# Effect of the 11+ injury prevention programme on fundamental movement patterns in soccer players

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**ABSTRACT:** No studies have assessed whether changes in an individual's fundamental movement patterns can be achieved with the 11+ prevention programme in soccer players. The aim of this study was to assess the effect of the 11+ compared with a standard warm-up on fundamental movement patterns using the Functional Movement Screen (FMS) in amateur male soccer players. Twenty-three male soccer players (age: 24.7±.3.8 years; height: 1.77±0.58 m; body mass: 73.9±6.2 kg) were randomly assigned to the 11+ (n= 12) or control (n= 11) group. The intervention programme had to be carried out 3 times a week over 6 weeks. The 11+ warm-up lasted ~25 minutes and was conducted before starting regular practice, replacing the team's standard warm-up. The control group warmed up with standard jogging, ball exercises, and active stretching to match the duration of the 11+. Within-group analysis revealed significant improvements in the FMS total score in the 11+ (+10.51%; *d*= 0.83) and control group (+7.99%; *d*= 0.68) from pre-test to post-test. In the between-group analysis, there were no significant differences between groups. At the post-test a significantly greater number of players in the 11+ group exhibited a score that improved to above the injury threshold (≤14) (p= 0.046). This study suggests that regular implementation of the 11+ injury prevention programme may not produce additional improvements in fundamental movement patterns other than those produced by a standard warm-up.

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## INTRODUCTION

Soccer is a high-intensity and contact team sport with one of the highest injury rates [1], higher than in other sports such as basketball or handball [2]. Estimates of the incidence of overall injuries in male soccer players vary between 6.2 and 9.4 per 1000 hours of soccer exposure (training and games) [3,4] and mainly affect the lower extremities, in particular the ankle, knee or hamstring [5,6]. Moreover, injuries in soccer result in substantial economic costs for teams and public health systems [7] and may even cause long-term disability for injured players [8]. It has been estimated that the average cost for a first team player being injured for 1 month is approximately € 500 000 [8,9]. Additionally, an elite European team with 25 players can expect around 50 injuries per season, with severe injuries (causing absence of >28 days) representing 16% of all injuries [8,9]. Consequently, there is every reason to emphasize the development and implementation of injury prevention programmes in soccer.

In view of this, in 2008 an expert group convened by the FIFA's Medical Assessment and Research Centre (F-MARC) developed the 11+ injury prevention programme [10], a structured warm-up that combines strength, coordination, and neuromuscular control training, with the aim of reducing the most common injury types in soccer. The 11+ focuses on intrinsic risk factors and comprises 15 exercises divided into three parts (initial running and active stretching session; a core and leg strength exercise session; and a high-speed planting and cutting exercise session), and should be implemented as a standard warm-up at the start of each training session, at least twice a week [11]. Several studies have been conducted to test the efficacy of the 11+ on injury prevention in different soccer populations [12-14]. A recent systematic review and meta-analysis on the efficacy of the 11+ concluded that the use of the F-MARC injury prevention programme can decrease the risk of non-contact injuries among soccer players by 20 to 50% in the long term [15]. Additionally, the FIFA 11+ has also been shown to produce positive changes in physical fitness [16,17], muscle activity contribution [18], motor performance [19], concentric hamstring strength [20], neuromuscular control [21], and peak knee valgus moment [22]; in the long term, all of these factors may potentially contribute to minimizing risky movement patterns.

Previous literature has noted that poor movement quality may predispose to an increased risk of injury [23]. Thus, methods for assessing movement proficiency in sporting settings have been increasing in popularity. The Functional Movement Screen (FMS) is a reliable screening test that was developed with the goal of identifying limitations or asymmetries in core strength, coordination, balance, range of motion, and general movement proficiency that may predispose an athlete to injuries during activity [24]. The usefulness of the FMS, determined by correlating screening scores with injury incidence [25], has been demonstrated in different team sports populations, such as American football players [26,27] and male rugby union athletes [28,29]. These studies suggest that participants with composite scores <14 had a significantly higher likelihood of an injury compared with those with higher scores [25]. However, recent reviews have indicated limited utility of the FMS as an injury prediction tool [30,31].

