

Effects of different warm-up methods on endurance in soccer players: Comparison of conventional, FIFA 11+ and FIFA11+ plus self myofascial releasing warm-up methods

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Abstract:

Warm-up is important for increasing athlete performance, preventing injuries and rehabilitation. Different methods are used for warm-up. In professional soccer, warming up has an important place in preventing injuries while increasing performance. The effect of warm-up on performance, endurance and injuries is still controversial. Today, conventional warm-up (CWU), FIFA11+ and self myofascial release (SMR) methods are frequently used for warm-up and rehabilitation. The aim of this study was to evaluate the effects of CWU, FIFA11+ and FIFA11+ plus SMR (F+SMR) methods on endurance in soccer players. The study included 16 licensed amateur male soccer players (Age: 17.00±0.00 years, Height: 174.12±5.89 cm, weight: 60.87±8.09 kg, Body Mass Index: 20.01±1.90) who regularly trained five times a week and played one official competition. CWU, FIFA 11+ and F+SMR sessions were performed on different days, respectively. Care was taken to ensure that the soccer players were not tired during the practice. After each warm-up session, the 30-15 intermittent fitness test was performed and its effects on endurance were evaluated. When running times, peak velocities and maximal aerobic speeds were compared; it was found that running times after CWU were 12.3% higher than FIFA 11+ warm-up, while peak running speeds after FIFA 11+ warm-up were 6.3% lower than CWU warm-up. In terms of maximal aerobic speed, 7.1% higher values were found in CWU warm-up group compared to FIFA 11+ and 3.5% higher values compared to F+SMR. In conclusion, in terms of endurance performance of the athletes, CWU and F+SMR warm-up showed higher running speeds compared to FIFA 11+ warm-up session. The results of the study show that CWU gives better results in terms of endurance and FIFA11+ warm-up method may be insufficient in this respect. It can be speculated that it is important for coaches to apply different warm-up methods for different purposes in the performance of soccer players.

Key Words: football, intermittent fitness test, aerobic capacity, peak velocity, performance.

Introduction

Activities performed before a physical activity or sporting performance to improve performance and reduce the risk of injury are called warm-ups (Gil, Neiva, Sousa, Marques, & Marinho, 2019). The purpose of the warm-up is to prepare the athletes for training, competition, or tests and to prevent sports injuries that may occur at the same time (McCrary, Ackermann, & Halaki, 2015). There are studies showing that the physiological changes in the body caused by properly applied warm-up improve athlete performance and increase competition performance (Hammami, Zois, Slimani, Russell, & Bouhel, 2016; McGowan, Pyne, Thompson, & Rattray, 2015). However, it is still open to debate how the application should be done and in which steps of sportive performance it is effective (Chen, Chang, et al., 2022; Chen, Chiu, et al., 2022; Silva, Neiva, Marques, Izquierdo, & Marinho, 2022).

Many studies have suggested that a sufficiently active warm-up strategy applied correctly in addition to physical training can improve performance by increasing body temperature, increasing metabolism and altering oxygen kinetics (Burnley et al., 2005; Temesi et al., 2017). Increased oxygen kinetics results in more efficient utilization of oxygen and therefore better muscle contraction performance (Woods, Bishop, & Jones, 2007).

However, in order to obtain a clear efficiency from the warm-up stages, it is necessary to design the warm-up sessions in accordance with the targeted purpose in the main stage, and in this sense, there are many research topics in the literature examining the effects of the warm-up sessions (Hammami et al., 2016; Palucci Vieira et al., 2021). Among these studies, there are many studies examining different types of warm-up such as dynamic and static stretching, self myofascial release method, FIFA 11+ and prior exercises and their effects (Cornell & Ebersole, 2020; Opplert & Babault, 2018; Palmer, Pineda, Cruz, & Agu-Udemba, 2019; Sadigursky et al., 2017).

It is stated that static and dynamic types of stretching exercises increase the temperature of the body core region and have a positive effect on performance by increasing blood flow (Costa, Herda, Herda, & Cramer, 2013). However, the extent to which it serves the purpose of the main session is also discussed (Haddad et al., 2019). Several studies in recent years have shown that static stretching exercises, especially those lasting longer than 60 seconds or involving more than one muscle, even if shorter, can lead to a loss in physical performance (Behm, Blazevich, Kay, & McHugh, 2016; Chaabene, Behm, Negra, & Granacher, 2019; Palmer et al., 2019). On the other hand, when the aim is to increase joint range of motion and improve muscle strength, dynamic stretching is suggested to be a better alternative to static stretching because it does not negatively affect muscle strength (Opplert & Babault, 2018).

Self-myofascial release is a soft tissue procedure that relies on gentle stretching to reduce fibrous adhesions between layers of fascial tissue. The goal focuses on realigning the deep layers of muscles and connective tissue (MacDonald et al., 2013). It involves slower movement and deeper pressure application. It has become increasingly popular as it is a method that can be applied without being therapist-dependent. Another reason for the increased use of this method is the increase in muscle tissue extensibility and range of motion without any reduction in force output (Halperin, Aboodarda, Button, Andersen, & Behm, 2014).

