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The effect of 12 times training of the FIFA 11+ on fundamental movements in football academy athletes aged 14-17 as an effort to prevent injury

El efecto de entrenar 12 veces el FIFA 11+ sobre los movimientos fundamentales en atletas de academias de fútbol de 14 a 17 años para prevenir lesiones

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Abstract

This study aimed to examine the impact of the FIFA 11+ program, conducted over 12 training sessions, on improving fundamental movements in male football academy athletes aged 14-17. The research utilized a quasi-experimental design with pre- and post-tests. The sampling technique used was purposive sampling, involving 18 male players (age: 14.78 ± 1.00 ; height: 1.59 ± 7.27 ; weight: 46.64 ± 7.95) divided into a control group ($n=9$) and an experimental group ($n=9$). The experimental group performed the FIFA 11+ program as part of their 20-minute warm-up, three times per week over 12 sessions. This program comprises 15 exercises divided into three sections. Fundamental movement abilities were assessed using the Functional Movement Screen (FMS) instrument, and data were analyzed with a paired sample t-test and Cohen's D value to determine the effect size for each group. Results indicated no significant improvement in the control group following conventional warm-up exercises ($p=0.050$, Cohen's $D=0.770$). Conversely, the experimental group demonstrated a significant improvement with the FIFA 11+ intervention ($p=0.001$, Cohen's $D=2.287$). The effect size for the FIFA 11+ program was notably larger than for conventional warm-ups, which typically include running, stretching, and joint mobilization exercises. In conclusion, the study found that 12 sessions of the FIFA 11+ program effectively enhance fundamental movement skills in male football academy athletes aged 14-17.

Keywords: FMS, fundamental movements, injury prevention, FIFA 11+, football.

Resumen

Este estudio tenía como objetivo examinar el impacto del programa FIFA 11+, llevado a cabo durante 12 sesiones de entrenamiento, en la mejora de los movimientos fundamentales en atletas masculinos de academias de fútbol de entre 14 y 17 años. La investigación utilizó un diseño cuasiexperimental con pruebas previas y posteriores, en el que participaron 18 jugadores masculinos (edad: $14,78 \pm 1,00$; altura: $1,59 \pm 7,27$; peso: $46,64 \pm 7,95$) divididos en un grupo de control ($n=9$) y un grupo experimental ($n=9$). El grupo experimental realizó el programa FIFA 11+ como parte de su calentamiento de 20 minutos, tres veces por semana durante 12 sesiones. Este programa consta de 15 ejercicios divididos en tres secciones. Las capacidades fundamentales de movimiento se evaluaron mediante la prueba Functional Movement Screen (FMS), y los datos se analizaron con una prueba t de muestras emparejadas y el valor D de Cohen para determinar el tamaño del efecto para cada grupo. Los resultados no indicaron ninguna mejora significativa en el grupo de control tras los ejercicios de calentamiento convencionales ($p=0,050$, D de Cohen= $0,770$). Por el contrario, el grupo experimental demostró una mejora significativa con la intervención FIFA 11+ ($p=0.001$, D de Cohen= 2.287). El tamaño del efecto del programa FIFA 11+ fue notablemente mayor que el de los calentamientos convencionales, que suelen incluir correr, estiramientos y ejercicios de movilización articular. En conclusión, el estudio halló que 12 sesiones del programa FIFA 11+ mejoran eficazmente las habilidades de movimiento fundamentales en atletas masculinos de academias de fútbol de entre 14 y 17 años.

Palabras Clave: FMS, movimientos fundamentales, prevención de lesiones, FIFA 11+, fútbol.