Previous studies [32-34] have evaluated the effects of different intervention programmes focused on coordination, neuromuscular control, and/or strength training on FMS scores, as a reliable measurement of movement capacity. Similarly, both Bodden et al. [32] and Kiesel et al. [34] observed that an individualized training programme could improve FMS scores in adults participating in high-intensity activities. In contrast, Frost et al. [33] did not find significant differences in movement patterns after an individualized training programme in professional fire-fighters. Thus, due to the inconsistent evidence, the utility of the FMS to capture changes in movement patterns after a training intervention remains unknown [35].

Whilst previous research has suggested that poor fundamental movement patterns might impact injury risk, and despite the growing interest in the use of the 11+, no studies have assessed whether the 11+ can improve the quality of individual movement patterns. Thus, the aim of this randomised controlled trial study was to examine whether implementing the FIFA 11+ for 6 weeks as a warm-up can improve FMS scores in male soccer players.

## MATERIALS AND METHODS

### *Participants*

Twenty-three amateur male soccer players (age: 24.7±.3.8 years; height: 1.77±0.58 m; body mass: 73.9±6.2 kg) participated in this study. All players were members of the same team, performed 3-4 soccer sessions weekly, and on average exercised 7.1±0.7 h•wk$^{-1}$ in their normal training cycle. The team also regularly completed one official match per week. An a priori power analysis [36] (G*Power, version 3.1.9.2, Universität Kiel, Düsseldorf, Germany) for an effect size of 1.05, an assumed type I error of 0.05 and a type II error rate of 0.20 (80% statistical power) was conducted. The total sample size computed by this method revealed that 11 persons per group would be sufficient to observe medium group × time interaction effects. The study protocol took place during the second half of the competitive period of the season (i.e. March to April). The players had never participated in a regular/systematic 11+ training programme. Players' data were excluded from analysis if they did not attend 90% of the training sessions. Exclusion criteria were injuries resulting in missing one or more soccer matches/training sessions in the 3 months prior to the initiation of the study. All the subjects were informed of the purpose of the study and gave their informed consent according to the Declaration of Helsinki. The study was approved by the Investigational Review Committee of the Department of Physical Education and Sport Sciences. The subjects were randomized by a co-author not directly involved in testing or the training intervention into one of two groups, the 11+ group (*n*= 12) and the control group (*n*= 11). The flow of participants is presented in Figure 1. No significant baseline differences were found between

