Sport Sciences and Health Research

University of Tehran
Faculty of
Physical Education and Sport Science

The effect of 11+Kids program on the scores of musculoskeletal screening tests

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Article Info

Original Article

Article history:

Received: 18 August 2020

Revised: 26 August 2020

Accepted: 12 October 2020

Published online: 1 January 2021

Keywords:
FIFA 11+ Kids,
injury prevention,
neuromuscular training,
soccer player.

Abstract

Background: Children and adolescents are more vulnerable to injuries than other groups. Therefore, it is necessary to use screening tests to identify players who are more susceptible to be injured and in parallel, using intervention programs to reduce the risk of injury.

Aim: The purpose of this study was to investigate effect of 11+Kids program on the scores of musculoskeletal screening tests

Materials and Methods: Forty-eight players were randomly assigned into the FIFA 11+Kids (mean±SD; age= 12.70±1.30 years; weight= 44.34±6.16 kg; height= 1.52±0.09 m) and control groups (mean±SD; age= 12.91±1.31 years; weight= 45.51±8.13 kg; height= 1.55±0.11 m). The FIFA 11+ Kids performed instead of the usual warm-up for 8 weeks, while the control group performed their usual warm-up program. Functional movement screen (FMS) and special football jump-landing task (SFJLT) tests were examined in pre-test and post-test.

Results: The independent t-test showed no significant differences between the FIFA 11+ Kids and the control group in the FMS test (*P*= 0.055). Furthermore, results showed significant differences between groups in the SFJLT test (*P*= 0.001).

Conclusion: Performing 8 weeks of FIFA 11+Kids can improve the musculoskeletal screening test score of SFJLT as a field-assessment soccer-specific jumping-landing test. It is suggestive that a field-based assessment tool to identify prone athletes is more beneficial than the FMS test of adolescent male soccer players.

Cite this article: Alimoradi M, Daneshjoo A, Sahebozamani M, Noorian, S. "The effect of 11+Kids program on the scores of musculoskeletal screening tests". *Sport Sciences and Health Research*. 2021, 13(1): 115-126. doi: 10.22059/SSHR.2021.88450.

EISSN: 2717-2422 | Web site: https://sshr.ut.ac.ir/ | Email: sshr@ut.ac.ir

 Publisher: University of Tehran, Faculty of Sport Sciences and Health

1. Introduction

Soccer is one of the most widely played sports in the world with almost 300 million male and female registered players in the world, being equivalent to 4% of the world's population [1, 2, 3]. In addition, about 58% of soccer players are under 18-year-olds and nearly 75% of these young players are under 14-year-olds [4]. Although soccer has many health benefits for players, as a high-impact challenging sport by requiring variety of skills associated with a notable risk of injury such as jumping-landing and change of direction maneuver [1, 5, 6]. Soccer players aged under 14-year-olds seem that associated with more non-contact injuries [7].

Kolstrup et al. (2016) reported 15.3 per 1000 player hours rate of injury among adolescent soccer players [8]. Moreover, previous studies demonstrated the rate of injuries among adolescent soccer players increase with age [9]. For instance, injuries to players under 12-year-olds have been reported to be 1.0 to 1.6 per 1000 hours, whilst adolescents have demonstrated an injury rate of 2.6 to 15.3 per 1000 hours [4, 10, 11]. It has been affirmed that multifaceted warm-up exercise programs aiming to improve the modifiable risk factors such as strength, balance, and flexibility can reduce the incidence of injury in soccer players [12, 13]. Thus, the injury prevention programs may be effective to reduce health concerns in terms of the burden on health care systems, financial losses, and time lost and productivity [14].

One structured injury prevention program that designed especially for under age of 14 players is FIFA 11+ Kids [4]. The FIFA 11+Kids have been designed by specialists at FIFA Medical Assessment and Research Center (FMARC) [4]. This age-specific program has been aimed to improve the spatial orientation, anticipation, and attention, increase the postural stability, neuromuscular coordination, strength, and finally teach the appropriate landing techniques [4]. Recent studies have indicated that FIFA 11+Kids is effective to enhance some modifiable risk factors such as concentric hamstring and quadriceps' strength [15], landing pattern [16], physical fitness [7], motor performance [17] and neuromuscular control [18]. Additionally, it has been revealed that use of 11+Kids can reduce risk of lower extremities in adolescent soccer players [4]. All of these factors may potentially effective to decrease risk of movement patterns [19].

