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Comparison of the Effects of Physiotherapy Based Warm-Up Methods Combined with FIFA 11+ Warm-Up Program on Some Performance Parameters in Football Players*

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Abstract: The aim of this study was to examine the effects of the acute addition of physiotherapy-based applications to the FIFA 11+ warm-up program on sprint performance, strength, balance, agility, range of motion, and anaerobic performance in young male football players. Nineteen licensed male players aged 19–22 years participated in this repeated-measures study design. The participants completed four different conditions: FIFA 11+ alone and FIFA 11+ combined with dry cupping, the Graston technique, and vacuum interferential current. Following each condition, 30-m sprint, lower-extremity muscle strength, flamingo balance, Illinois agility, knee flexion range of motion, and running-based anaerobic sprint test (RAST) measurements were performed. Data were analyzed using repeated-measures ANOVA with Bonferroni post-hoc comparisons ($p<0.05$), and effect sizes (Cohen's d) were calculated to determine the magnitude of differences. The addition of physiotherapy-based applications to the FIFA 11+ program resulted in significant improvements in sprint performance, muscle strength, balance, and agility compared to FIFA 11+ alone, with large effect sizes ($d = 1.11–2.14$; $p<0.05$). However, no significant differences were observed between conditions in knee range of motion or anaerobic performance parameters ($p>0.05$). In conclusion, the acute addition of physiotherapy-based applications to the FIFA 11+ program may provide additional benefits, particularly in performance components requiring high speed and lower-extremity strength. Nevertheless, these findings reflect short-term responses and should be supported by studies including different age groups and long-term interventions.

Keywords: Physiotherapy-based warm-up, Acute performance, Football, FIFA 11+

Futbolcularda FIFA 11+ Isınma Programı ile Kombine Edilmiş Fizyoterapi Temelli Isınma Yöntemlerinin Bazı Performans Parametreleri Üzerine Etkisinin Karşılaştırılması

Öz: Bu çalışmanın amacı, fizyoterapi temelli uygulamaların FIFA 11+ ısınma programına akut olarak eklenmesinin genç erkek futbolcularda sürat, kuvvet, denge, çeviklik, eklem hareket açıklığı ve anaerobik performans üzerindeki etkilerini incelemektir. Tekrarlı ölçümler deseninde yürütülen araştırmaya 19–22 yaş aralığında 19 lisanslı erkek futbolcu katılmıştır. Katılımcılar, yalnızca FIFA 11+ ısınma programının uygulandığı koşul ile bu programa kuru kupa, Graston tekniği ve vakum interferans akımının eklendiği üç farklı koşul olmak üzere toplam dört koşulu tamamlamıştır. Her koşul sonrasında 30 m sürat, alt ekstremite kas kuvveti, flamingo denge, Illinois çeviklik, diz fleksiyon hareket açıklığı ve koşu temelli anaerobik sprint testi (RAST) ölçümleri yapılmıştır. Veriler tekrarlı ölçümlerde varyans analizi (ANOVA) ve Bonferroni post-hoc testi ile analiz edilmiş ($p<0,05$) ve farkların büyüklüğünü ortaya koymak amacıyla etki büyüklükleri (Cohen's d) hesaplanmıştır. Fizyoterapi temelli uygulamaların FIFA 11+ programına eklenmesi, sürat, kas kuvveti, denge ve çeviklik performansında yalnızca FIFA 11+ uygulamasına kıyasla anlamlı iyileşmeler sağlamış ve bu farklılıklar büyük düzeyde etki büyüklükleri ile desteklenmiştir ($d = 1,11–2,14$; $p<0,05$). Ancak diz eklem hareket açıklığı ve anaerobik performans parametrelerinde koşullar arasında anlamlı farklılık saptanmamıştır ($p>0,05$). Sonuç olarak, fizyoterapi temelli uygulamaların FIFA 11+ programına akut olarak eklenmesi, özellikle yüksek hız gerektiren ve alt ekstremite kuvvetine dayalı performans bileşenlerinde ek katkı sağlayabilir. Bununla birlikte, elde edilen bulgular yalnızca kısa süreli yanıtları yansıtmaktadır ve farklı yaş grupları ile uzun dönem uygulamaları içeren çalışmalarla desteklenmesi gerekmektedir.

Anahtar Kelimeler: Fizyoterapi temelli ısınma, Akut performans, Futbol, FIFA 11+

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INTRODUCTION

In sports, warming up is the preparation process applied before training or competition to reduce the risk of injury and maximize performance (Woods et al., 2017). The primary physiological effects of warming up are related to increased intramuscular blood flow and, consequently, increased oxygen utilization (Broussal-Derval & Ganneau, 2019). Increased muscle temperature positively affects force and power production by improving muscle viscoelastic properties, increasing nerve conduction velocity, and facilitating motor unit activation (McGowan et al., 2015). The literature reports that an increase of approximately 1°C in muscle temperature can lead to significant increases in sprint, jump, and isometric strength output; conversely, a decrease in muscle temperature can reduce performance (Racinais et al., 2017). Furthermore, with increasing body temperature, improvements are observed in parameters such as range of motion, flexibility, agility, and endurance; this contributes to the multifaceted support of performance (Behm & Chaouachi, 2011; Bergh & Ekblom, 1979; Sargeant, 1987). Active warm-up consists of low-to-moderate intensity aerobic activities and dynamic exercises, and is considered an effective method for increasing muscle temperature (Ayala et al., 2016). Such practices not only provide physiological preparation but also serve as a neuromuscular rehearsal for the performance to be carried out (Dadebo et al., 2004). The primary goal of active warm-up is to stimulate the central nervous system, increase range of motion, optimize the mechanical properties of the muscle-tendon unit, and prepare the athlete for performance-specific movements (Jeffreys, 2007).