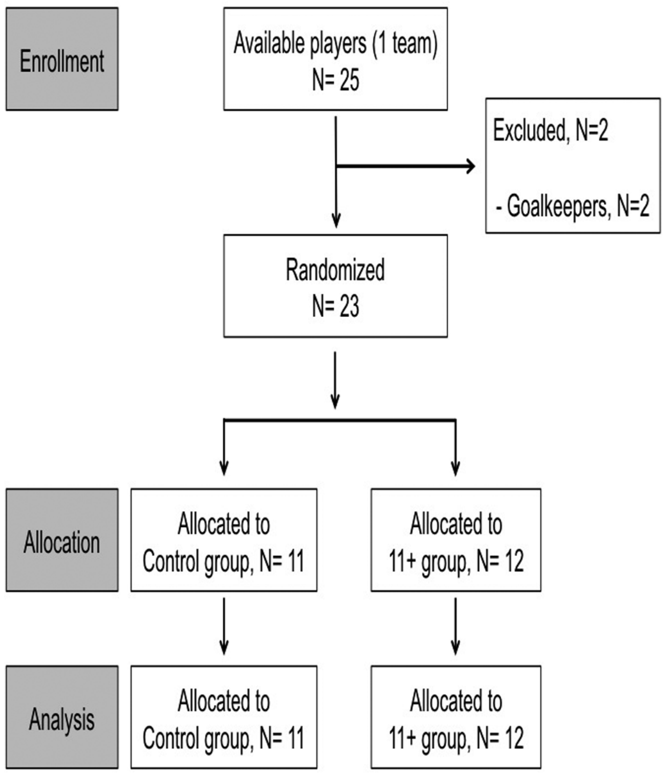


**FIG. 1.** Flow chart showing the selection of the study sample.

**TAB. 1.** Physical characteristics (mean±SD) of the players participating in the study.

| | 11+ group (n= 12) | Control group (n= 11) |
|---|---|---|
| Age (y±SD) | 24.9±3.7 | 24.6±.3.1 |
| Weight (kg±SD) | 73.7±6.1 | 74.1±6.8 |
| Height (cm±SD) | 177.5±5.9 | 178.0±4.8 |

groups in terms of age, body mass, body height, and body mass index (Table 1). The randomization was computer generated. Both the 11+ group and the control group had a similar distribution of playing positions and playing time.

### *Design*

A 2-group randomized controlled trial design was used to determine the effects of the 11+ warm-up training programme when conducted in combination with regular soccer training on FMS performance. The 11+ programme was added to their daily training routines. The experimental intervention consisted of 1 session of pre-test, 6 weeks of supervised training intervention, and 1 session of post-test. A week before the pre-testing session commenced, all participants attended a familiarisation session to learn how to perform each of the 11+ exercises correctly. During testing sessions, the participants were required to wear the same athletic equipment and measurements were conducted at the same time of the day to minimize the effect of diurnal variations on the selected parameters during the two experimental sessions. All soccer players were instructed to maintain their habitual lifestyle and normal dietary intake before and during the study. Additionally, the subjects were told to consume their last (caffeine-free) meal at least 3 hours before the scheduled test time. All data collection and test sessions were performed in an indoor court where ambient temperature ranged from 18 to 21 degrees Celsius.

### *Fundamental Movement Patterns Assessment Procedures*

To determine the effects of the 11+ programme on fundamental movement patterns, the FMS test was selected. All tests were performed after 48 hours of rest and at the same venue under identical conditions. Three of the authors of the study completed the FMS screening with each subject. All of them had at least three years of experience and training in FMS administration and interpretation. The FMS consists of 7 movement patterns that include an overhead deep squat, hurdle step, in line lunge, shoulder mobility, active straight leg raise, rotary stability, and push-up. Participants completed the test stations in a counterbalanced order to minimize the influence of an order effect. Details of each task have been published previously [24]. The administration of the FMS was carried out in accordance with previously published guidelines [24] using the FMS test kit (Functional Movement Systems, Chatham, VA). The players were familiarized with the movements required prior to the recorded testing. All movement patterns were scored on a 0-3 scale, and the maximal FMS score that could be achieved was 21. Each test was performed 3 times with approximately 30 s of rest between each repetition, and the best value of each attempt was recorded, while bilateral tests utilized lower score values. In the bilateral tests (hurdle step, in line lunge, shoulder mobility, active straight leg raise, and rotary stability) the lower of the two scores (right or left) was assigned to contribute to the FMS total score. To achieve a deeper understanding of where differences in the FMS total score existed between the 11+ group and the control group, we separated the screen into 3 parts [37]: $FMS_{move}$ (overhead deep squat, hurdle step, inline lunge); $FMS_{flex}$ (shoulder mobility, active straight leg raise) and $FMS_{stab}$ (rotary stability, push-up). Players completed the FMS with guidance from a researcher trained in using the FMS. Other than the standardized verbal instructions, no additional coaching points were used during the screening process. In order to increase the reliability of measurement, FMS tests were recorded on video and analyzed using video analysis software [38]. Baseline testing occurred in mid-July during the pre-season while post-testing occurred in late August one week after the season started. Three raters reviewed all videos and scored each test individually according to the scoring criteria. A subgroup analysis showed good inter-rater reliability (intraclass correlation coefficient, 0.899) between the raters and excellent intra-rater reliability (intraclass correlation coefficient, 0.991) for FMS total score via video observation.