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Introduction

Football is a very popular sport worldwide, with more than 265 million players, mostly young people (Aguilar Gómez, 2023). There are advantages to these high participation numbers but they also increase the chance of injury. Prevention of these injuries was closely linked to the presence of modifiable risk factors, underscoring the importance of neuromuscular control as an effective means of preventing injury (Akbari et al., 2018; Zadeh et al., 2019; Zareei et al., 2018). Vanmeerhaeghe & Rodriguez (2013) defines *neuromuscular control* as the correct activation of muscles that allows the development of complex and efficient motor actions or tasks; therefore, the correct execution of these actions is linked to a reduction in the occurrence of injuries because it is associated with improvements in articulatory movements, muscle activation patterns, strength, and balance. Suppose these need to be developed correctly and precisely. In that case, the athlete's movement quality is affected, causing biomechanical changes, imbalances between muscle groups, proprioceptive changes, and muscle fatigue (Vanmeerhaeghe & Rodriguez, 2013; Georgiadis et al., 2024; Sannicandro et al., 2023), which results in injury. Studies report that the incidence of injuries in football in 2008 was very scary, with three to five injuries per 1000 hours of practice and 24 to 30 injuries per 1000 hours of play (Ekstrand, 2008). The risk of injury increases in children aged 6 to 12 years due to their development leading to participation in more complex games and activities that require greater dynamism (Caracuel-Cáliz et al., 2023). Therefore, efforts must be made to prevent the continuity of football athletes' careers from lasting longer.

It has been shown that neuromuscular training programs can have a significant effect during the pre-adolescent stage of development as long as they coincide with the development of basic motor skills, which are defined as "an organized set of basic movements that affect the combination of movement patterns of two or more parts of the body" which is also important for the development of individual motor skills (Batrakoulis et al., 2018; Sañudo et al., 2019). Many authors suggest that the use of injury prevention training based on neuromuscular control during essential stages of growth, such as infancy and adolescence, improves different abilities, such as sensing specific positions and movements of joints, strength, and balance (Hewett et al., 2012; Hrysomallis, 2007).

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One program known to be effective in preventing injuries is FIFA 11+. Football teams that use such programs generally reduce their risk of injury by 30% to 70% compared to those that do not (Soligard et al., 2010). When implemented, this program significantly improved players' functional capacity in neuromuscular control, strength, static/dynamic balance, and agility skills over eight weeks (Daneshjoo et al., 2013).

Several tools allow movement assessment, such as the Fundamental Movements Screen (FMS). This series of tests mainly emphasizes quality (neuromuscular control) over quantity, as it can detect when a person is at risk of injury (Cook et al., 2006a, 2006b).

Although many studies have been conducted on the effectiveness of the FIFA 11+ program in improving specific physical components such as isokinetic strength (Brito et al., 2010), endurance (Edis et al., 2023), landing biomechanics (Zareei et al., 2018), and vertical jump performance (Akbari et al., 2018) and physical fitness (Tseng et al., 2021), studies exploring its impact on fundamental movement skills are limited. Previous research, such as that conducted by Baeza et al. (2017), showed that the program had minimal impact on FMS scores over six weeks, raising questions about its effectiveness over longer training durations. In addition, most research on FIFA 11+ has focused on adult or early childhood soccer player populations. At the same time, there has been minimal research on the adolescent age range, especially in the 14-17 age range. This creates an important gap in the literature that must be bridged to understand how the FIFA 11+ program can influence fundamental movements in adolescence, a critical phase in athlete development. Therefore, this study aimed to explore the effects of a 12-session FIFA 11+ program on fundamental movement ability using FMS in adolescent football players at an academy.

Methodology

Research Design

This research was a quasi-experiment in which there were 2 groups, namely the control and experimental groups. The State University of Malang granted ethical approval (No: 218/EC/KEPK-UM/07/2023). The study adhered to ethical standards as outlined in the 2013 Declaration of Helsinki regulations.