In this context, the FIFA 11+ program developed by FIFA is a structured and easy-to-implement dynamic warm-up protocol designed to reduce the risk of injury in footballers (Sadigursky et al., 2017), and it has also been reported that it can be used to improve physical performance (Silva et al., 2015). The program consists of three sections and a total of 15 exercises; it includes running, balance, strength, plyometric, and core stabilization exercises (Myer et al., 2004). Several studies have shown that long-term application of the FIFA 11+ program can improve parameters such as lower extremity balance, trunk stability, knee strength, and sprint performance (Al Attar et al., 2017; Brito et al., 2010; Daneshjoo et al., 2012; Daneshjoo et al., 2013; Impellizzeri et al., 2013). However, the vast majority of these studies have examined chronic adaptations that emerge after intervention programs lasting weeks. However, findings regarding acute performance responses generated by the program after single-session or short-term applications are limited and contradictory.

On the other hand, it is known that some physiotherapy-based practices can have short-term effects on circulation, muscle activation, and soft tissue properties. Interferential current is an electrotherapy method that results from the interaction of two alternating currents of medium frequency within the tissue and is reported to provide pain modulation and increased circulation. It is stated that this application may produce temporary therapeutic effects on muscle performance and neuromuscular activation (Hogenkamp et al., 1983). Graston Technique, defined as instrument-assisted soft tissue mobilization, is a method used in soft tissue problems such as strains and sprains (Bhattacharya et al., 2021). It is reported that it can increase local circulation through mechanical stimulation, induce myofascial relaxation, and support

proprioceptive feedback (Cheatham & Baker, 2019; Da Silva et al., 2020; Silbaugh, 2013). Similarly, cupping therapy is a traditional practice that aims to increase microcirculation and remove metabolic waste through negative pressure created on the skin's surface (AlBedah et al., 2019; Cao et al., 2012). Although the effects of these methods in the context of rehabilitation and pain management have been studied, their impact on acute outcomes of athletic performance has not been sufficiently clarified.

In recent years, the FIFA 11+ program has been widely used not only for injury prevention but also for performance improvement (Thorborg et al., 2017). However, the majority of studies in the literature have focused on long-term adaptations; the effects of implementing the program in conjunction with physiotherapy-based methods on acute neuromuscular and performance responses have been investigated to a limited extent. It is unclear how the integration of techniques with the potential to increase blood flow, promote myofascial relaxation, and support neural stimulation into active warm-up protocols affects short-term performance parameters. This constitutes a significant research gap in the current literature. The aim of this study is to examine the effects of physiotherapy-based interventions added to the FIFA 11+ program on acute performance parameters (sprint, agility and balance) in football players. Thus, unlike the existing literature focusing on chronic adaptations, the effects of single-session applications on short-term performance outcomes will be revealed; and the aim is to contribute to a more holistic and evidence-based warm-up approach to performance optimization for coaches and physiotherapists.

MATERIAL AND METHODS

Research Design and Participant Group: The research was carried out between November-2024 and December-2024 with 19 football players selected from the students of Iğdır University Faculty of Sports Sciences at the Şehit Mehmet Tayfur Bora Sports Hall building. The universe of the study consisted of licensed football players in Iğdır province. The sample of the study consisted of 19 male football players (height: 178.26±7.26 cm, age: 20.05±1.35 years, weight: 74.47±12.14 kg, age in sports: 5.26±2.47 years) who had been playing football for at least 3 years and were selected from among the students of Iğdır University Faculty of Sports Sciences. Warm-up programs and measurements began at 11:00 a.m. observing circadian rhythms. Participants were asked to have breakfast at 9:00 a.m. and not eat anything after that time. Fluid intake was limited to water. Participants were asked to wear comfortable shorts and a t-shirt during the warm-up and measurements, and to wear indoor shoes. Participants were verbally asked each time if they would participate in any training or competition until all measurements were completed. All measurements were completed after three days of intervals to ensure they arrived well rested. In the first session, the 19 football players participating in the study were given a detailed introduction to the FIFA 11+ warm-up program and the procedures for the performance tests to be administered; thus, a standardized familiarization process was applied in order to minimize the learning effect related to the tests. All measurements were performed at the same time, under the same field conditions, and by the same researchers. The test sequence was kept constant across all sessions, equal rest periods (3 minutes) were provided between trials, and a minimum of 3 days of rest was allowed between measurements to control

for potential fatigue and carry-over effects. Since the same order was applied to all participants and sufficient rest intervals were provided, potential order effects were minimized; however, the absence of a counterbalanced design may still be considered a methodological limitation. The first measurement session involved a three-stage FIFA 11+ warm-up program lasting approximately 18 minutes. This protocol is an active warm-up method, and the standard application time has been maintained. Following the warm-up, 30m sprint (2 repetitions, 3 minutes rest), flamingo balance, and Illinois agility (2 repetitions, 3 minutes rest) tests were performed. In the second measurement session, muscle strength (2 repetitions), range of motion (3 repetitions), and anaerobic power were measured after another 18-minute FIFA 11+ session. In the third and subsequent sessions, dry cupping, vacuum interferential current, and Graston myofascial release techniques were applied in addition to the FIFA 11+ method. These methods are passive warm-up/application protocols and were considered as separate application approaches, not as supportive applications integrated into the active warm-up of FIFA 11+. To equalize the total times, it might have been necessary to shorten the FIFA 11+ duration; however, this was not preferred as it would disrupt the program's unique structure and the standard application integrity defined in the literature. Therefore, the combined protocols were treated as distinct experimental conditions rather than modifications of the standard FIFA 11+ structure. We believe that maintaining a constant active warm-up time in each application is one of the limitations of our research.

Performance measurements were conducted immediately after the intervention in all sessions to standardize the duration of acute effect; furthermore, the difference in total application time was considered a potential confounding variable and this was taken into account in the interpretation of the findings. The data collection process was completed after a total of 8 measurement sessions, with a 3-day rest period between all measurements and standardized application procedures.