### *Intervention programme*

The 11+ programme consisted of 3 different parts: 6 running exercises at low speed (part 1), 6 exercises targeting strength, balance, neuromuscular control and core stability with 3 levels of increasing difficulty (part 2), and 3 running exercises at moderate/high speed (part 3). For the second component, players progressed to the next difficulty level of an exercise once they demonstrated the correct form for the entire duration of the exercise. The intervention programme had to be carried out 3 times a week, on non-consecutive days (48 h rest) during 6 consecutive weeks. The 11+ warm-up lasted ~25 minutes and was conducted before starting regular practice, replacing the team's standard warm-up. The 11+ warm-up was conducted and controlled by the team's fitness trainer, who was experienced in the delivery of the 11+. The control group warmed up with standard jogging, ball exercises, and active stretching to match the duration of the 11+. Additionally, the control group was guaranteed that they would undertake the 11+ programme in the following season.

### *Statistical Analysis*

All variables were normally distributed (Shapiro-Wilk test). The homogeneity of variance was verified with the Levene test. Data are presented as means with standard deviation (SD). A 2 (group: 11+ and control group) × 2 (time: pre, post) mixed repeated measures analysis of variance (ANOVA) was performed for each parameter. Partial eta squared ($\eta_p^2$) effect sizes for the time × group interaction effects were calculated. An effect of $\eta_p^2 \geq 0.01$ indicates a small, ≥ 0.059 a medium, and ≥ 0.138 a large effect [39]. Additionally, Cohen's *d* effect sizes for identified statistical differences were determined. Effect sizes with values of 0.2, 0.5, and 0.8 were considered to represent small, medium, and large differences respectively [39]. Finally, a chi-square ($\chi^2$) analysis was carried out to determine whether the group was related to improvement above the injury risk threshold (≤14). In addition, effect sizes were computed to qualify the $\chi^2$ test results. The appropriate index of effect size is the phi coefficient ($\varphi$) if there is one degree of freedom [40]. A value of 0.1 is considered a small effect, 0.3 a medium effect and 0.5 a large effect.

**TAB. 2.** Changes in individual and total scores of the Functional Movement Screen (FMS™) following 6 weeks of 11 Plus training performed on and control condition in male amateur soccer players.

