles' strength could lead to a reduction in lesions in these muscles and increase sprint speed [29]. Furthermore, Ueno et al. [30] showed that hamstring contraction could regulate the magnitude and timing of the peak anterior cruciate ligament loading during the landing of a vertical jump, leading to injury prevention in sports. As it was observed, the improvements were mainly in landing patterns and hamstring endurance, which are the main two main causes that lead to injuries in football [31]. Therefore, these findings enhance the belief that an increase in athletes' performance could lead to fewer injuries during a season.

Finally, through the analysis of the articles, it was observed that the FIFA 11+ was performed three times per week in most studies. In addition, one study performed the FIFA 11+ warm-up program five times per week [22]. This finding created the curiosity for the investigation of the adherence to the FIFA 11+. Only one study in the literature dealt with the frequency of the program's execution. This randomized controlled trial was from Steffen et al. [32], which provided evidence that the FIFA 11+ had positive outcomes in balance and injury prevention, especially in groups with high adherence. High adherence is described as the execution of the program three or more times per week. These findings led to the inference that the studies which were selected for this review used the program appropriately for their intervention groups, but there is no evidence as to whether the execution of the FIFA 11+ more than three times per week results in better outcomes.

4.1. Limitations

Our investigation should be interpreted in light of its limitations. Firstly, the researchers and coaches could not be blinded in the allocation of the groups because they had to monitor compliance and evaluate the injured players. In addition, the diagnosis of the injuries was mainly conducted through the subjective and objective assessment of the athletes by the therapists. This happened due to limited funding and resources for the studies. Finally, in studies with a great population, the administration of the FIFA 11+ program was conducted by coaches with occasional supervision by physiotherapists, and that may have affected the appropriate execution of the exercises and the appropriate progression.

Moreover, there were some low-quality studies with scores of 4 and 5 in the PEDro scale. In addition, the conventional training program of the athletes was not analyzed properly. It is of high importance for the players to perform an appropriate training program in order to reduce their injury rate. The quality of the training is as important as the warm-up, yet this was not analyzed in any study. In addition, there were few randomized controlled trials and that led the investigators to include a heterogenic sample of studies in this review (amateur versus professional players). The life of a professional footballer is totally different to the life of an amateur player. Professional footballers have personalized training programs, with better equipment and a variety of training programs. In addition, the diet, which has an important role in injury prevention, is based on their

needs and created by health care professionals, while amateur players rarely have all these parameters in their training program [33].

4.2. Effectiveness

From the analysis of this literature review, there is a strong belief that the FIFA 11+ is an effective warm-up program. The FIFA11+ can reduce the incidence of injuries and increase the performance of athletes. More high-quality studies should investigate the effectiveness of the FIFA 11+. Finally, it would be useful if future trials investigate the FIFA 11+ outcomes in comparison with the other training programs of the footballers and if it could be personalized based on the needs of each athlete for the maximization of the outcomes assessed.

5. Conclusions

This systematic review investigated the effect of the FIFA 11+ warm-up program in injury prevention and performance in football players. The results showed that the FIFA 11+ is an effective warm-up program which every team should include in their training sessions because it reduces the incidence of injuries and increases the performance of athletes. More high-quality studies are needed in order to increase the transparency of its clinical implications.

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