Research Publication Ethics: Before the study could be conducted, the Iğdır University Scientific Research and Publication Ethics Board held a meeting dated December 5, 2024, numbered 2024/32, and determined that the research complied with scientific research and publication ethics, as per Article 10/1 of the Iğdır University Scientific Research and Publication Ethics Directive. Participants who agreed to participate in the study were informed about the purpose of the study, the research plan, and where and for what purposes the data obtained from the study would be used. Only those who wanted to participate voluntarily were included in the research, and written and verbal consent was obtained from the participants in accordance with the principle of 'Respect for Autonomy' and the principle of 'Privacy of Private Life and Protection of Confidentiality', stating that all information obtained from the research would remain confidential.

Warm-Up Methods Applied

FIFA 11+ Warm-Up Program: A track and mat were used for the FIFA 11+ warm-up program, which includes a total of 15 exercises and consists of 3 parts. In the first part, active stretching and straight runs were performed; in the second part, six types of exercises focusing on strengthening, balance and agility; and in the third part, medium/fast paced running exercises

combined with change of direction movements were performed; the application lasted an average of 18 minutes.

Table 1. FIFA 11+ warm-up program

EXERCISES			
PART 1: RUNNING EXERCISES	**SET**	**REPEATS**	**DURATION**
Straight running, Hips out, Hips in,	2	1	8 min
Alternating, Shoulder to shoulder, Back and forth			
PART 2: STRENGTH AND BALANCE EXERCISES			
Prone bench	3	1	20-30 sec
Side sleeping	3	1	20-30 sec
Hamstring	1	3-5	60 sec
Balance on one leg	2	1	30 sec
Squat	2	1	30 sec
Bounce	2	1	30 sec
PART 3: ADVANCED RUNNING EXERCISES			
Tempo running	2	1	2 min
TOTAL			**18-20 min**

Dry Cupping: Following the FIFA 11+ warm-up program, which lasted an average of 18 minutes, participants were placed on the treatment bed and placed in a side-lying position. Dry cupping was then applied to the quadriceps and hamstring muscles of both extremities, with three cups per muscle, for 10 minutes. Performance measurements were taken after the total warm-up program lasted an average of 28-30 minutes.

Graston Myofascial Release Technique: Following the FIFA 11+ warm-up program, participants were placed supine and then prone on the treatment bed, and the quadriceps and hamstring muscles were treated. Before the treatment, cream was applied to the treatment area to provide lubrication, and a sweeping technique was used with an auxiliary tool to mobilize soft tissue along the muscle. The right and left quadriceps and hamstring muscles were each exercised for two and a half minutes, totaling 10 minutes. Performance measurements were taken after the total warm-up program lasted approximately 28 to 30 minutes.

Vacuum Interferential: After the FIFA 11+ warm-up program, participants were placed in a side-lying position on a treatment bed, and vacuum electrodes were placed in pairs on the quadriceps and hamstring muscles. The current was increased until muscle contraction was achieved, and the application continued for 10 minutes. Performance measurements were taken after the total warm-up program lasted approximately 28-30 minutes.

Data Collection Tools and Data Collection: Research data were collected using a Personal Information and Data Form. The Personal Information Form included age, athletic age, height, weight, 30-meter sprint test measurement, normal range of motion measurement, muscle strength measurement, flamingo balance test measurement, anaerobic power test measurement, and Illinois agility test measurement. A Seca brand portable height and weight measuring device was used to measure the height and weight of the participating football players. Height measurements were recorded in 'cm' and weight in 'kg'. Measurements were taken in anatomical positions, without shoes, with the players holding their breath, with the headrest touching their heads.

30 m Speed Test: A photocell (± 0.01-second accuracy) was used for measurement. Participants began the sprint with a high start when they felt ready, starting from a line one meter behind the starting photocell. Measurements began with the athlete automatically activating the photocell at the starting point of the sprint track and ended with the photocell automatically stopping at the finish point 30 meters away. Participants were asked to run at maximum speed and completed the test twice, with a 3-minute passive rest interval. Speed test results were measured in seconds and milliseconds, and their best times were recorded (Mor et al., 2022).

Range of Motion Measurement (Goniometric Measurement): Knee flexion goniometric measurement was assessed by monitoring the midpoint of the fibula with the goniometer during active knee flexion with the subject in a prone position. Measurements were taken three times, and the arithmetic mean values were recorded in degrees (Norkin, 2016).

Muscle Strength Measurement: A LaFayette brand digital handheld dynamometer was used for measurement. For quadriceps strength measurement, participants were verbally instructed on how to perform the test, and the test began with participants sitting on a flat surface with their hips and knees flexed at 90º, feet free, and unsupported. The dynamometer was placed perpendicular to the leg, 1-2 cm above the level of the malleolus, and participants were asked to apply maximum force to the device. All measurements were taken twice by the same researcher using the same hand on both legs, and the best value was taken. To measure hamstring strength, participants were asked to lie face down on a flat table with their knees fully extended and unsupported. After a verbal explanation of the test, the dynamometer was placed perpendicular to the leg, 2-3 cm above the malleoli, and they were asked to flex their knees with maximum force. All measurements were taken twice by the same researcher with the same hand from both legs of the participants in lbs (pounds), and the best measurement was accepted.

Flamingo Balance Test: For the Flamingo Balance Test, used to assess static balance, participants were asked to balance on a board measuring 50 cm long, 4 cm high, and 3 cm wide with their dominant foot. Participants flexed their knee, pulled their free leg toward their hip, and held it with the ipsilateral hand. They attempted to maintain this position for 1 minute. The stopwatch was stopped when the subject's balance was disrupted due to circumstances such as letting go of a hand or foot, falling off the board, or touching the ground with any part of the body. The timer was restarted when the subject regained the starting position. The test continued

in this manner for 1 minute, and at the end of the time, the subject's attempts to maintain balance were counted and noted (Deforche et al., 2003).