| | Control Group (n=11) | | | 11 + Group (n=12) | | |
|---|---|---|---|---|---|---|
| | **Pre** | **Post** | **Δ (%)** | **Pre** | **Post** | **Δ (%)** |
| Total FMS score | 14.81±1.40 | 15.90±1.22 | 7.99 | 13.90±2.21 | 15.18±1.40 | 10.51 |
| $FMS_{move}$ | 5.90±0.70 | 6.09±0.94 | 3.63 | 4.72±0.90 | 5.27±1.00 | 14.24 |
| Deep Squat | 1.90±0.70 | 2.00±0.77 | 4.54 | 1.50±0.67 | 1.66±0.65 | 20.83 |
| Hurdle Step | 1.83±0.38 | 1.83±0.38 | 4.16 | 1.36±0.50 | 1.54±0.52 | 22.72 |
| Right | 2.00±0 | 2.00±0.42 | 0 | 1.63±0.50 | 2.09±0.53 | 40.90 |
| Left | 1.83±0.38 | 1.83±0.57 | 0 | 1.54±0.52 | 1.54±0.52 | 0 |
| In-line Lunge | 2.16±0.38 | 2.25±0.62 | 4.16 | 1.90±0.53 | 2.00±0.44 | 6.06 |
| Right | 2.18±0.40 | 2.18±0.40 | 0 | 2.25±0.62 | 2.66±0.49 | 26.38 |
| Left | 2.09±0.70 | 2.18±0.60 | 7.57 | 2.16±0.38 | 2.41±0.51 | 8.33 |
| $FMS_{flex}$ | 4.58±1.24 | 5.16±0.83 | 18.33 | 4.54±1.29 | 4.91±0.83 | 14.39 |
| Shoulder Mobility | 2.25±0.75 | 2.50±0.52 | 22.22 | 2.18±0.75 | 2.45±0.52 | 22.72 |
| Right | 2.66±0.49 | 2.50±0.52 | -4.16 | 2.63±0.67 | 2.63±0.50 | 6.06 |
| Left | 2.36±0.81 | 2.63±0.50 | 22.72 | 2.33±0.77 | 2.66±0.49 | 25.39 |
| Straight Leg Raise | 2.33±0.77 | 2.66±0.65 | 12.50 | 2.36±0.80 | 2.45±0.68 | 4.54 |
| Right | 2.50±0.67 | 2.66±0.65 | 5.55 | 2.63±0.67 | 2.73±0.50 | 7.57 |
| Left | 2.50±0.67 | 2.66±0.65 | 5.55 | 2.36±0.80 | 2.44±0.68 | 4.54 |
| $FMS_{stab}$ | 4.50±0.52 | 4.66±0.49 | 4.16 | 4.63±0.92 | 5.00±0.44 | 10.90 |
| Rotary Stability | 1.50±0.52 | 1.66±0.49 | 16.66 | 1.72±0.78 | 2.00±0.44 | 34.84 |
| Right | 1.58±0.51 | 1.83±0.57 | 20.83 | 1.72±0.78 | 2.09±0.53 | 43.93 |
| Left | 1.50±0.52 | 1.66±0.49 | 15.71 | 1.81±0.87 | 2.09±0.53 | 54.54 |
| Push-up | 3.00±0 | 3.00±0 | 0 | 2.91±0.30 | 3.00±0 | 4.54 |

$\eta_p^2$= partial eta squared; Total FMS score = sum of the seven individual test items in the Functional Movement Screen; $FMS_{move}$= FMS movement; $FMS_{flex}$= FMS flexibility; $FMS_{stab}$= FMS stability.

## RESULTS

Absolute values for each parameter at pre- and post-test, together with the ANOVA results, are displayed in Table 2. In the within-group analysis, significant improvements in FMS total score were found in the 11+ (+10.51%; *d*= 0.83) and control group (+7.99%; *d*= 0.68) from pre-test to post-test (Figure 2). Players in both the 11+ and control groups also showed significant enhancements in $FMS_{flex}$ (+14.39%; *d*= 0.34 and +18.33%; *d*= 0.54, for 11+ and control group, respectively) from pre-test to post-test. There were no between-group differences (11+ vs. control) in any variable (Table 2). Finally, at the post-test a significantly greater number of players in the 11+ group exhibited a score that improved to above the injury threshold (≤14) ($\chi^2$= 3.967, p= 0.046, $\varphi$= 0.408) (Table 3).

| Δ (%) between 11+ and control group | ANOVA *P* values ($\eta p^2$) | | |
|---|---|---|---|
| | time | group | time × group |
| 2.51 | **0.001 (0.453)** | 0.202 (0.080) | 0.757 (0.005) |
| 10.60 | 0.090 (0.137) | **0.006 (0.324)** | 0.384 (0.038) |
| 16.28 | 0.200 (0.077) | 0.192 (0.08) | 0.701 (0.007) |
| 18.56 | 0.410 (0.033) | **0.023 (0.222)** | 0.410 (0.033) |
| 40.9 | 0.068 (0.150) | 0.307 (0.050) | 0.068 (0.150) |
| 0 | --- | --- | --- |
| 2.10 | 0.584 (0.015) | 0.090 (0.131) | 0.981 (0.001) |
| 26.38 | 0.140 (0.101) | 0.087 (0.133) | 0.140 (0.101) |
| 0.76 | 0.275 (0.056) | 0.390 (0.035) | 0.607 (0.013) |
| -3.94 | **0.010 (0.277)** | 0.725 (0.006) | 0.518 (0.020) |
| 0.50 | **0.034 (0.196)** | 0.818 (0.003) | 0.923 (0.001) |
| 10.22 | 0.451 (0.027) | 0.796 (0.003) | 0.451 (0.027) |
| 2.67 | **0.006 (0.303)** | 0.991 (0.001) | 0.765 (0.004) |
| -7.96 | **0.023 (0.224)** | 0.760 (0.005) | 0.174 (0.086) |
| 2.02 | 0.451 (0.027) | 0.828 (0.002) | 0.451 (0.027) |
| -1.01 | 0.200 (0.077) | 0.538 (0.018) | 0.701 (0.007) |
| 6.74 | 0.055 (0.164) | 0.307 (0.050) | 0.459 (0.026) |
| 18.18 | 0.100 (0.124) | 0.182 (0.083) | 0.682 (0.008) |
| 23.10 | 0.053 (0.167) | 0.342 (0.043) | 0.708 (0.007) |
| 38.83 | 0.139 (0.101) | 0.101 (0.123) | 0.714 (0.007) |
| 4.54 | 0.307 (0.050) | 0.307 (0.050) | 0.307 (0.050) |

