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Research Article / Araştırma Makalesi

Comparison of the effects of general warm-up and FIFA 11+ warm-up programs on Functional Movement Screen test scores and athletic performance

Genel ısınma ve FIFA 11+ ısınma programlarının Fonksiyonel Hareket Tarama testi puanlarına ve atletik performansa etkisinin karşılaştırılması

Umut Gök[1], Hasan Aka[2], Zait Burak Aktuğ[2], Serkan Ibiş[2]

[1]*Health Sciences Institute, Tokat Gaziosmanpaşa University, Tokat, Turkiye*
[2]*Faculty of Sport Sciences, Niğde Ömer Halisdemir University, Niğde, Turkiye*

ABSTRACT

Objective: The aim of this study is to compare the effects of the general warm-up and the FIFA 11+ warm-up program on athletic performance and Functional Movement Screen (FMS) test scores.

Materials and methods: Participants were divided into two groups, the general warm-up group (GWG) (n=20) and the FIFA 11+ warm-up group (FWG) (n= 20). Anthropometric measurements, 10-20-30m sprint, zig-zag agility with and without the ball, vertical jump, sit and reach flexibility, Yo-Yo, star excursion balance and FMS tests were performed. "Wilcoxon Signed Rank Test" was used to determine the difference between the pretest and post-test of the participants.

Results: 20 meters and 30 meters sprint, endurance skills and the FMS subtests in shoulder mobility and FMS total score improved in the posttest of GWG group. 10 m, 20 m, 30 m speed, agility, vertical jump, balance, endurance, flexibility and all FMS subtests and the FMS total scores improved in the posttest of FWG group.

Conclusion: FIFA 11+ exercises in warm-up have a significant impact on athletic performance and Functional Movement Screen test scores.

Keywords: *Football, warm-up, FIFA 11+, FMS, athletic performance*

ÖZ

Amaç: Bu çalışmanın amacı, genel ısınma ve FIFA 11+ ısınma programlarının atletik performans ve Fonksiyonel Hareket Taraması (FMS) test puanları üzerindeki etkilerini karşılaştırmaktır.

Gereç ve Yöntem: Katılımcılar genel ısınma grubu (GWG) (n=20) ve FIFA 11+ ısınma grubu (FWG) (n= 20) olmak üzere iki gruba ayrıldı. Katılımcılara antropometrik ölçümler, 10-20-30m sprint, toplu ve topsuz zig-zag çeviklik, dikey sıçrama, otur ve uzan esneklik, Yo-Yo, yıldız denge ve FMS testleri uygulanmıştır. Ön test ile son test arasındaki farkı belirlemek için "Wilcoxon İşaretli Sıra Testi" kullanılmıştır.

Bulgular: GWG grubunda 20 metre ve 30 metre sprint, dayanıklılık becerileri ve FMS alt testlerinde omuz hareketliliği ve FMS toplam puanında anlamlı gelişme görülmüştür. geliştiği görülmüştür. FWG grubunda 10 m, 20 m, 30 m sürat, çeviklik, dikey sıçrama, denge, dayanıklılık, esneklik ve tüm FMS alt testleri ve FMS toplam puanında anlamlı gelişme saptanmıştır.

Sonuç: FIFA 11+ egzersizlerinin atletik performans gelişimi ve FMS test skorları üzerinde anlamlı etkisi vardır.

Anahtar Sözcükler: *Futbol, ısınma, FIFA 11+, FMS, atletik performans*

INTRODUCTION

Football is a sport branch in which aerobic and anaerobic systems are utilized together, many physical fitness parameters such as speed, strength, agility, flexibility, balance and endurance affect performance, conditional and mental characteristics are prominent, as well (1). It is stated that physical fitness of football players can be improved with regularly applied and scientifically based exercise programs (2). Many methods such as stretching, plyometrics, exercises for core muscles, isokinetic exercises are used to improve physical fitness in football players (3). Before applying these training methods, one of the prerequisites to get high efficiency from the athletes is to apply a correct warm-up program (4).

The warm-up program is necessary to optimize the muscles to work with efficiency (4). A warm-up before the competition and training has a very important role on reducing the muscle stiffness and preventing possible injuries, incre–

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Correspondence / Yazışma: Umut Gök · Tokat Gaziosmanpaşa Üniversitesi, Sağlık Bilimleri Enstitüsü, Tokat Türkiye · gokumut80@gmail.com

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asing the speed of muscle contraction, blood flow to the active tissues, getting the heart ready for exercise, and even mentally preparing the athletes (5). Although mostly general warming methods are used in warming up of athletes, new warming methods developed in accordance with the requirements of the branch. One of these methods is the FIFA 11+ warm-up program. The FIFA 11+ warm-up program has been developed to prevent injuries and to maximize the performance of football players (6). It is a program that systematically and harmoniously brings features together that are generally included in every warm-up, such as balance, core body exercises, leg strength, and dynamic flexibility. This protocol both improves athletic performance and protects against injuries in football players (6).