Running-Based Anaerobic Sprint Test (RAST): The RAST test is a 35-meter sprint run performed six times, with a 10-second rest after each run. Before the test, participants were briefed on the test's administration and given a hands-on demonstration. Sprint times were automatically measured using electronic photocells placed at the beginning and end of the 35-meter track. The software on the photocell monitored a 10-second rest period after the sprint run, prompting the athlete to be ready at the end of the sprint to begin a new run at the 10-second mark. The test was completed after six sprints. In the RAST test, the average and total test time were recorded in seconds, and the average and maximum speeds of the sprint runs were recorded in km/h. The speed=distance/time formula was used for sprint speed, and the test times and minimum, maximum, and average power parameters were determined using the following formula (Gravisse et al., 2018).

Illinois Agility Test: Before the test, participants were given the necessary explanations and a familiarization with the course. They were then allowed to run 3-4 trials at a slow pace. A test course was prepared consisting of three cones, 5 m wide, 10 m long, and arranged in a straight line, 3.3 m apart in the middle. The test consisted of a slalom run with 180° turns every 10 meters, 40 meters on the flat surface and 20 meters between cones. Athletes were asked to start from the starting line of the test track, lying face down, with their hands touching the ground at shoulder height. The test was repeated twice with complete rest, and the best time was recorded in seconds (Özbay et al., 2018).

Statistical Analysis: In this study, analysis of variance (ANOVA) was performed to evaluate the effects of different training and application protocols (FIFA 11+, FIFA 11+ Dry Cup, FIFA 11+ Graston and FIFA 11+ Vacuum Interferential) on physical performance parameters. Before the analysis, normality and variance homogeneity tests were applied to determine whether the parametric test assumptions were met. Normality assumption was assessed with the Kolmogorov-Smirnov test, and variance homogeneity was assessed with the Levene test. P-values greater than 0.05 in both tests indicated that the data were normally distributed and the variances were homogeneous. Power analysis for repeated measures was performed using G*Power (version 3.1.9.7) software. A large effect size was assumed ($f = 0.40$), significance level was set at $\alpha = 0.05$, statistical power ($1-\beta$) = 0.95, number of measurements = 4, inter-measurement correlation = 0.50, and non-sphericity correction was set at $\varepsilon = 1$. The analysis determined that a minimum of 15 participants was needed to detect a statistically significant difference. A repeated-measures ANOVA was used to analyze the significance of different warm-up methods, and a Post-Hoc Bonferroni test was used to determine the difference between groups. All analyses were conducted using IBM SPSS Statistics 27.0. To complement null hypothesis significance testing, effect sizes (Cohen’s d) were calculated to assess the magnitude of differences between conditions. Effect sizes were derived using pooled standard deviations and interpreted following conventional thresholds (0.2 = small, 0.5 = medium, 0.8 = large).

RESULTS

Table 2. Average age, height, body weight and sports age values of the participants

Variable	Mean ± Standard Deviation
Age (years)	20.05±1.35
Height (cm)	178.26±7.26
Body Weight (kg)	74.47±12.14
Sports Age (years)	5.26±2.47

Table 2 presents the anthropometric characteristics of the participants. The participants' mean height was 178.26±7.26 cm, their mean age was 20.05±1.35 years, their mean weight was 74.47±12.14 kg, and their mean athletic age was 5.26±2.47 years. The data obtained indicate that the study group consisted of young, active individuals with a track record of athletic performance. The standard deviations in participants' height and weight indicate some variability among individuals within the group, but a homogeneous distribution in terms of age and athletic performance. These characteristics demonstrate a suitable sample profile for the study's validity and intergroup comparisons.

Table 3. 30 m speed test performance values of subjects according to warm-up protocols

Variable (sec)	Group	X	SS	Min.	Max.	P
30 m Speed Test	Fifa 11+ (a)	4.69	.23	4.42	5.30	**0.001***
	Fifa 11+ Dry Cup (b)	4.40	.25	3.39	5.04	**b<a**
	Fifa 11+ Graston (b)	4.44	.23	4.13	5.06	
	Fifa 11+ Vacuum Interferential (b)	4.40	.21	4.12	4.88	

a,b: Different letters in the same column indicate differences between groups ($p<0.05$).

When Table 3 is examined, there is a statistically significant difference between the groups in terms of the participants' 30 m speed test results ($p=0.001$). According to the results of the post-hoc analysis performed to determine which groups the difference was between, it was observed that there was no statistically significant difference ($p>0.05$) between the FIFA 11+ Dry Cup (4.40±0.25), FIFA 11+ Graston (4.44±0.23) and FIFA 11+ Vacuum Interferential (4.40±0.21) applications, but in all three combined methods, a significant improvement in speed ability was observed compared to the FIFA 11+ (4.69±0.23) application ($p<0.05$).

Table 4. Range of motion values of subjects according to warm-up protocols

Variable (cm)	Group	X	SS	Min.	Max.	P
Knee Flexion Range of Motion Right	Fifa 11+ (a)	131.42	5.44	123	140	0.740
	Fifa 11+ Dry Cup (a)	132.05	4.66	122	141	
	Fifa 11+ Graston (a)	133	5.61	123	146	
	Fifa 11+ Vacuum Interferential (a)	131.05	6.98	118	144	
Knee Flexion Range of Motion Left	Fifa 11+ (a)	127.47	6.06	120	139	0.766
	Fifa 11+ Dry Cup (a)	128.57	5.24	119	136	
	Fifa 11+ Graston e(a)	128.26	6.75	119	140	
	Fifa 11+ Vacuum Interferential (a)	126.57	6.97	119	143	

a,b: Different letters in the same column indicate differences between groups ($p<0.05$).

In goniometric measurements of the right knee range of motion, no significant difference was found in the normal joint motion values in the FIFA 11+ Dry Cup (131.42±5.44), FIFA 11+ Graston (132.05±4.66) and FIFA 11+ Vacuum Interferential (131.05±6.98) applications compared to the FIFA 11+ (131.42±5.44) application (P>0.05). Again, in the goniometric measurements of the left knee range of motion, no significant difference was detected in the normal joint motion values in the FIFA 11+ Dry Cup (128.57±5.24), FIFA 11+ Graston (128.26±6.75) and FIFA 11+ Vacuum Interferential (126.57±6.97) applications compared to the FIFA 11+ (127.47±6.06) application (p>0.05).