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Participants

The population was 30 football academy players aged over 14-17 years. The sampling technique used was purposive random sampling. The criteria for the participants involved were: aged over 14-17 years and had a musculoskeletal injury in the last six months, which did not involve using additional equipment. Participants who fulfill less than 90% of the training program would be excluded from research activities. The criteria for the participants involved were: aged over 14-17 years and had a musculoskeletal injury in the last six months, which did not involve using additional equipment. To check whether the participants fit the inclusion and exclusion criteria, researchers conducted an initial screening with questionnaires, enrollment forms, and initial interviews to check the criteria. Supporting documents such as medical records, exercise history, or parental consent were also requested for verification and validation. The criteria for the participants involved were: aged over 14-17 years and had a musculoskeletal injury in the last six months, which did not involve using additional equipment. Participants who fulfilled less than 90% of the training program would be excluded from research activities. Participants took part voluntarily, so when participating in any evaluation, parents and children had the right to read the consent form. Based on the implementation of the research, at least 2 players were found not to meet 90% of attendance, and 10 players did not meet the requirements, so they were excluded from research activities, and 18 players were obtained (Ages $14,78 \pm 1,00$); height $1,59 \pm 7,27$; body weight $46,64 \pm 7,95$) who were fully involved in research activities. All participants come from the same geographic area.

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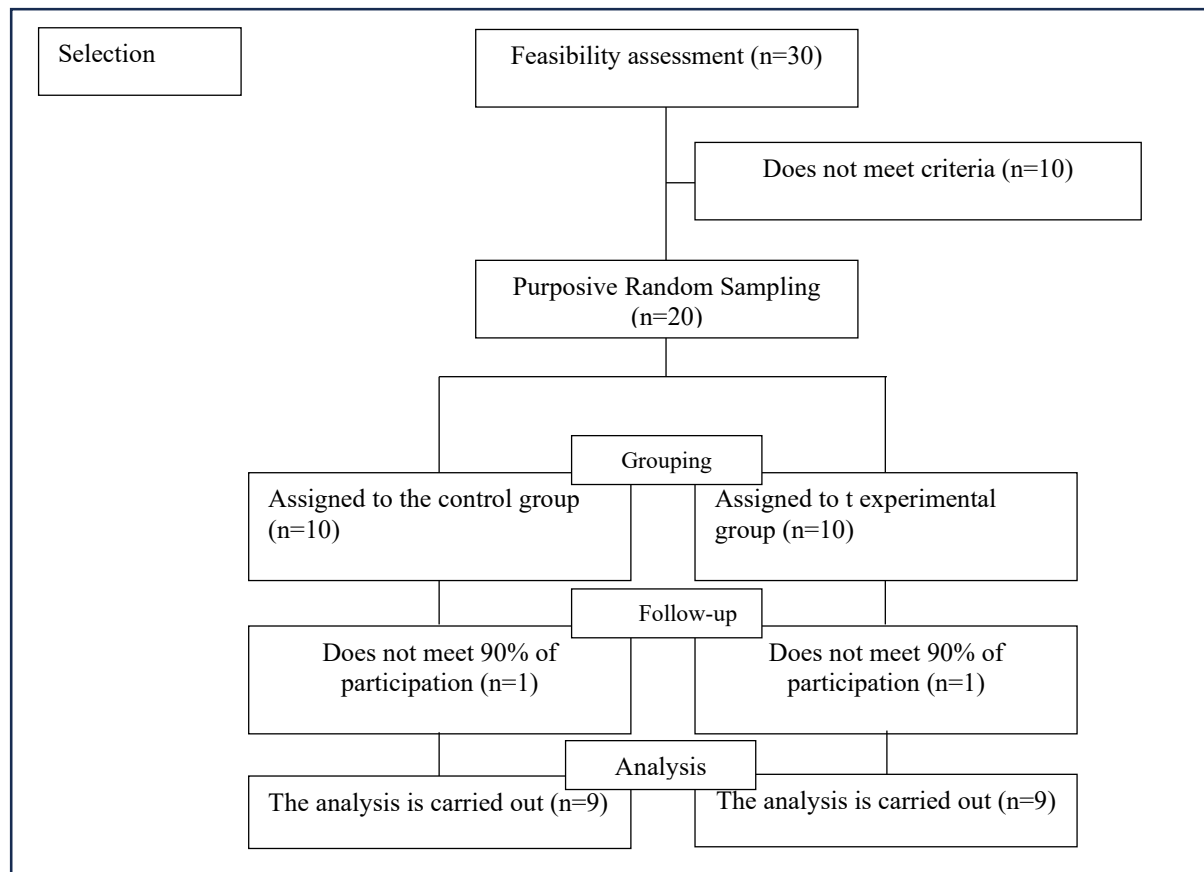