Studies have shown that sports injuries are associated with the quality of movement, athletic performance and disorders in basic movement patterns of athletes (7-10). Therefore, test batteries have been developed to predict injuries by evaluating basic movement patterns. The FMS test battery is one of those aiming to evaluate the basic movement patterns of the athletes (11). The FMS test battery is a biomechanical screening and evaluation method used to determine the limitations and asymmetries in the functional movement quality of the athletes (12). The asymmetry, mobility and stability conditions of the athletes can be observed and injury risk is estimated through this test (13).

Although warming up is of vital importance for the health and performance of athletes, there is no standard warm-up program. These are known to prepare athletes for loading and improve their athletic performance. FIFA 11+ warm-up protocol developed by FIFA to create a protective strategy against injuries in football players and improve athletic performance. This study has been conducted to compare the effects of the general warm-up program and the FIFA 11+ warm-up program on athletic performance and FMS test scores.

MATERIALS and METHODS

Working group

40 male football players; FIFA 11+ warm-up group (FWG) (n=20, age=14.37±0.79) and general warm-up group (GWG) (n=20, age=14.81±0.82) participated in the study. The FIFA 11+ warm-up protocol was implemented to the FWG before their routine training for four days a week during eight weeks. General warm-up program was applied in GWG before their routine training as described for FWG group. Anthropometric measurements, speed and agility tests were applied to all participants on the 1st day, balance, flexibility and vertical jump tests on the 2nd, Yo-Yo IR on the 3rd and the FMS test on the 4th day before the implementation of warm-up programs.

All the participants were informed about the purpose of the study, and a consent form was signed by the participants as well as their parents. Ethics committee approval was obtained from the Niğde Ömer Halisdemir University Non-Interventional Clinical Research Ethics Committee.

Data Collection Tool

Athletic Performance Tests

Aerobic endurance of the participants was determined by the Yo-Yo Intermittent Recovery test. It is an endurance test consisting of repeated runs in which the running speed is gradually increased according to the sound coming from the test signal device. The test was terminated if the participant missed the beep three times in a row. 10 meters, 20 meters, 30 meters sprint performances and Zig-Zag agility tests were determined by Newtest 2000 photocell device, vertical jump performances were determined by Microgate jump mat and flexibility performances were determined by sit and reach flexibility test. The balance performances of the participants were determined by the star excursion balance test (SEBT). [(Maximum Reaching Distance/Extremity Length) x 100 = %Y test score] calculation formula was used to ensure standardization in SEBT (14). Yo-Yo test was applied once, speed, Zig-Zag agility test, vertical jump test, sit and reach flexibility test and SEBT were applied twice, and the best scores were recorded.

Functional Movement Screen Test

The functional movement screen is a test used to identify asymmetry in functional movement patterns. The functional movement screen test consists of seven different movements including the deep squat test, trunk stability push-up test, the obstacle step, stepping forward, shoulder mobility, active straight leg raise and rotational stability. The total score obtained from these evaluations shows the functional movement capacity of the athlete. FMS tests were performed without any warm-up phase by a certified physiotherapist. Each participant was tested individually to eliminate learning effect. Each movement repeated three times. Athletes were informed to report any pain that might occur during the tests. Tets were applied bilaterally and scores were recorded accordingly. The lowest score obtained was accepted as the result of the test. Each movement has been scored between 0 to 3, therefore participants could get a total score between 0 to 21. A score below 14 points stands for decreased functional movement capacity and higher risk for injury (15).

Warm-up Procedures and Application Principles

FIFA 11+ Warmup Protocol

FIFA 11+ is a package program for football created by many experts. This program has three parts consisted of fifteen exercises. These exercises are performed before each training session. First part of the program includes low paced running exercises with active stretching movements, second part is consisted of six sets of exercises focusing on strengthening for the trunk and legs, balance and plyometrics, agility, third part includes moderate to fast paced running exercises combined with direction change movements (6). The exercises in the FIFA 11+ warm-up protocol are designed as indicated belows (Table 1.)

Jogging: Hip out jog, hip inward jog, co-running, shoulder-to-shoulder jog, forward-backward jog.

Plank: Static plank, alternating leg plank, one leg plank.

Side Plank: Straight stance on one arm and foot.

