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WJO covers topics concerning arthroscopy, evidence-based medicine, epidemiology, nursing, sports medicine, therapy of bone and spinal diseases, bone trauma, osteoarthritis, bone tumors and osteoporosis, minimally invasive therapy, diagnostic imaging. Priority publication will be given to articles concerning diagnosis and treatment of orthopedic diseases. The following aspects are covered: Clinical diagnosis, laboratory diagnosis, differential diagnosis, imaging tests, pathological diagnosis, molecular biological diagnosis, immunological diagnosis, genetic diagnosis, functional diagnostics, and physical diagnosis; and comprehensive therapy, drug therapy, surgical therapy, interventional treatment, minimally invasive therapy, and robot-assisted therapy.

We encourage authors to submit their manuscripts to *WJO*. We will give priority to manuscripts that are supported by major national and international foundations and those that are of great basic and clinical significance.

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Basic Study

Effect of a specialized injury prevention program on static balance, dynamic balance and kicking accuracy of young soccer players

Ayelet Dunskey, Ido Barzilay, Orly Fox

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Author contributions: Dunskey A designed and coordinated the research, and wrote the paper; Barzilay I performed the majority of experiments; Fox O analyzed the data.

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Abstract

AIM

To study the effect of balance intervention program using the "FIFA 11+" program on static and dynamic balance and kicking accuracy of young soccer players.

METHODS

Twenty young soccer players were allocated to experimental ($n = 10$) or control ($n = 10$) groups. The experimental group performed the "FIFA 11+" program three times a week for six weeks. The control group performed their normal warm-up routine. The primary outcomes were measured pre and post intervention, and assessed kicking accuracy, static balance and dynamic balance.

RESULTS

No differences were found in kicking accuracy following intervention, for both groups, however, static balance improved significantly among the experimental group with significant interaction with the control group, and with high effect size. In addition, the dynamic balance of the left leg of the experimental group, with medium effect size for interaction between groups.

CONCLUSION

The large effect size of balance improvement that was observed following six weeks of intervention sessions, implies that soccer trainers and coaches should consider the inclusion of "FIFA 11+" as components of programs aimed at improving balance ability/control in young soccer players, as improvement in balance abilities may prevent injuries.

Key words: Soccer; Injury prevention; Balance; Warm-up; Kicking accuracy

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Core tip: The implementation of "FIFA 11+" for six weeks of intervention, led to a large effect size of balance improvement among young soccer players. As improvement in balance abilities may prevent injuries, soccer trainers and coaches should consider the inclusion of "FIFA 11+" as a component of training programs in young soccer players.

Dunsky A, Barzilay I, Fox O. Effect of a specialized injury prevention program on static balance, dynamic balance and kicking accuracy of young soccer players. *World J Orthop* 2017; 8(4): 317-321 Available from: URL: <http://www.wjgnet.com/2218-5836/full/v8/i4/317.htm> DOI: <http://dx.doi.org/10.5312/wjo.v8.i4.317>

INTRODUCTION

Soccer is a sport requiring a plethora of technical skills as well as static, semi-dynamic and dynamic balance. Most of these skills, such as passing, juggling the ball in the air, dribbling or receiving the ball, are achieved through standing on one leg. Balance plays a pivotal role in the harsh conditions, such as pushing opponents, slippery grass, changes to the ball's orbit, moving, facing footballers during a football game^[1].

Balance ability has been found to be significantly related to several performances in sport, such as shooting accuracy of archers, pitching accuracy of baseball pitchers, maximum skating speed during ice hockey, and putting accuracy of golfers^[2]. While the relationship between balance and accuracy of ball kicking in soccer is randomly reported, it is well known that good balance seems to be effective in neuromuscular control performance^[1], and is considered a distinctive characteristic of high level soccer players at the same time^[3]. In addition, soccer players have been proved to surpass basketball players in static and dynamic balance and do not differ from gymnasts or dancers^[2].

Playing soccer, as with any other sport, entails some risk of injury. With more than 240 million amateur soccer players worldwide, it has the highest participation rate in the world, and it accounts for more than 10% of sport injuries requiring medical attention in adolescents^[4,5]. Based on those facts, injury prevention programs should be of major importance for soccer coaches and trainers. Considerable reductions in the number of injured players, ranging between 30% and 70%, have been observed among the teams that implemented the FIFA 11+ program^[6].