Prior researches have indicated that low-quality movement patterns may predispose to an increased risk of injury [20]. Due to the increased number of sports injuries among adolescent soccer players, pre-participation screening physical evaluation is extremely crucial and important, and its aim is to improve physical performance abilities and consequently prevent injuries [21, 22]. Two widely used in-the-field sport medicine screening tools are the functional movement screen (FMS) test and the special soccer jump-landing task (SFJLT) [2, 23]. These two tests are used to identify functional movement deficits to stratify movement patterns based on the normal performance of active healthy people and may be predictive of players at risk of lower extremities injury [2, 24].

Identifying risk factors and injury prevention factors in the largest sport population in the world is a critical issue [25]. Earlier studies have shown FIFA 11+ Kids program is beneficent and effective to prevent injuries in adolescent soccer players [4, 26]. Moreover, previous literature have

suggested that poor fundamental movement might increase risk of injury and researchers have evaluated the effect of different intervention programs on musculoskeletal screening tests [19, 27, 28, 29], but to our knowledge, no studies have measured the effect of 11+Kids on quality of movement patterns among adolescent soccer players. Therefore, the purpose of current study was to examine whether performing the FIFA 11+Kids for 8 weeks as a warm-up can improve scores of musculoskeletal screening test in adolescent soccer players.

2. Materials and Methods

2.1. Ethics

All subjects signed a written consent form. Informed consent from the next of kin, caretakers or guardians on the behalf of the minors was obtained. The study procedures complied with the latest version of the Declaration of Helsinki. It was approved by the ethical committee of Shahid Bahonar University of Kerman, Iran (IR.UK.VETMED.REC.1399.022).

2.2. Subjects

Two under-14 (U10-U14) teams from two elite soccer clubs (i.e., the Sanat Mes Kerman F.C and the Technique club) with at least 3 years experiences of playing soccer and regular training, volunteered to participate in this study (the demographic information of subjects is available in Table1). The players from one team were randomly selected and assigned to one of the intervention programs. The sample size estimation was determined by G*Power (version 3.1.9.4) and with effect size of 0.8, an alpha level of 0.05 comparing two groups using independent t-test, 48 subjects showed power of 0.86 [30]. Exclusion criteria consisted of no history of the severe injury or surgery in last 6 months ago, fractures, joint replacements of the lower extremity, and absence in three intervention sessions. Goal keeper were excluded from this study.

Table 1. Demographic information of the subjects

Group	Players (n)	Age (years)	Height (cm)	Weight (kg)	Experience (years)	Fat (%)
11+	24	12.70±1.30	152.75±9.79	44.34±6.16	4.08±0.71	9.57±2.19
Control	24	12.91±1.31	155.79±11.11	45.51±8.13	3.95±0.80	9.57±2.23

2.3. Procedure

Before starting the intervention program, the coaches and players of the intervention group were invited to an education course that was given by an experienced researcher who aimed to prescribe the warm-up intervention programs in detail. All the coaches and participants received video and illustrations of the FIFA 11+Kids program. All the training sessions were supervised by the same researcher to ensure their compliance with the programs. Verbal encouragement was given throughout the intervention period to motivate the players concentrate on the quality of their exercise. The groups were matched during the pre-test using the anthropometric measurements. All tests were conducted between 1:00 and 4:30 p.m. All tests were demonstrated for the players and they were allowed to practice some trials until they felt more comfortable with the test procedure. The 11+Kids performed by one coach of each team and it should be noted that one of the researchers randomly attended the training session of the teams to confirm the correctly perform the 11+Kids program.

2.4. FIFA 11+Kids

The 11+Kids is a special prevention soccer injury program for 7 to 13-year-old players. It was developed based on findings on epidemiological data related to incidence and characteristics in child soccer players [4]. The program consisted of seven different exercises: a running game, two jumping exercises, a balance/coordination task, two exercises focusing on body stability, and one exercise to enhance landing technique [17]. The 11+Kids has a modular structure and each exercise includes five difficulty levels with progressive load [4]. If players do exercises without error, they can proceed to the next level of the program [31]. In the current study, the intervention group replaced the 11+Kids with their normal warm-up and the players completed the 11+Kids two times a week for 8 weeks.

2.5. Control group

The control group was asked to use their usual warm-up routine and warm-up without any restrictions.