Hamstring strength: Nordic hamstring movement

Balance on one leg: Steady ball holding on one leg (1-3 weeks), mutual throwing on one leg (4-6 weeks), pushing one's partner on one leg (6-8 weeks).

Squatting: Toe squatting (weeks 1-3), forward squats (weeks 4-6), squatting on one leg (weeks 6-8).

Jumping: Jump in place (week 1-3), side jump (week 4-6), four-way jump (week 6-8).

Brisk runs: Running with jumping big strides, zig-zag running

Table 1. Implemented FIFA 11+ warm-up program

Exercises	1-3 Week			4-6. Week			6-8. Week		
	Sets	Recap	Time	Sets	Recap	Time	Sets	Recap	Time
Jogging	2	1	8 min	2	1	8 min	2	1	8 min
Plank	3	1	20-30 s	3	1	40-60 s	3	1	40-60 s
Side Plank	3	1	20-30 s	3	1	20-30 s	3	1	20-30 s
Hamstring Strength	1	3-5	60 s	1	7-10	60 s	1	12-15	60 s
Balance on the leg	2	1	30 s	2	1	30 s	2	1	30 s
Squatting	2	1	30 s	2	10	30 s	2	10	30 s
Jumping	2	1	30 s	2	1	30 s	2	1	30 s
Brisk runs	2	1	2 min	2	1	2 min	2	1	2 min
Total			20 min			22,5 min			25 min

min: minute, s: second

General Warm Up Protocol

The general warm-up method consists of four parts with total duration of 25 minutes. 10 minutes warm-up run (jogging), 6 minutes of dynamic movements in the (turning the arms forward, turning the arms back, turning the hips clockwise, turning the hips counterclockwise, turning the legs inward, turning the legs outward, knees pulling to the chest, pulling the heels to the hips) 6 minutes of static flexibility (trapezoid stretching, shoulder rotator cuff stretching, calf stretching, quadriceps stretching, hamstring stretching, adductor stretching), and fianlly 3-minutes of jogging.

Analysis of Data

SPSS 22.0 statistical package program was utilized for data analysis. The differences between the pretest and posttest of the participants' athletic performance and FMS scores were determined using the non-parametric inverse Wilcoxon Signed Rank Test. The level of significance was accepted as $p<0.05$.

RESULTS

Table 2. Physical characteristics of FWG and GWG participants

Measurement	Variable	N	FWG ± Sd	GWG ± Sd
Pre-Test	Height (cm)	20	169.80 ±6.47	163.05 ±6.45
	Weight (kg)	20	58.70 ± 7.28	59.05 ± 5.71
Post-Test	Height (cm)	20	170.48 ±6.02	163.35 ±6.47
	Weight (kg)	20	59.60 ± 7.03	59.25 ± 6.12

cm: centimetre, kg: kilogram, FWG: FIFA 11+ warm-up group, GWG: general warm-up group

Table 3. Athletic performance of FWG and GWG participants

Measurement		FWG (n=20) ± Sd	Z	p	GWG (n=20) ± Sd	Z	p
Speed 10 m	Pre-test	1.82 ± 0.13	-3.53	,000	1.77 ± ,131	-1,19	,230
	Post-test	1.74 ± 0.13			1.76 ± ,138		
Speed 20 m	Pre-test	3.24 ± 0.26	-3.45	,001	3.23 ± ,254	-3,38	,001
	Post-test	3.14 ± 0.24			3.15 ± ,248		
Speed 30 m	Pre-test	4.62 ± 0.45	-3.77	,000	4.51 ± ,253	-2,57	,010
	Post-test	4.46 ± 0.38			4.41 ± ,198		
Agility (With the ball)	Pre-test	8.14 ± 0.65	-3.65	,000	8.23 ± ,686	-1,83	,067
	Post-test	7.68 ± 0.59			8,22 ± ,659		
Agility (Without ball)	Pre-test	6.28 ± 0.36	-2.69	,007	6.47 ± ,231	-1,68	,093
	Post-test	6.13 ± 0.29			6.48 ± ,245		
Vertical Jumps	Pre-test	30.46 ±6.28	-3.66	,000	31.70 ±5.58	-,954	,340
	Post-test	33.66 ±5.42			32.11 ±5.11		
Flexibility	Pre-test	32.60 ±5.42	-2.88	,004	31.22 ±6.80	-1,44	,148
	Post-test	34.65 ±5.47			32.55 ±6.97		
Yo-Yo Test	Pre-test	1286.00 ± 488.39	-3.36	,001	800.00 ± 129.12	-2,93	,003
	Post-test	1666.00 ± 576.34			871.00 ± 89.73		
SEBT (Right Foot)	Pre-test	726.25 ± 91.25	-3.17	,002	821.85 ± 97.15	-,485	,627
	Post-test	836.50 ± 79.23			826.89 ± 89.40		
SEBT (Left Foot)	Pre-test	779.15 ±92.22	-3.65	,000	819.10 ±91.45	-,161	,872
	Post-test	833.15 ±80.46			825.60 ±82.09		

m: metre, SEBT: Star Excursion Balance FWG: FIFA 11+ warm-up group, GWG: general warm-up group p<0,05