Figure 1. Flow Diagram of Study Group Randomization

Intervention

All subjects were asked to fill out a form with their name, age, height, weight, weekly training volume, and previous injury records. All subjects were asked to fill out a form with their name, age, height, weight, weekly training volume, and previous injury records. *Fundamental Movements Screen* (FMS) was used to evaluate appropriate fundamental movements, where each test was recorded on video, using front and side cameras. The test was explained to the subjects before taking part, and they all wore standard shirts each time they were evaluated for the study. This research was conducted one week before the start of the training program and one week after its completion. Immediately after re-evaluating both groups, they proceeded to edit the videos, which were submitted to the evaluators along with

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the appropriate information about each participant without revealing their identity or which group they belonged to, using "Wondershare Filmora." Evaluators were then asked to categorize the results using the FMS. The videos were analyzed by expert physiotherapists, who recorded the scores in a Google spreadsheet.

The experimental group received the FIFA 11+ program in warm-up activities for 20 minutes. This routine was carried out three times a week for 12 meetings. The program consisted of 15 exercises divided into three parts. It should also be mentioned that the "Nordic hamstring" exercise has been removed from the program to avoid possible risks for those taking part due to the strain this exercise places on the bones and considering the participant's stage of bone maturation. Meanwhile, the control group warmed up as usual (conventional) (a routine training program from the trainer), namely running, stretching, and joint movements.

Data analysis

Data were analyzed using Jeffreys's Amazing Statistics Program (JASP) version 18.1. If $p < 0.05$ and a dominant value of 95% were considered statistically significant, the T-test was used in parallel to determine whether there was a statistically significant difference between the FMS values before and after the intervention. Cohen's D value was used to determine the effect size of each group.

Results

All 14 football academy players who were eligible to participate were 14 players. Data on participant characteristics is shown in Table 1. Data from pre-test and post-test results from the experimental and control groups were then subjected to pre-requisite test analysis, namely the normality test before paired t-test analysis was carried out. In Table 2, it was known that there was an increase in the average value (mean) in both the experimental group and the control group.

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Table no. 1 Participant Characteristics by Group (mean±sd)

	Age (year)	Height (m)	Weight (kg)	Body Mass Index
Control Group (Conventional Warm-up) (n=9)	15.11±1.67	1.58±8.40	45±8.94	17.83±2.17
Experimental Group (Program FIFA 11+) (n=9)	14.44±0.73	1.61±6.19	48.27±6.96	18.75±2.74

Table no. 2 Descriptive Statistics

	N	Mean	SD	SE	Coefficient of variation
Control Group Pre-test Data	9	33.111	1.269	0.423	0.038
Control Group Post-test Data	9	33.778	1.202	0.401	0.036
Experimental Group Pre-test Data	9	32.556	1.740	0.580	0.053
Experimental Group Post-test Data	9	34.778	1.716	0.572	0.049

Table no. 3 Test of Normality (Shapiro-Wilk)

		W	p
Control Group Pre-test Data	- Control Group Posttest Data	0.873	0.132
Experimental Group Pre-test Data	- Experimental Group Post-test Data	0.903	0.273

Note. Significant results suggest a deviation from normality.

Referring to Table 3, where the P value for the control group pre-test-post-test data (0.132) and the experimental group pre-test-post-test data (0.273) was > 0.05, it was stated that the data was normally distributed. A paired t-test was conducted to determine whether there were differences before and after receiving intervention in The FIFA 11+ program (Table 3).

Table no. 4 Paired Samples T-Test

Measure 1	Measure 2	t	df	p	Mean Difference	SE Difference	Cohen's d	SE Cohen's d
Control Group Pre-test Data	- Control Group Posttest Data	2.309	8	0.050	-0.667	0.289	-0.770	0.265
Experimental Group Pre-test Data	- Experimental Group Post-test Data	6.860	8	< .001	-2.222	0.324	-2.287	0.356

Note. Student's t-test.