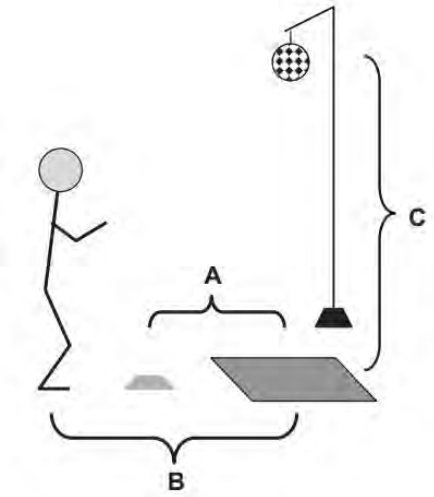
2.6. Functional Movement Screen (FMS)

The Functional Movement Screen (FMS) is a comprehensive screening program that assesses the quality of fundamental movement patterns to identify an individual's limitations or asymmetries (ICC= 0.92) [24]. The FMS test consists of seven movements, which are: deep squat, hurdle step, in-line lunge, shoulder mobility, active straight leg, push-ups, and rotatory stability. Performance was assessed on a scale of 0 to 3 (0=pain during movement, 1=fail to complete movement, 2=perform compensatory movement, 3=perform to perfection). In this test, each movement was repeated three times and the overall score can range from 0-21 [32]. Subjects performed each movement three times with a one-second rest between each and a one-minute rest between each element of the FMS test [33, 34].

2.7. Special Football Jump-Landing Task (SFJLT)

The Special Football Jump-Landing Task (SFJLT) is a field-assessment soccer-specific jumping-landing test for identifying movement error patterns [35]. Movement patterns and errors are scored based on landing error scoring system. There are 17 scored items in this test. A higher score shows poor landing technique and a lower score show better jump-landing movement technique [27].

Before the SFJLT, vertical jumping height of all participants using the Sargent jump test was assessed and used to normalize the height of the ball for the jump heading task. The participants were then asked to perform a jumping header (ball at 50% of the subject's maximum jump height) and then landed. The participants were asked to start at a position that was half of their body height away from the ball (Figure 1). A 7.5-cm cone placed in the middle of start position and under the ball place. They were asked to jump over the cons, down under the ball, and immediately perform a jumping header. The participants were asked to perform the task as naturally as possible and no restriction on upper bodies during jumping landing was made [35]. In this study, during the SFJLT task, two digital cameras (Gopro9) that were located at 3 m distance of the subjects, were used to record tests in two sagittal and frontal planes [2]. Then, data was analyzed using Kinovea software (version 0.7.10) and the players were scored based on their jumping-landing movement errors.



A= 25% subject height from center of under the ball to start position
B= 50% subject height from center of under the ball to start position
C= center of soccer is ball is 50% maximum vertical jump height

Figure 3. Diagram subjects testing SFJLT

2.8. Statistical analysis

Statistical analysis was performed by using SPSS software version 26 at a significance level of $P \leq 0.05$. Independent sample t-test was used to compare group age, weight, and height ($P > 0.05$). To analyze data between and within groups independent sample t-test and paired sample t-test were used, respectively. The effect sizes of 2-independent groups were tested using Cohen's d [$d = (M1 - M2 / \sqrt{((SD1^2 \times SD2^2) / 2)}$], (0.1, 0.3, and 0.5 as small, medium, and large effects, respectively) [36]. P values of 0.05 or less were considered statistically significant.

3. Results

For FMS test, the independent t-test showed no significant differences between the 11+ Kids and control group (t= 1.967, *P*= 0.055, d= 0.623). The paired sample t-test showed significant improvement by 7.6% in FMS scores of the 11+ Kids group (t= 9.094, *P*= 0.001, d= 0.783). No significant improvement between pre-test and post-test in control group (t= 0.327, *p*= 0.747; Table 2).

For SFJLT, results showed significant differences between groups (t= 5.141, *P*= 0.001, d= 1.514) and significant improvement between pre-test and post-test scores by 20.2% in the 11+ Kids' group (t= 8.877, *P*= 0.001, d= 1.188), but no significant difference between pre-test and post-test in control group was found (t= 1.543, *P*= 0.137; Table 3).

4. Discussion

This is the first study to investigate the effect of FIFA 11+Kids as an injury prevention program on the scores of musculoskeletal screening tests. The main results of present study showed that after an 8-week performing 11+Kids, significant improvements in scores of SFJLT between 11+ and control groups were observed.