As poor balance has been correlated to increased risk of injury in athletes^[7], it was suggested that a program

Table 1 Descriptive statistics for anthropometric data of the participants (means and standard deviations)

Variable	Experimental	Control
Age (yr)	12.91 ± 0.26	12.75 ± 0.3
Height (cm)	153.6 ± 7.58	149.7 ± 7.45
Weight (kg)	44.8 ± 6.33	40.7 ± 6.5
Right leg length (cm)	80.4 ± 4.95	76.8 ± 5.05
Left leg length (cm)	79.7 ± 4.57	77.1 ± 4.86

based on balance improvement may reduce the risk of injury^[8].

One suggested program was the "FIFA 11+", which is a complete warm-up package that combines cardiovascular activation and preventive neuromuscular exercises. The key element of the program is the promotion of proper neuromuscular control during all exercises ensuring correct posture and body control, thus it is mainly based on balance control. Recently the "FIFA 11+" was found to induced improvements in neuromuscular control in amateur football players^[8], however in another study it was found to have no significant effect on vertical jump tests, sprint running and soccer skill tests in comparison to control condition^[9].

To the best of our knowledge, no studies have examined the changes in accuracy of ball kicking among young soccer players induced by the "FIFA 11+". Therefore, the main aim of this study was to examine whether implementing the "FIFA11+" for six weeks as a routine warm-up can improve kicking accuracy as well as static and dynamic balance abilities in young soccer players.

MATERIALS AND METHODS

The study was approved by the Zinman College of Physical Education and Sport Sciences Institutional Review Board.

Participants

Twenty young soccer players who agreed to participate, and had confirmation from their parents, were selected to take part in the study, and were allocated into two groups by their football group for convenience of training routine.

Inclusion criteria for the players were: (1) male amateur players competing in the Official Amateur Championships of the Israeli Football Federation; (2) supervised training 3 times a week for 90 min; (3) no major recent injuries; and (4) good physical condition for completing the baseline measurements.

Descriptive statistics for the group are presented in Table 1.

Intervention

Experimental group: The players completed "The FIFA 11+" (for details see the manual and instructions freely

1	3	1
3	5	3
1	3	1

Figure 1 Scoring grid for the kicking-accuracy protocol.

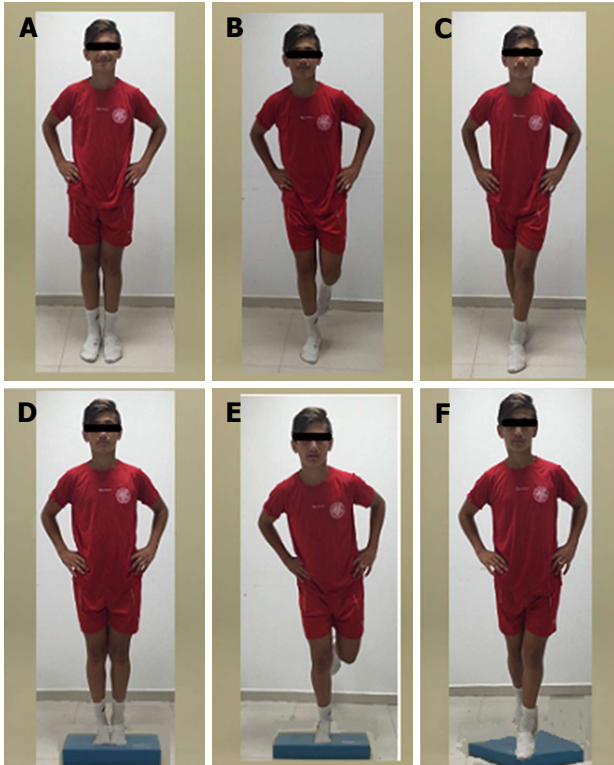


Figure 2 Stances used in Balance Error Scoring System. A: Double-leg stance; B: Single-leg stance; C: Tandem stance; D: Double-leg stance with foam; E: Single leg on foam; F: Tandem stance on foam.

available on the official website: <http://f-marc.com/fifa-11-kids/>) three times a week for six weeks substituting their normal warm-up routine. In brief, the protocol includes three parts: 8 min of running exercises, 10 min of strength, plyometric and balance exercises, and 2 min of explosive running exercises. From week one to two players performed the level 1, from week three to four they performed the level 2 and from week five to six they performed the level 3.

Control group: The control group received a normal warm-up routine while matching the duration of the "FIFA 11+" (20-25 min). This routine involved a combination of running, stretching, technical exercises with the ball and small-sided games.