## DISCUSSION

This is the first study to investigate the effects of the in-season 11+ injury prevention warm-up programme in combination with regular soccer training on FMS scores in amateur male soccer players. The main finding of our study was that the post-training changes in FMS scores were not different between the 11+ and control groups.

Movement screening is a type of assessment frequently used within athletes that aims to measure the quality of fundamental movement patterns in order to identify injury risk factors [41]. FMS is one such screening test that is widely used with the goal of identifying deficits in movements that may predispose to future injury [25]. Moreover, the 11+ warm-up is frequently used as a prophylactic strategy in an attempt to reduce sport-related injuries in soccer and other team sports. However, there is currently no evidence of the ability to change scores on the FMS based on an in-season 11+ programme intervention.

Several studies have shown that the 11+ injury prevention programme can induce various positive adaptations in the long term that may potentially contribute to improving or preventing risky movement patterns [16-22]. For example, Daneshjoo et al. [20] reported that, as compared to a control group, an eight-week 11+ programme

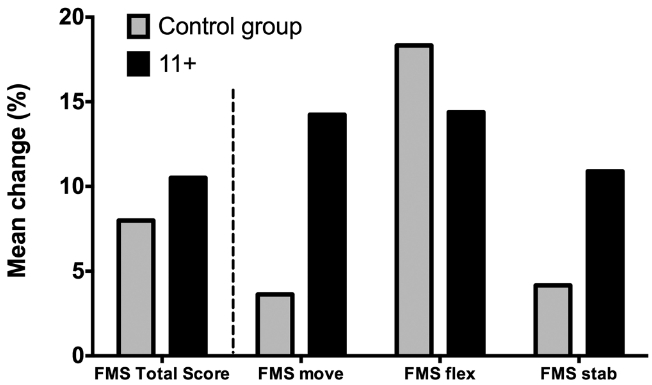


**FIG. 2.** Percentage of change from pre-test to post-test in FMS total score, $FMS_{move}$, $FMS_{flex}$, and $FMS_{stab}$.

**TAB. 3.** Changes in number of players of composite FMS score from pretest to posttest.

| | | Pre-test | | Post-test | | $\chi^2$ (Degrees freedom) | p value | Phi (φ) |
|---|---|---|---|---|---|---|---|---|
| | | n | % | n | % | | | |
| 11+ group | ≤14 | 6 | 50 | 1 | 8.4 | | | |
| | >14 | 6 | 50 | 11 | 91.6 | 3.967 (1) | 0.046 | 0.408 |
| Control group | ≤14 | 6 | 54.5 | 3 | 37.5 | | | |
| | >14 | 5 | 45.5 | 8 | 62.5 | 1.692 (1) | 0.193 | 0.277 |

increased concentric and eccentric hamstring strength in young male professional soccer players, which might reduce the susceptibility of a player to suffering hamstring muscle injuries. In a similar way, Impellizzeri et al. [21] analysed the effects of the 11+ performed 3 times a week for 9 weeks on neuromuscular control in male amateur soccer players. The results of the study showed that the 11+ improved the time to stabilisation after a double-leg take-off jump and core stability of the trunk through the unstable sitting posture test, which may be relevant for injury prevention in soccer players.