Table 2. Changes in individual FMS following 8 weeks of 11+Kids training, percentage of change (Δ) (values are (post-test-pre-test/pre-test) ×100))

	The 11+ Kids			Control		
	Pre-test	**Post-test**	**Δ%**	**Pre-test**	**Post-test**	**Δ%**
Deep squat	1.55±0.39	1.69±0.70	9.0	1.86±0.70	1.82±1.07	2.1
Hurdle step	1.41±0.29	1.57±0.56	11.3	1.79±0.38	1.67±0.53	6.7
In-line lunge	1.97±0.31	2.04±0.47	3.5	2.11±0.38	2.05±0.86	2.8
Shoulder-mobility	2.26±0.44	2.50±0.56	10.6	2.20±0.75	2.28±0.72	3.6
Straight leg raise	2.44±0.47	2.50±0.73	2.4	2.28±0.77	2.43±0.91	6.6
Rotary-stability	1.78±0.46	2.04±0.47	14.6	1.47±0.52	1.51±0.68	2.7
Push-up	3.01±0.18	3.06±0	1.7	2.94±0	2.74±0	6.8

Table 3. Tests scores (values are mean ± SD), and percentage of change (Δ) (values are (post-test-pre-test/pre-test) ×100))

	The 11+kids			Control		
	Pre-test	**Post-test**	**Δ%**	**Pre-test**	**Post-test**	**Δ%**
FMS	14.4±1.3	15.5±1.5	7.6%	14.5±1.4	14.5±1.7	0%
SFJLT	9.4±1.8	7.5±1.4	20.2%	9.7±2.1	9.9±1.7	2.1%

FMS= Functional Movement Screen; SFJLT= Special Football Jump-Landing Task

Movement screening, a type of assessment, is used frequently within athletes that aims to evaluate the quality of fundamental movement patterns to identify injury risk factors [37]. Jump-landing is one of the main movements in soccer players and being classified as common injury mechanism in soccer players [27]. The results of the present study are similar to work of Hopper et al. (2017) who used neuromuscular training program to increase lower extremity biomechanics during landing among adolescent (11-13 years old) female netball players [38]. The results of their study affirmed that 6-week neuromuscular training program can improve landing biomechanics factors such as maximum knee flexion and extension range of motion that related to Anterior Cruciate Ligament (ACL) injury in adolescent female players [38]. In another study, Aerts et al. (2015) investigated the effect of a 3-month coach-supervised jump-landing injury prevention program on jump-landing pattern in 116 basketball players aged 15-41 years old [39]. They founded malalignments detected in the jump-landing score system such as knee valgus, knee flexion, and hip flexion improved after 3 months using injury prevention programs. Moreover, Parsons et al. (2019) showed performing 11+ program could improve the quality of landing pattern [40]. They founded athletes who performed the 11+ program had less error than control group during Landing Error Score System (LESS) test.

Knee injuries are multifactorial in essence and movement patterns are proposed to play a crucial role [41]. Improvement of the jumping landing movement pattern can decrease the risk of knee injuries, especially ACL injury [2]. Because normal movement pattern is induced the proper distribution of force on the tibia-femoral joint and consequently reduce risk of injuries [42]. However, Donnelly et al. (2013) with balance and technique training consisting of unilateral and unstable surface training with verbally instruction to maintain proper joint alignment during exercises [42] and Parsons et al. (2017) with strength training consisting of squats, lunges, side-lying leg lifts, and supine hamstring curls that all of those were selected to target major muscle groups which act to reduce acceleration and control landing movement [43] observed no tangible change on jump-landing biomechanics.

The FIFA 11+ Kids is not similar to the previous mentioned studies' intervention programs because those programs focused on only one or two factors, whereas the FIFA 11+Kids program is multifaceted and includes components such as running exercises, jumping, balance/coordination, body stability and improving fall technique that are performed during team warm-up [7, 31]. With investigation in previous literature, earlier researchers indicated that combination exercise such as plyometric and eccentric or strength and feedback training had positive effect on landing

pattern [44, 45], but exercise programs that their aims are only on improvement one factor did not show any positive effects [46].