Table 5. Quadriceps muscle strength performance values of subjects according to warm-up protocols

Variable (Ibs)	Group	X	SS	Min.	Max.	P
Quadriceps	Fifa 11+ (a)	43.36	7.46	35.5	59	**0.006***
Muscle Strength	Fifa 11+ Dry Cup (ab)	48.18	6.72	39	64.50	
Measurement	Fifa 11+ Graston (b)	50.23	8.51	39	67	**a<ab<b**
Right	Fifa 11+ Vacuum Interferential (b)	52.42	8.81	36	66.50	
Quadriceps	Fifa 11+ (a)	40	7.39	28	55.50	
Muscle Strength	Fifa 11+ Dry Cup (b)	45.50	6.49	34	56	**0.018***
Measurement	Fifa 11+ Graston (b)	46.10	8.39	33	60.50	
Left	Fifa 11+ Vacuum Interferential (b)	48.13	9.47	35	67	**a<b**

a,b: Different letters in the same column indicate differences between groups (p<0.05).

When Table 5 is examined, there is a statistically significant difference between the groups in terms of the participants' right quadriceps muscle strength test results (p=0.006). According to the results of post-hoc analysis performed to determine which groups the difference was between, it was seen that in right quadriceps muscle strength measurements, the FIFA 11+ Dry Cupping (48.18±6.72) application had significantly higher values than the FIFA 11+ (43.36±7.46) application, while the FIFA 11+ Graston (50.23±8.51) and FIFA 11+ Vacuum Interferential (52.42±8.81) applications had significantly higher values than the FIFA 11+ Dry Cupping application (p<0.05). When Table 5 is examined, there is a statistically significant difference between the groups in terms of the participants' left quadriceps muscle strength test results (p=0.018). Post-hoc analysis performed to determine which groups the difference occurred between showed that there was no statistically significant difference (p>0.05) between the FIFA 11+ Dry Cup (45.50±6.49), FIFA 11+ Graston (46.10±8.39) and FIFA 11+ Vacuum Interferential (48.13±9.47) applications in left quadriceps muscle strength measurements, but significantly higher results were obtained compared to the FIFA 11+ (40±7.39) application in all three combined methods (p<0.05).

Table 6. Hamstring muscle strength performance values of subjects according to warm-up protocols

Variable (Ibs)	Group	X	SS	Min.	Max.	P
Hamstring	Fifa 11+ (a)	34.02	4.28	23.50	40.5	**0.001***
Muscle Strength	Fifa 11+ Dry Cup (b)	39.65	4.83	29	48	
Measurement	Fifa 11+ Graston (b)	39.65	6.22	28	51.5	**a<b**
Right	Fifa 11+ Vacuum Interferential (b)	40.31	5.18	32.50	49	
Hamstring	Fifa 11+ (a)	32.28	4.55	23	39	
Muscle Strength	Fifa 11+ Dry Cup (b)	36.94	4.53	26.50	43	**0.002***
Measurement	Fifa 11+ Graston (b)	36.52	4.99	25.50	44.5	
Left	Fifa 11+ Vacuum Interferential (b)	38.86	6.38	31	52	**a<b**

a,b: Different letters in the same column indicate differences between groups (p<0.05).

When Table 6 is examined, there is a statistically significant difference between the groups in terms of participants' right hamstring muscle strength test results (p=0.001). Post-hoc analysis to determine which groups accounted for the difference revealed that there was no statistically significant difference (p>0.05) in right hamstring muscle strength measurements between the FIFA 11+ Dry Cupping (39.65±4.83), FIFA 11+ Graston (39.65±6.22), and FIFA 11+ Vacuum Interferential (40.31±5.18) applications. However, a significant increase in strength ability was observed in all three combined methods compared to the FIFA 11+ (34.02±4.28) application (P<0.05). There was a statistically significant difference between the groups in terms of left hamstring muscle results (p=0.002). Post-hoc analysis was performed to determine which groups the differences were between. It was determined that there was no statistically significant difference (P>0.05) in left hamstring muscle strength measurements between FIFA 11+ Dry Cupping (36.94±4.53), FIFA 11+ Graston (36.52±4.99) and FIFA 11+ Vacuum Interferential (38.86±6.38) applications, but significantly higher strength values were achieved in all three combined methods compared to FIFA 11+ (32.28±4.55) application (p<0.05).

Table 7. Flamingo balance test performance values of subjects according to warm-up protocols

Variable (Number of attempts to remain balanced)	Group	X	SS	Min.	Max.	P
Flamingo Balance Test	Fifa 11+ (a)	5.73	1.75	4	10	**0.000*** **c<b<a**
	Fifa 11+ Dry Cup (b)	3.73	1.40	2	6	
	Fifa 11+ Graston (b)	3.68	1.10	2	6	
	Fifa 11+ Vacuum Interferential (c)	2.47	1.26	1	4	

a,b: Different letters in the same column indicate differences between groups (p<0.05).

When Table 7 is examined, there is a statistically significant difference between the groups in terms of the participants' flamingo balance test results (p=0.000). According to the results of the post-hoc analysis conducted to determine which groups the difference was between, it was determined that in the Flamingo balance test measurements, significantly lower values were obtained in the FIFA 11+ Dry Cup (3.73±1.40), FIFA 11+ Graston (3.68±1.10) applications compared to the FIFA 11+ (5.73±1.75) application, and in the FIFA 11+ Vacuum Interferential (2.47±1.26) application compared to all other groups, meaning that balance ability improved (p<0.05).