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In Table 4, it was known that the results of the paired samples t-test show that there was no difference before and after conventional warm-up exercises because the p-value was $0.050 > 0.05$. Cohen's d value shows an effect of 0.770. Meanwhile, the group that received intervention in the form of The FIFA 11+ program showed a difference before warm-up training with The FIFA 11+ program and after warm-up training with The FIFA 11+ program because the p-value was $0.001 < 0.05$. Cohen's d value showed an effect of 2.287. The value of Cohen's D also showed the size of the effect size given. Cohen's D value showed that the effect size generated by The FIFA 11+ program was much greater than the conventional warm-up program (a routine training program from the coach), namely running, stretching, and joint movement.

Table no. 5 Mean (SD) scores for FMS for the Control and Experimental groups before and after intervention.

		Control Group (n=9)	p-value	Experimental Group (n=9)	p-value
Squatting	Pre	2.33	0.347	2.60	0.008*
	Post	2.89		2.70	
Stepping	Pre	2.63	0.347	2.74	0.091
	Post	2.81		2.78	
Lunging	Pre	2.41	0.178	2.26	0.115
	Post	2.63		2.52	
Reaching	Pre	2.89	1.00	2.89	1.00
	Post	2.89		2.89	
Leg Raising	Pre	2.78	0.169	2.44	0.347
	Post	2.89		2.67	
Push-up	Pre	2.22	1.00	2.00	1.00
	Post	2.22		2.11	
Rotatory Stability	Pre	2.11	1.00	2.00	1.00
	Post	2.11		2.00	
	Post	18.44		17.66	

FMS= Functional Movement Screen; *= $p < .05$.

The results of the fundamental movement tests collected using FMS are shown in Table 5. A significant difference was found between the EG results before and after FMS intervention in Squatting, while there were no significant differences for the others.

The significant improvement in the experimental group's FMS scores, particularly in squatting ($p=0.008$), indicates that the program successfully improved bilateral stability, joint

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mobility, and neuromuscular control, all essential in preventing injury and improving performance. However, these results also highlighted limitations in the program's effectiveness on several other movements, such as stepping, lunging, and reaching, which did not show significant improvements. This could be influenced by the program design, which may not directly target or optimize these movement patterns. For example, movements such as lunging and reaching require a greater focus on dynamic flexibility and core strengthening, which may be less of a priority in FIFA 11+.

The comparison between the experimental and control groups also showed a clear difference in effect, with the effect size (Cohen's d) in the experimental group reaching 2.287, much larger than the control group (Cohen's d = 0.770). This indicates that the FIFA 11+ program is much more effective than the conventional warm-up, which consists of running, stretching, and joint movement activities. This significant effect provides a basis for football coaches to integrate the FIFA 11+ program as a mandatory component in their warm-up routine.

Discussion

This study aimed to evaluate the impact of the FIFA 11+ program on improving fundamental movements in football academy athletes aged 14-17 years over 12 training sessions. The findings revealed significant enhancements in the experimental group's fundamental movement skills, as measured by the Functional Movement Screen (FMS), compared to the control group. Below, we provide a detailed synthesis of the findings, their broader implications, and avenues for future research.

Linking Results to Themes and Trends

Theme: Effectiveness of Neuromuscular Training Programs

The results strongly support the effectiveness of neuromuscular training programs like FIFA 11+ in enhancing fundamental movement skills. The experimental group exhibited a significant improvement in FMS scores (Mean = 2.222, $p < 0.001$), with a large effect size (Cohen's d = 2.287). This aligns with prior studies demonstrating that neuromuscular training

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enhances motor control, strength, and balance (Daneshjoo et al., 2013; Soligard et al., 2010). Notably, the significant improvement in squatting performance highlights how structured interventions targeting biomechanical movement patterns can directly benefit functional mobility and stability. FIFA 11+ not only corrects basic movements but can also improve core stability and balance (Bizzini et al., 2013; Daneshjoo et al., 2012b, 2012a) and proprioception (Seyedi et al., 2023). The FIFA 11+ encourages the correct change of basic motion from an incorrect movement created by the athlete. FMS educates football academy athletes to carry out effective basic movements that reduce the potential for injury.