The guidance of both groups were performed by the fitness coach who is familiar with the "FIFA 11+".

Assessments

Kicking accuracy: This test was performed based on Currell *et al.*^[10]. A goalmouth was split into nine equal targets by a series of ropes. Each target was allocated a different score: The center was worth 5 points, around

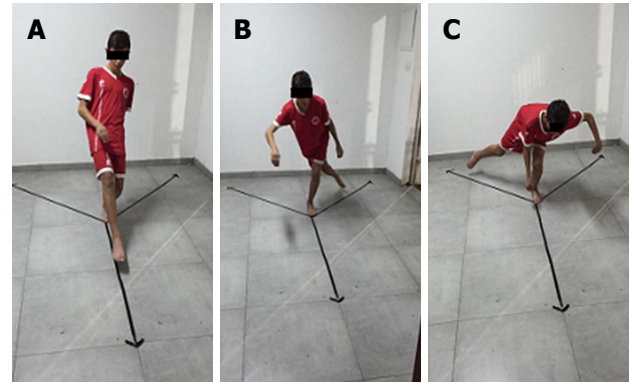


Figure 3 Postures used in the Y Balance Test. A: Y-balance anterior reach; B: Y-balance posteromedial reach; C: Y-balance posterolateral reach.

the center 3 points and the corners 1 point (Figure 1). Participants had 10 attempts from 16 m away, using their preferred foot and with the ball being stationary. On the completion of one kick the next immediately followed.

Balance ability: Static balance - Balance Error Scoring System^[11]. This test consists of three stances: Double-leg stance (hands on the hips and feet together), single-leg stance (standing on the non-dominant leg with hands on hips), and a tandem stance (non-dominant foot behind the dominant foot) in a heel-to-toe fashion (Figure 2). The stances are performed on a firm surface and on a foam surface with the eyes closed, with errors counted during each 20-s trial. An error is defined as opening eyes, lifting hands off hips, stepping, stumbling or falling out of position, lifting forefoot or heel, abducting the hip by more than 30°, or failing to return to the test position in more than 5 s. Dynamic balance - The Y Balance Test (YBT) assesses range of motion (ROM), strength, and neuromuscular control of the lower extremity and was chosen to assess the participants' lower limb balance as prior studies have demonstrated its utility as a clinical test to assess for lower limb balance deficits in the athletic population^[12]. The participant reaches with one foot in the anterior, posteromedial, and posterolateral directions while standing on the other foot on a centralized stance platform. The test is performed barefoot with both left and right limbs (Figure 3). Following the protocol, each participant was required to perform six practice trials before the three data-collection trials. With the stance-foot toes immediately behind the start line, the participant was instructed to reach as far as he could while maintaining his balance. Each participant was instructed that any of the following activities would constitute a failed attempt, after which an additional trial would be performed: (1) touching the reach foot down before returning to the stance platform under control; or (2) losing balance before returning under control to bilateral stance. The reach distance in each direction was normalized to the limb length (*i.e.*, inferior anterosuperior iliac spine to inferior medial malleolus). The sum of three normalized reach distances was then averaged and

Table 2 Means, standard deviations and analysis of variance comparing performance for kicking accuracy, static balance and dynamic balance

Variable	Experimental		Control		Cohen's <i>d</i>
	Pre	Post	Pre	Post	
kicking accuracy	2.69 ± 0.54	3.06 ± 0.72	2.5 ± 0.51	2.82 ± 0.38	0.11
Static balance - BESS	3.52 ± 0.78	3.35 ± 1.04	1.72 ± 0.66	2.94 ± 1.17 ¹	1.92
Dynamic balance - YBT-R	0.98 ± 0.07	1.03 ± 0.07	0.97 ± 0.06	1.00 ± 0.04	0.31
Dynamic balance - YBT-L	0.98 ± 0.08	1.04 ± 0.07 ²	0.97 ± 0.06	1.01 ± 0.04	0.32

¹Significant interaction ($F_{1,18} = 21.05$, $P < 0.01$); ²Significant improvement ($t = 1.78$, $P = 0.05$). BESS: Balance Error Scoring System; YBT-R: Y Balance Test Right leg; YBT-L: Y Balance Test Left leg.

multiplied by 100 to generate a composite score^[3].

Statistical analysis

A repeated measures ANOVA model was employed in order to determine possible statistically significant differences between the measurements and between the experimental and control group.