In the present study, the FMS was used to evaluate the fundamental movement patterns of soccer players before and after 6 weeks of 11+ warm-up training. It was hypothesized that the FMS scores of the 11+ group would exhibit greater changes than what would be expected in the control group. However, the present data did not corroborate this hypothesis. The results showed that both the 11+ group (ES=0.83) and the control group (ES= 0.68) significantly improved the total score on the FMS. The data also indicated that both intervention programmes significantly increased the partial score for $FMS_{flex}$. However, surprisingly, no differences between groups were observed. At first glance, these findings apparently suggest that regular soccer practice may be sufficient to improve FMS scores in amateur players and that the use of the 11+ training programme provides no additional gains in fundamental movement patterns quality. However, it may also suggest that longer intervention periods than those used in this study may be required. It is difficult to directly compare our results to other research, as we are unaware of any other published study to date which has tested the FMS changes after the 11+ training programme. However, these findings are partially in agreement with previous scientific evidence in female soccer athletes: Thompson et al. [22] examined changes in biomechanical risk factors for an anterior cruciate ligament injury in preadolescent female soccer players after 15 in-season sessions of the F-MARC 11+ programme. Their study revealed an increase in peak knee valgus moment during pre-planned and unanticipated cutting tasks for both the control and intervention groups, without significant differences between them.

Despite the 11+ warm-up being a multifaceted soccer-specific prevention programme that includes core stability, balance, and neuromuscular control that promotes proper motion patterns, in light of these results, the 11+ does not seem to provide additional benefits regarding the standard warm-up in the improvement of movement patterns. Nevertheless, due to the greater pre-to-post percentage changes observed in the 11+ group, future research with broader samples and longer intervention periods is required in order to confirm these findings.

Despite divergent results of previous studies, most of the evidence suggests that FMS total scores of ≤14 are associated with an increased injury risk compared with scores of >14 [27,34]. In the present study we observed a significant increase in the number of players who scored above the injury threshold at the post-test only in the 11+ group (from 50% in the pre-test to 91.6% in the post-test) (Table 3). These findings are comparable with the results of Kiesel et al. [34] following a 7-week programme of corrective exercises in professional American football players, and with those observed by Bodden et al. [32] in mixed martial arts athletes, who reported improvements of 52% and 66%, respectively, in the number of subjects who scored higher than 14. Although the present study did not investigate the effects of the 11+ warm-up training programme on lower limb injury, the findings of the study highlighted important practical implications within the context of injury prevention, as 41.6% (from 50% in the pre-test to 91.6% in the post-test) (Table 3) of the players in the 11+ group were able to improve the previously established injury factor of 14 [25].

The interpretation and broader implications of the present data must be understood within the limits of the specific data collection undertaken. Although the study had many unique aspects, there are some limitations to note. First, the duration of the intervention period was relatively short (6 weeks), and due to the greater pre-to-post percentage changes observed in the 11+ group, future studies with longest intervention periods may offer more conclusive findings. While participant numbers in this study were similar to other studies that have assessed the efficacy of the 11+ in soccer players [42], our sample size was relatively small. Future studies using larger sample sizes may be able to provide more generalizable results. Finally, other movement proficiency indicators were not included in the study in an attempt to keep it simple, non-invasive, and practical.

Although implications for injury prevention cannot be deduced from the present study, due to the improvements observed in the number of players who scored above the injury threshold in the 11+ group, it may plausible to hypothesize that the regular implementation of the 11+ might also expose soccer players to reduced injury rates.

## CONCLUSIONS

In conclusion, this study suggests that regular implementation of the 11+ injury prevention programme may not produce additional improvements in the quality of fundamental movement patterns other than those produced by a standard warm-up.

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