One of the reasons effectiveness of FIFA 11+Kids program to improve the landing pattern may be using core exercises and correct lower extremity and body alignment during multiple exercises with coach commands (such as push-ups and spiderman) and verbal feedback [31, 47]. It was reported a strong relationship between weakness of core muscles complex and low control on body stability [48]. One of the roles of the core muscles is to help prevent incorrect movement patterns and keep trunk alignment and improve dynamic postural balance during dynamic movements [27]. Thus, improving the neuromuscular control of the core muscles likely promoted the landing movement pattern [49]. On the other hand, one aim of the FIFA 11+Kids program is to correct movement error techniques such as knee valgus and lopsided pelvis during landing and cutting movements (such as one leg hops and skating hops) by giving verbal and visual feedback about incorrect movement patterns. It is affirmed that coaches' feedback and instruction to correct jump and landing patterns can promote neuromuscular capabilities and quality of landing strategies [50]. It is suggestive using a field-based functional movement assessment tool because the generalization of results than other tests are more reliable.

In FMS test despite the improvement scores within 11+ group by 7.6%, surprisingly significant difference was not observed between the two groups from pre-test to post-test. At the first glance, it may seem the FIFA 11+Kids program was not sufficient adequately to provide additional gains on fundamental movement patterns quality, or it may need to perform intervention in more prolonged periods than in present study. FMS is movement screening test that is widely used to identifying movements error patterns that may lead to future injuries [19, 51]. Older studies suggested that FMS total scores of ≤14 are associated with an increased injury risk compared with scores of >14 [13, 52].

In the current study, we observed a significant increase in FMS total scores only in 11+ group, but it is difficult to conclude that this program can increase score test of FMS. The present results are in line with some studies [19, 28]. Rey et al. (2018) compare the effect of the 11+ with a routine warm-up on fundamental movement patterns using FMS test among amateur male soccer players [19]. They reported significant improvements in the FMS total score in the 11+ by 10.51%; and by 7.99% in the control group from pre-test to post-test, but no significant differences between groups was found. Furthermore, Baeza et al. (2017) examined changes in FMS total scores after 6 weeks of performing FIFA 11+ program in soccer players under 14 years old age [28]. They showed significant improvements in FMS total scores in the FIFA 11+ group, but between groups, no changes were found. They conclude that the six weeks FIFA 11+ program may not proper to significantly improvements movements patterns of soccer players. In contrast, Campa et al. (2019) showed functional movement patterns enhance (12.63±1.80 to 14.59±0.87 in intervention group) in youth elite male soccer players after 20 weeks performing specific corrective exercise program [53]. Sawczyn (2020) reported that 12-week functional strength training could be beneficial to enhance poor quality movements in physical education students

[54]. Some explanation for no significant differences between the effect of FIFA 11+Kids warm-up program and routine warm-up program in FMS test may be because of some movements in FMS test are not similar with exercise of the FIFA 11+ Kids exercises. For example, there is no exercise in FIFA 11+Kids which can improve quality of movements and scores of test such as: hurdle step, lunge and shoulder mobility. Although the FIFA 11+Kids is known as a multifaceted program that has divergent training elements, but no observed additional benefits seen between two groups. Nevertheless, because of greater pre-to-post percentage changes observed in the 11+, future studies with larger samples, and longer intervention periods is needed to support these results.

There are a few limitations that should be considered in interpreting the results. First, in the current study the sample size was small and it is suggested to consider a larger sample size for similar future studies. Second, The FIFA 11+Kids is a multifaceted warm-up program included seven different exercises being unable to explain the separate effects of each of these program elements. Third, the current study was done in limit duration (8 weeks) and the researchers could not conduct the follow-up tests to evaluate the effect of intervention over an extended period. Thus, the persistence of intervention should be measured over more an extended duration.

5. Conclusion

It can be concluded that implementation of the FIFA 11+Kids two times per week for 16 sessions can improve musculoskeletal screening test score of SFJLT as a field-assessment soccer specific jumping-landing test whereas the routine warm-up program did not change the SFJLT score. In FMS test despite the improvement scores within FIFA 11+Kids by 7.6%, significant difference was not observed between the two groups from pre-test to post-test. Based on our results it is difficult to conclude that this program can increase score test of FMS. It is suggested that field-based assessment tool to identify prone athlete is more beneficial than FMS test. It is suggested to using FIFA 11+ Kids more than 8-week intervention to find more improvement in movement patterns of adolescent male soccer players.

Conflict of interest

The authors declared no conflicts of interest.

Authors' contributions

All authors contributed to the original idea, study design.

Ethical considerations

The study was approved by the Research Ethics Committee of Sport Science Research Institute of Iran (Code No.: SSRI.REC-2106-1060 (R1)).

Data availability

The dataset generated and analyzed during the current study is available from the corresponding author on reasonable request.

Acknowledgments

The authors gratefully acknowledge all participants involved in this study.

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