Table 8. Illinois agility test performance values of subjects according to warm-up protocols

Variable (sec)	Group	X	SS	Min.	Max.	P
Illinois Agility Test	Fifa 11+ (a)	19.64	1.00	18.05	21.50	**0.001*** **b<a**
	Fifa 11+ Dry Cup (b)	18.73	.78	17.84	20.98	
	Fifa 11+ Graston (b)	18.61	.98	16.98	20.63	
	Fifa 11+ Vacuum Interferential (b)	18.41	.93	17.23	20.04	

a,b: Different letters in the same column indicate differences between groups (p<0.05).

When Table 8 is examined, there is a statistically significant difference between the groups in terms of the participants' Illinois agility test results (p=0.001). According to the results of the post-hoc analysis performed to determine which groups the difference was between, there was no statistically significant difference (p>0.05) between the participants' FIFA 11+ Dry Cup

(18.73±0.78), FIFA 11+ Graston (18.61±0.98) and FIFA 11+ Vacuum Interferential (18.41±0.93) applications in the Illinois agility test measurements, but it was observed that agility ability improved significantly compared to the FIFA 11+ (19.64±1.00) application in all three combined methods (p<0.05).

Table 9. Running-Based anaerobic sprint test (RAST) performance values (maximum and minimum power) of subjects according to warm-up protocols

Variable (Watt/kg)	Group	X	SS	Min.	Max.	P
Maximum Power	Fifa 11+ (a)	642.84	148.24	476	994	0.993
	Fifa 11+ Dry Cup (a)	635.21	132.37	453	865	
	Fifa 11+ Graston (a)	629.63	133.23	465	846	
	Fifa 11+ Vacuum Interferential (a)	633.52	135.92	454	896	
Minimum Power	Fifa 11+ (a)	312.21	79.15	193	467	0.994
	Fifa 11+ Dry Cup(a)	310.89	62.95	202	423	
	Fifa 11+ Graston (a)	311.36	55.29	215	414	
	Fifa 11+ Vacuum Interferential (a)	306.73	53.24	218	398	

a,b: Different letters in the same column indicate differences between groups (p<0.05).

In anaerobic maximum power measurements, no significant difference was found in FIFA 11+ Dry Cupping (635.21±132.37), FIFA 11+ Graston (629.63±133.23) and FIFA 11+ Vacuum Interferential (633.52 ± 135.92) applications compared to FIFA 11+ (642.84±148.24) application (p>0.05). Likewise, in anaerobic minimum power measurements, no significant difference was found in FIFA 11+ Dry Cupping (310.89±62.95), FIFA 11+ Graston (311.36±55.29) and FIFA 11+ Vacuum Interferential (306.73±53.24) applications compared to FIFA 11+ (312.21±79.15) application (P>0.05).

Table 10. Running-Based anaerobic sprint test (RAST) performance values (average power and fatigue index) of subjects according to warm-up protocols

Variable (Watt/kg,%)	Group	X	SS	Min.	Max.	P
Fatigue Index (%)	Fifa 11+ (a)	9.32	3.30	5.80	17.70	0.998
	Fifa 11+ Dry Cup (a)	9.21	2.94	5.70	16.10	
	Fifa 11+ Graston (a)	9.14	2.93	6.00	16.30	
	Fifa 11+ Vacuum Interferential (a)	9.26	2.84	5.70	15.70	
Average Power (Watt/kg)	Fifa 11+ (a)	452.52	110.47	294	734	0.999
	Fifa 11+ Dry Cup (a)	450.68	105.25	290	714	
	Fifa 11+ Graston (a)	450.84	105.87	288	704	
	Fifa 11+ Vacuum Interferential (a)	455.00	103.92	302	709	

a,b: Different letters in the same column indicate differences between groups (p<0.05).

In fatigue index measurements, no significant difference was found in FIFA 11+ Dry Cupping (9.21±2.94), FIFA 11+ Graston (9.14±2.93) and FIFA 11+ Vacuum Interferential (9.26±2.84)

applications compared to FIFA 11+ (9.32±3.30) application (P>0.05). Likewise, in anaerobic mean power measurements, no significant difference was found in FIFA 11+ Dry Cupping (450.68±105.25), FIFA 11+ Graston (450.84±105.87) and FIFA 11+ Vacuum Interferential (455.00±103.92) applications compared to FIFA 11+ (452.52±110.47) application (P>0.05).

Table 11. Effect size (Cohen's d) values for significant performance parameters

Variable	FIFA 11+ (Mean ± SD)	FIFA 11+ Vacuum Interferential (Mean ± SD)	Cohen's d	Effect Size Interpretation
30 m Sprint (sec)	4.69±0.23	4.40±0.25	1.21	Large
Illinois Agility (sec)	19.64±1.00	18.41±0.93	1.27	Large
Quadriceps Strength Right (lbs)	43.36±7.46	52.42±8.81	1.11	Large
Hamstring Strength Right (lbs)	34.02±4.28	40.31±5.18	1.32	Large
Flamingo Balance (attempts)	5.73±1.75	2.47±1.26	2.14	Very Large

Effect sizes were calculated using Cohen's d based on pooled standard deviations. Interpretation was made according to Cohen's criteria: small (0.2), medium (0.5), large (0.8), and very large (>1.2).

The statistically significant improvements observed in sprint, agility, muscle strength, and balance parameters were associated with large to very large effect sizes (d = 1.11–2.14), indicating substantial practical significance of the combined warm-up protocols compared to FIFA 11+ alone.

DISCUSSION

The primary purpose of this study was to determine whether the acute integration of selected physiotherapy-based interventions into the FIFA 11+ warm-up program would elicit greater improvements in performance compared to the FIFA 11+ protocol alone. The main findings indicate that combining FIFA 11+ with dry cupping, Graston technique, or vacuum interferential current produced significantly greater enhancements in sprint performance, lower-extremity muscle strength, balance, and agility. In contrast, no additional effects were observed in knee range of motion or anaerobic performance parameters. These results suggest that while certain neuromuscular performance components may respond positively to the acute addition of passive physiotherapy-based techniques, other physiological capacities appear less sensitive to short-term modifications of the warm-up protocol.