There was a statistically significant improvement in favor of the post-test in all athletic performance tests of FWG (p<0.05). Statistically significant improvement has been detected in the 20 m, 30 m sprint and Yo-Yo post-tests of the GWG (p<0.05).

Table 4. FMS scores of FWG and GWG

Measurement		FWG (n=20) ± Sd	Z	p	GWG (n=20) ± Sd	Z	p
Deep Squat	Pre-test	2.15 ± 0.67	-2.64	,008	1.45 ± 0.51	-0.57	,564
	Post-test	2.50 ±0.60			1.50 ± 0.51		
Hurdle Step	Pre-test	1.60± 0.50	-3.35	,001	1.50 ± 0.51	-0.57	,564
	Post-test	2.25 ± 0.55			1.55 ± 0.51		
In Line Lunge	Pre-test	1.85 ± 0.58	-2.88	,004	1.80 ± 0.61	-0.47	,655
	Post-test	2.35± 0.48			1.85 ± 0.48		
Shoulder Mobility	Pre-test	2.45 ± 0.60	-2.44	,014	1.80 ± 0.69	-2.23	,025
	Post-test	2.75 ±0.44			2.05 ± 0.51		
Active Straight Leg Raise	Pre-test	1.60± 0.50	-2.82	,005	1.75 ± 0.63	-1.00	,317
	Post-test	2.00 ± 0.45			1.85 ± 0.58		
Trunk Stability Push Up	Pre-test	2.70 ± 0.47	-2.44	,014	2.15 ± 0.48	-1.41	,157
	Post-test	3.00 ±0.00			2.25 ± 0.44		
Rotary Stability	Pre-test	1.15 ± 0.36	-2.82	,005	1.00 ± 0.00	-1.00	,317
	Post-test	1.55 ± 0.51			1.05 ± 0.22		
FMS total score	Pre-test	13.50 ±1.10	-3.95	,000	11.45 ±1.60	-2.96	,003
	Post-test	16.40 ±1.14			12.10 ±1.44		

FWG: FIFA 11+ warm-up group, GWG: general warm-up group, FMS: Functional movement screen; p<0,05

Statistically significant difference was found in all FMS subtest scores and and FMS total scores of FWG post-tests (p<0.05). There was a statistically significant difference in shoulder mobility and FMS total score at the post-test of the GWG (p<0.05).

Improvement in both athletic performance and FMS scores of FWG were better than GWG.

DISCUSSION

It is known that warming up, especially in football, which is an open field sport, affects performance positively and many physiological changes occur as a result of temperature increase (16). It is stated that FIFA 11+ warm-up exercises considered as an injury prevention program, reducing fatigue and increasing muscular activation (17,18).

Bizzini et al. (6) performed speed tests to 20 amateur male football players with an average age of 25.5 before and after applying the FIFA11+ warm-up program and reported a significant improvement in the sprint test times after the FIFA 11+ warm-up exercises. In a study, an improvement of 8.9% in the 5 m and 3.3% in the 30 m sprint test were found after the FIFA 11+ warm-up program in young futsal players. (19) Further studies have also shown significant improvements in speed performance after FIFA 11+ warm-up exercises (20).

Table 5. Changes of pretest and posttest measurement values of athletic performance and FMS total scores

Variable	GWG	FWG
Speed 10 m	%0.56	%4.40
Speed 20 m	%2.47	%3.08
Speed 30 m	%2.21	%3.46
Agility (with the ball)	%0.12	%5.65
Agility (without ball)	%0.15	%8.23
Vertical Jumps	%1.27	%10.51
Flexibility	%4.08	%6.28
Yo-Yo IR	%8.15	%29.54
Balance (Right Leg)	%0.60	%15.18
Balance (Lef Leg)	%0.78	%6.93
FMS total score	%5.67	%21.48

FWG: FIFA 11+ warm-up group, GWG: general warm-up group, FMS: Functional movement screen, m:metre

It is thought that this improvement is due to the Nordic hamstring exercise, which is included in the FIFA 11+ warm-up program, which increases hamstring muscle strength. Exercises such as squatting and jumping increase lower extremity muscle strength and neuromuscular efficiency, as well. It is stated that FIFA 11+ warm-up exercises improve neuromuscular control of the lower extremities, increase the strength of the knee flexor muscles, and increase the excitability of the motor units, thus taking an active role during activities such as speed (21,22).