RESULTS

Both groups showed excellent adherence during the intervention period. More specifically, participants of the experimental group expressed their high enthusiastic about the "FIFA 11+" program, and asked their coach to continue with it.

The differences in kicking accuracy and balance assessments between pre and post intervention for the experimental group and the control group are presented in Table 2. No differences were found in kicking accuracy following intervention, for both groups, however, static balance improved significantly among the experimental group with significant interaction with the control group, and with high effect size. In addition, the dynamic balance of the left leg of the experimental group, with medium effect size for interaction between groups.

DISCUSSION

The results of this study show that the integration of "FIFA 11+" program for six weeks improved both static as well as dynamic balance ability, among young soccer players, but it did not improve the accuracy of kicking. The "FIFA 11+" has been developed for improving neuromuscular control^[8], which explains the improvement in balance control among the experimental group in the current study, and also in other studies^[8,13]. In addition, the implementation of "FIFA 11+" led to reductions in the number of injured players, ranging between 30% and 70%^[6].

Improvement in balance control as measured by the YBT is considered to be important for soccer players, since it is based on the combination of ROM, movement abilities, strength, and proprioception^[3]. Thus, improvements found in that assessment may imply better performances during soccer game.

In addition, some researchers investigated the effects of balance training on injury rates reduction concerning soccer players, since soccer is a contact sport associated with a large number of injuries involving adult as well as young players^[14]. In that matter, it was found that balance training was associated with reduced number of injuries among soccer players^[15,16]. However, Malliou *et al.*^[15] suggested that for better results of injury prevention, proprioceptive training should be incorporated with the balance training. It is important to mention in this matter, that the prevention of muscular injuries seems multifactorial and would imply nutrition and hydration to optimize performances and recovery, type of grounds, climatic conditions, or still stretching and strengthening protocols to restore limbs muscle imbalance^[17], thus, the possibility to predict injuries or to prevent injuries may still considered to be inconclusive.

The fact that the accuracy of kicking was not changed significantly may be explained by the short duration of the intervention, since we found some improvement in that variable, however it was not significant. It is possible that longer period of intervention would lead to significant improvement in kicking accuracy, based on the fact that kicking requires control and exploitation of large reactive forces while the performer preserves stability over a narrow base of support^[18].

Another possible explanation for the lack of changes in kicking accuracy is based on the "FIFA 11+" protocol. It is possible that if training protocols were designed to not just prevent injuries but also increase performance, they would lead to higher potential for athlete compliance^[9]. The "FIFA 11+" does not contain specific accuracy exercises, however based on the correlations that were found between kicking accuracy and single-leg balance^[18], it was suggested that improved balance would lead to improved accuracy. Still, no significant improvement was seen in kicking accuracy among the experimental group in comparison to the control group.

In the current study, the large effect size of balance improvement that was observed following six weeks of intervention sessions implies that soccer trainers and coaches should consider the inclusion "FIFA 11+" as components of programs aimed at improving balance ability/control in young soccer players, as improvement in balance abilities may prevent injuries.

COMMENTS

Background

Playing soccer entails some risk of injury and it accounts for more than 10% of sport injuries requiring medical attention in adolescents. As poor balance has been correlated to increased risk of injury in athletes, it was suggested that a program based on balance improvement might reduce the risk of injury.

Research frontiers

The "FIFA 11+", which is a complete warm-up package that combines cardiovascular activation and preventive neuromuscular exercises, was found to induce improvements in neuromuscular control in amateur football players. The key element of the program is the promotion of proper neuromuscular control during all exercises ensuring correct posture and body control, thus it is mainly based on balance control.

Innovations and breakthroughs

To the best of our knowledge, no studies have examined the changes in both balance as well as accuracy of ball kicking among young soccer players induced by the "FIFA 11+". The major result of the study implies a large effect size of balance improvement following six weeks of intervention sessions, with no significant change in kicking accuracy.

Applications

The large effect size of balance improvement that was observed following six weeks of intervention sessions, implies that soccer trainers and coaches should consider the inclusion of "FIFA 11+" as components of programs aimed at improving balance ability/control in young soccer players, as improvement in balance abilities may prevent injuries.

Terminology

The "FIFA 11+" program - A warm-up program that includes three parts: 8 min of running exercises, 10 min of strength, plyometric and balance exercises, and 2 min of explosive running exercises.

Peer-review

The review has a good level of quality and it is very interesting and adequate.

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