In our study, when comparing 30 m sprint test values between groups, it was determined that there was no significant difference between the FIFA 11+ Dry Cup, FIFA 11+ Graston, and FIFA 11+ Vacuum Interferential combined methods (P>0.05), but the measured values in all three groups were statistically significantly higher than those in the FIFA 11+ group (P<0.05). The literature contains studies similar to ours that report that the FIFA 11+ warm-up program improves speed performance (Asgari et al., 2023; Bizzini et al., 2013; Kahraman et al., 2023). However, studies directly examining the acute effects of dry cupping, Graston myofascial release technique, and vacuum interferential applications on speed appear to be limited. It is stated in the literature that dry cupping may cause temporary circulatory changes in the local

area (Emerich et al., 2014), Graston technique may be related to blood flow and muscle function (Harris, 2020; Kim et al., 2014), and interferential flow may affect muscle contraction and circulation (Long, 2017; Rajan et al., 2018; Vieira et al., 2012). However, these physiological variables were not directly measured in the present study. Therefore, while it is thought that the increase in speed obtained after combined applications may be related to increased neuromuscular activation, muscle strength, or local circulatory changes, these interpretations should be evaluated at the level of probability, not as directly proven cause-and-effect relationships.

In our study, when comparing the normal joint range of motion (NJ) values of the right and left knee flexion between groups, no significant difference was found in the normal joint range of motion goniometric measurements for both the right and left knees in FIFA 11+ Dry Cupping, FIFA 11+ Graston, and FIFA 11+ Vacuum Interferential applications compared to FIFA 11+ application alone ($P>0.05$). A review of the literature revealed that there were studies reporting that the FIFA 11+ warm-up program increased normal joint range of motion (Martin, 2023; Trajković et al., 2020). This increase in flexibility achieved with the FIFA 11+ warm-up program is thought to stem from the fact that the exercises target the core muscles, specifically increasing flexibility, strength, and blood flow to the hamstring and quadriceps muscles. There have been studies in the literature that examined the effect of dry cupping on normal joint movement and reported that dry cupping increased normal joint movement (Kim et al., 2017; Murray & Clarkson, 2019). There have also been studies indicating that the Graston technique increases normal joint range of motion (Lee et al., 2016; Stanek et al., 2018). There have been studies reporting that vacuum interferential current increases normal joint movement (Kim & Choi, 2013). However, in our study, it was found that combined applications did not provide an additional advantage compared to the FIFA 11+ program alone. This suggests that the dynamic exercise and stretching content of the FIFA 11+ program may be sufficient to achieve a certain level of flexibility in the acute phase. However, these statements should be treated with caution, as parameters such as soft tissue viscoelastic properties, muscle-tendon unit behavior, or intramuscular circulation are not directly assessed.

In our study, it was observed that FIFA 11+ Dry Cupping application resulted in significantly higher values in right and left quadriceps muscle strength measurements compared to FIFA 11+ application, and FIFA 11+ Graston and FIFA 11+ Vacuum Interferential applications resulted in significantly higher values compared to FIFA 11+ Dry Cupping application ($P<0.05$). When the relationship between the FIFA 11+ warm-up program and muscle strength was examined, it was seen that there were studies in the literature reporting that the FIFA 11+ warm-up program increased vertical jump height (Gómez-Álvarez et al., 2021; Palazón et al., 2016). Although no study combining the FIFA 11+ warm-up program with the physiotherapy-based methods we applied was found in the literature, it was seen that there were studies where these methods were applied alone. Kim et al. (2017) divided the participants into two groups in their study with 30 participants. One group underwent passive stretching, while the other received 10 minutes of dry cupping. EMG measurements taken after the applications showed significantly better results in terms of muscle activity in the dry cupping group. In the literature, there are studies that support this view of the researchers (Coutinho et al., 2004; Koh, 1995) and also

report that the Graston technique (Peacock et al., 2014; Uysal et al., 2025) and interferential current increase muscle strength. However, in the present study, mechanisms such as EMG activity, intramuscular oxygenation, or neuromuscular transmission were not directly measured. Therefore, while it is thought that the observed increases in force may be related to local circulatory changes, increased neuromuscular excitability, or soft tissue mobilization, these inferences should be considered as possible mechanisms consistent with the literature, not as definitive causal explanations.

In our study, when comparing flamingo balance test values between groups, it was determined that FIFA 11 + Dry Cup and FIFA 11 + Graston applications showed significantly higher values compared to FIFA 11+ application, and FIFA 11 + vacuum interferential application showed significantly higher values compared to all other groups ($P<0.05$). A review of the literature revealed only one study examining the acute effect of the FIFA 11+ warm-up program on balance. Kahraman et al. (2023) evaluated the static balance of 13 futsal players by applying the FIFA 11+ warm-up program, static stretching, and dynamic stretching, and reported that there was no significant difference between the groups. Some studies have found that the FIFA 11+ warm-up program has a positive effect on balance, but these studies were long-term programs, not acute ones (Rössler et al., 2016; Oliano et al., 2017). Studies in the literature have reported an increase in balance after dry cupping (Brandon et al., 2019). Researchers speculate that this increase is due to increased muscle flexibility. Although our study found no difference between groups in terms of normal joint movement, it was determined that the FIFA 11+ application combined with dry cupping significantly increased muscle strength compared to the FIFA 11+ application alone. It is estimated that the reason for this difference in static balance ability may be increased muscle strength. There are only a few studies in the literature reporting that the Graston technique improves balance (Croft et al., 2022; Yana et al., 2025). Researchers have argued that the Graston technique improves neuromuscular control by stimulating sensorimotor receptors, and that this increase in balance can be explained in this way. It has been observed that there are few studies in the literature reporting that interferential current increases balance (Lee et al., 2018; Suh et al., 2014). Interferential current has been reported to enhance proprioception by providing subcutaneous and intra-articular sensory input (Pérennou et al., 2001). However, variables such as proprioceptive sensitivity, reflex response time, or postural sway parameters were not directly measured in this study. Therefore, while it is thought that the increase in balance performance may be related to increased muscle strength, sensory input, or neuromuscular coordination, these explanations remain speculative and should be interpreted with caution.