In our study, there was no significant difference between the pre- and post-tests in the GWG in terms of agility tests with and without ball, whereas FWG revealed statistically significant improvement in the post-test.

Gomes et al. (23), determined that the FIFA 11+ warm-up program significantly increased the agility performance of football players. Pomares-Noguera et al. (24) stated that the FIFA 11+ warm-up applied twice a week for four weeks improved agility performance of male football players. Similar results have been reported in several studies. (25-27)

In the studies mentioned above, it is clearly stated that the FIFA 11+ warm-up protocol applied to the athletes improves agility performance which is supporting our results. This is thought to be related to the zig-zag running, Nordic hamstring and jump exercises in the FIFA 11+ warm-up program. Quadriceps and hamstring muscles have a major role in cutting and changing direction. The strengthening of the hamstring muscle by Nordic hamstring exercises may be associated with the improved agility performance. Same principles are valid for the improved zig-zag runs, as well.

Daneshjoo et al. (27), reported that the FIFA 11+ warm-up protocol significantly improved the vertical jump performance. Silva et al. (28) found that the vertical jump performance of the participants who applied FIFA 11+ warm-up exercises improved significantly. Similar results were reported regarding the improved vertical jump performance of athhletes applied FIFA 11+ warm-up exercises (6, 29).

Plyometric jumps and core muscle exercises have been thought to be directly related with the improved jumping performance which are present in the FIFA 11+ warm-up program. During the jump, the quadriceps muscles play a major role while the feet are off the ground, and core muscles actively help in the continuation of the movement.

There are several studies concluding with improved balance performance following FIFA 11+ warm-up protocol. (19,23,30)

The similar results have been depicted in our study. Running, squatting and jumping exercises in FIFA 11+ warm-up protocol might have positively effected the balance skills of the players, as well as plank and core strengthening exercises. It was stated that athletes with higher hip flexion, extensor and abductor strength had higher anterior posterolateral balance scores (31).

Flexibility of the athletes in FWG has been found significantly increased in the final test. Talović et al. (32) reported significant improvement in the flexibility of the participants following FIFA 11 + program. This improvement might probably be due to the implementation of stretching, plank and squatting exercises performed throughout the FIFA 11+ warm-up exercises.

In this study, Yo-Yo IR test revealed a significant improvement following both GWG and FWG groups, which was more prominent in FWG. Durukan et al. (33) found that the FIFA 11+ warm-up program applied to young football players for 8 weeks significantly improved the endurance performance. FIFA 11+ warm-up exercises include running exercises which might have positively effected endurance parameters in FWG.

We found that the shoulder mobility and FMS total score values of the participants in the GWG increased significantly. Despite this significant difference in the GWG participants, it is noteworthy that the FMS total scores remained below the injury critical limit (14) in both the pre-test (11.45) and the post-test (12.10). Our results revealed significant improvements in FMS subtests and FMS total scores of FWG participants. The FMS subtests and FMS total scores of the FWG were below the injury lower limit (14) at the beginning of the study (13.50). Following the FIFA 11 + exercises the total score exceeded the critical limit (16.40). FMS subtests include evaluation of balance, strength, coordination and flexibility skills of the athletes. Since FIFA 11+ warm-up protocol also have exercises targeting strength, balance, coordination and flexibility improvements, better results of FMS subtests and FMS total scores in FWG were consistent with the expectations.

CONCLUSION

FIFA 11+ exercises have an important effect on both the prevention of injuries and the development of athletic performance parameters. Although the implementation of the FIFA 11+ warm-up protocol requires more time than a general warm-up program, performing it two to three times a week before training will probably be effective in improving performance and preventing sports injuries.

Ethics Committee Approval / Etik Komite Onayı

This study was approved by the Niğde Ömer Halisdemir University Non-Interventional Clinical Research Ethics Committee (approval number E-95860085-050.02.04-15423, date: 03.02.2021).

Conflict of Interest / Çıkar Çatışması

The authors declared no conflicts of interest with respect to authorship and/or publication of the article.

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Author Contributions / Yazar Katkıları

Concept: UG, HA; Design: HA, ZBA; Supervision: UG, SI; Materials: ZBA, SI; Data Collection and Processing: UG; Analysis and Interpretation: HA; Literature Review: UG; Writing Manuscript: UG, HA; Critical Reviews: ZBA, SI

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