Theme: Injury Prevention and Athletic Performance

The findings underscore the broader role of FIFA 11+ in injury prevention, consistent with earlier studies that reported a 30-70% reduction in injury risk among participants (Bizzini et al., 2013; Al Attar et al., 2021). The significant improvement in FMS scores in movements like squatting, which test bilateral mobility and lower limb stability, further supports the assertion that structured warm-up programs can correct movement deficits predisposing athletes to injuries (Zareei et al., 2018). The benefits of the FIFA 11+ program were not only to improve fundamental movements, but scientific evidence showed that the FIFA 11+ program can increase muscle strength and improve balance in the knee extensors and flexors (Brito et al., 2010), improving jump landing mechanics to reduce the risk of ACL injury (Zareei et al., 2018), reduces injuries by up to 65% (Al Attar, Bizzini, et al., 2021), improve balance and leg muscle strength in children aged 9-12 years (Sumartiningsih et al., 2022), and reducing upper extremity injuries in Goalkeepers (Al Attar, Faude, et al., 2021). This is critical evidence for coaches and practitioners aiming to integrate effective injury prevention protocols into youth athletic programs.

Comparison with Existing Literature

While this study's results reinforce the benefits of FIFA 11+, they contrast with the findings by Baeza et al. (2017), which reported no significant improvements after six weeks of training. The key differentiator in our study was the strict adherence requirement (90% session participation), suggesting that consistency and compliance are crucial for achieving desirable outcomes. Additionally, our findings affirm that FIFA 11+ offers broader benefits

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beyond injury prevention, such as improved core stability and proprioception (Seyedi et al., 2023).

Broader Implications

The demonstrated success of FIFA 11+ in this study highlights its utility as an injury prevention tool and a means to enhance foundational athletic competencies. Neuromuscular programs tailored for youth can bridge the gap between injury risk management and athletic development. Coaches and sports academies can utilize the FIFA 11+ framework to improve performance metrics and reduce injury prevalence, fostering long-term athletic growth.

Areas for Further Research

Several limitations of this study provide avenues for future investigation. First, the sample was restricted to male athletes aged 14-17 years, limiting the generalizability of results to female or younger age groups. Future studies could explore gender-specific adaptations of FIFA 11+ and its applicability to broader age ranges. Additionally, while our study spanned 12 sessions over four weeks, extending the intervention duration might yield more profound insights into the long-term benefits of such programs. Finally, including qualitative feedback from participants and coaches could provide a more holistic understanding of the program's impact on training adherence and perceived effectiveness.

Conclusion

Our findings report that 12 FIFA 11+ program training sessions can improve fundamental movements in football academy athletes aged 14-17. This research also needs to be applied among female athletes, considering that women's football exists in several countries. Implementing FIFA +11 allows coaches to teach their players to do exercises with the right movement patterns to prevent future injuries.

Implementing an effective injury prevention program for football players requires a multifaceted approach that considers training, context, and stakeholder engagement. A successful program not only addresses the physical aspects of injury prevention but also incorporates strategies for effective implementation and adherence among players and coaches. Some recommendations for essential steps in injury prevention include identifying

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injury risks, regularly performing specialized warm-up exercises, increasing strength and flexibility, training in proper technique, implementing adequate rest and recovery, and monitoring training loads.

The limitations of this study include that it only involved 14-to 17-year-old participants who were all male. This limits the generalization of the results to other populations, especially female athletes or different age groups. With only 18 participants meeting the participation criteria (9 in each group), the small sample size reduces the study's statistical power and the ability to detect more subtle differences. The intervention was conducted for only 12 sessions (4 weeks). This duration may not be sufficient to reveal the long-term impact of the FIFA 11+ program on fundamental movement skills. The study did not include qualitative components such as interviews or surveys that could have elicited insights from participants or coaches regarding the effectiveness and their subjective experiences with the FIFA 11+ program.

These limitations provide opportunities for improvement in future research, such as expanding the sample size, extending the duration of the intervention, and involving different groups of participants.

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