In our study, when comparing Illinois Agility test values between groups, it was observed that significantly better results were obtained in FIFA 11+ Dry Cup, FIFA 11+ Graston and FIFA 11+ Vacuum Interferential applications compared to FIFA 11+ application ($P<0.05$). A review of the literature reveals that there are few studies examining the acute effects of the FIFA 11+ warm-up program on agility, and most of these studies are long-term studies (Anam et al., 2024; Hosseini et al., 2019). A review of the literature revealed no studies investigating the effect of dry cupping on agility. In our study, the significant increase in agility after dry cupping combined with the FIFA 11+ warm-up program is thought to be due to the release of soft tissues,

removal of toxins, elimination of adhesions, and increased blood flow to the muscles, all of which are results of dry cupping through suction and negative pressure (Gao, 2004). A review of the literature revealed that there were some studies investigating the acute effect of the Graston technique on agility and reporting positive results (Kabasakal, 2024; Kurt et al., 2024). However, no studies investigating the effect of interfering current on agility were found in the literature. Agility performance is a complex trait resulting from the interaction of multiple components such as muscle strength, coordination, balance, and neuromuscular control. Therefore, the observed increase in combined applications may be related to possible changes in muscle strength and neuromuscular activation, in particular. However, explanations based on increased circulation, tissue mobilization, or metabolic changes should be treated with caution as they have not been directly measured.

In our study, no significant differences were found between groups in anaerobic maximum power, anaerobic minimum power, fatigue index, and anaerobic mean power measurements in the Run-Based Anaerobic Sprint (RAST) test values ($P>0.05$). A review of the literature reveals that there are few studies examining the acute effects of the FIFA 11+ warm-up program on anaerobic performance. Bizzini et al. (2013) conducted a study with 20 amateur football players and measured lactate levels before and after the FIFA 11+ warm-up program. The results showed only a slight increase in lactate levels after the warm-up program, indicating that the FIFA 11+ warm-up program was not intense enough to significantly increase lactate levels. It has been reported that there are few studies in the literature that measure anaerobic performance after dry cupping, and these studies have not found a significant effect of dry cupping on anaerobic performance (Al-Horani et al., 2022; Sucan et al., 2024). No studies examining the effect of Graston technique or vacuum interferential application on anaerobic performance have been found in the literature. The values measured by the RAST test are indicators of anaerobic capacity and anaerobic power. Anaerobic capacity refers to the work capacity of muscles using their anaerobic energy systems during maximal and submaximal intensity exercise, while anaerobic power refers to the value of this work per unit time. The amount of lactic acid that accumulates in the muscles determines the limits of anaerobic capacity and power (Jonathan & Euan, 1997). Excess lactic acid will lower the pH value in the muscles and prevent them from working due to fatigue. Increasing anaerobic capacity requires vigorous and short-duration exercises. These types of exercises increase the metabolic capacity of the muscles, improving neuromuscular adaptation (McArdle et al., 1996). There was no significant change in RAST values after the short warm-up programs we conducted. It is estimated that this is because high-intensity, prolonged stress on the muscles is necessary for increased anaerobic capacity and power, and for the muscles to adapt, and our application did not involve such a practice.

Overall, the findings of this study indicate that the acute integration of selected physiotherapy-based techniques into the FIFA 11+ warm-up program may provide additional neuromuscular benefits in specific performance domains, particularly sprint performance, lower-extremity strength, balance, and agility. The large to very large effect sizes observed suggest that these improvements are not only statistically significant but also practically meaningful in applied sports settings. However, no additive effects were detected in range of motion or anaerobic

performance parameters, highlighting that not all performance components respond similarly to short-term interventions.

It is important to emphasize that the present study examined only immediate post-intervention responses; therefore, the persistence and cumulative impact of these effects remain unclear. Additionally, the absence of direct physiological measurements (e.g., electromyographic activity, muscle oxygenation, or circulatory parameters) limits the ability to confirm the underlying mechanisms discussed. Future research should investigate long-term adaptations, include objective neuromuscular and metabolic assessments, and explore whether these acute enhancements translate into meaningful performance improvements during competition.

CONCLUSIONS

The present study demonstrated that the acute addition of physiotherapy-based interventions (dry cupping, Graston technique, and vacuum interferential current) to the FIFA 11+ warm-up program resulted in greater improvements in sprint performance, lower-extremity muscle strength, balance, and agility compared to FIFA 11+ alone. These differences were supported by large to very large effect sizes, indicating practical as well as statistical significance.

In contrast, no additional benefits were observed in knee range of motion or running-based anaerobic performance parameters. The absence of changes in these variables may be related to the short duration of the interventions and the physiological demands required to elicit adaptations in anaerobic capacity.

Since the present findings are limited to acute responses in a relatively homogeneous sample of young male football players, caution is warranted when generalizing the results. Future studies should investigate the long-term effects of integrating physiotherapy-based methods into structured warm-up programs and explore underlying neuromuscular and physiological mechanisms.

Recommendations

- This study, which combines the FIFA 11+ warm-up program with different warm-up programs, should be conducted with more participants,
- This study, which combines the FIFA 11+ warm-up program with different warm-up programs, should also be conducted with women,
- This study, which combines the FIFA 11+ warm-up program with different warm-up programs, should also be conducted with sports branches other than football players,
- In addition to the physiotherapy-based methods we use in combination with the FIFA 11+ warm-up program, we also combine the application with other active and passive warm-up methods found in the literatüre,
- The methods we use can also be combined with other warm-up methods instead of the FIFA 11+ warm-up program,
- We recommend designing studies that investigate the long-term effects of warming methods, which we examined only for their acute effects.

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