It has been applied not only in exercise and sports related areas such as warm-up and stretching, but also in various myofascial pain and neuromuscular therapy areas (Warren, LaCross, Volberding, & O'Brien, 2020). The FIFA 11+ program is a dynamic warm-up program developed for injury prevention among soccer players (Sadigursky et al., 2017). It consists of 10 exercises emphasizing core stability, dynamic stabilization, eccentric thigh muscle training, proprioceptive training, and plyometrics with straight leg alignment (Bizzini et al., 2013). FIFA 11+ warm-up is used to reduce the injury risks of athletes (Sadigursky et al., 2017). This warm-up session consists of 3 different phases; part 1: running, part 2: proprioceptive, dynamic stabilization, and jumping exercises, part 3: sprinting, and at each stage, all skeletal muscle systems of the athletes are activated at appropriate levels. In studies, it is seen that there are results that the FIFA 11+ warm-up phase creates increases in the speed, strength, balance and endurance levels of the athletes (Bizzini et al., 2013; Sadigursky et al., 2017). However, there is still not enough research on the endurance levels of FIFA 11+, conventional warm-up (CWU) and self myofascial releasing warm-up sessions applied in combination with FIFA 11+(F+SMR) (Faelli et al., 2021; Lotia, Vyas, & Sheth, 2023).

In general, in the literature, it is seen that the effects of different warm-up methods on joint range of motion, flexibility and muscle strength are frequently discussed, but there are not enough studies on endurance. The aim of this study was to evaluate the effects of conventional warm-up, FIFA11+ and FIFA11+ with self myofascial release on endurance.

Material & methods

Sixteen amateur U-17 male soccer players, from Azerbaijan professional club took part in this study over the 2021-2022 season (Age: 17.00 ± 0.0 years, Height: 174.12 ± 5.89 cm, weight: 60.87 ± 8.09 kg, Body Mass Index: 20.01 ± 1.90). Concerning the sample size, the following equation was used: $\text{Sample Size} = Z^2 \times (p) \times (1 - p)/C^2$, where Z = confidence level (95%); $p = 0.05$ and C = margin of error 0.05. These players trained five times a week (90 min per session) and played one match a week.

The training sessions were based on technical and tactical content development (70% of training time), technical skill improvements (10% of training time), and general improvements in physical condition (20% of training time). The participants' parents obtained information about the main aims of the investigation and signed informed consent forms. The study was conducted in accordance with the ethical principles of the Helsinki declaration for human research and was approved by the ethics committee of Trabzon University (2022-11/1.28). Inclusion criteria for the participants in this study were (i) not using ergogenic support, (ii) not having a heart disease problem, and (iii) not having a muscle injury.

Procedure

Data Collection

First, the main researcher met with the team staff and informed them about the aims of the present study. In this sense, the researcher ensured that participants signed their informed consents after having received details of the possible benefits and risks of the study.

Secondly, the soccer players performed the tests following the same order. Thus, the anthropometry was performed in a dressing room with a stable temperature of 24°C. Subsequently, warm-ups sessions were performed in three different days [MD-3 (Thursday)] in counterbalanced order: I) conventional warm-up; II) FIFA 11+ and III) FIFA 11+ plus SMR). After different warm-up sessions, the 30-15 intermittent fitness test was performed (See Figure 1, for more information.). Previously, all participants were informed and familiarized about the FIFA 11+ and SMR warm-ups.

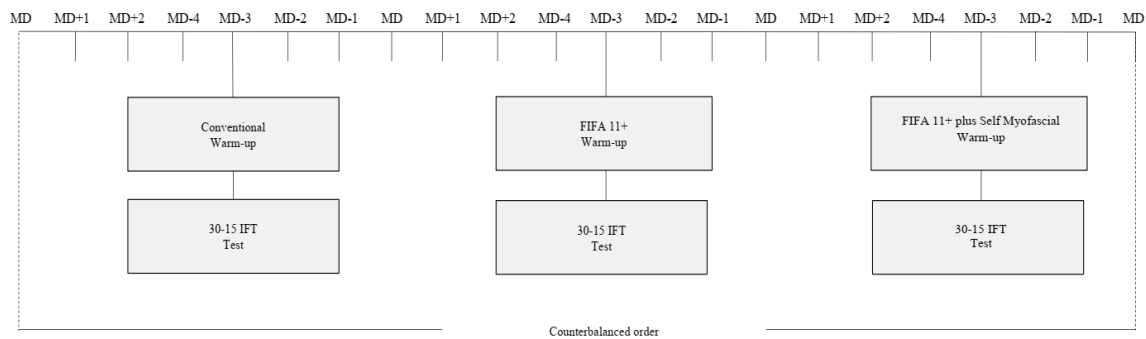


Figure I. Schematic representation of a test day (see text for full description). IFT: Intermittent Fitness Test.

Test protocol

Anthropometry: The weight measurements of the athletes were taking using a digital scale with only the shorts worn on the tops of the athletes being measured. The height of the athletes was measured with a tape measure fixed to the wall without shoes on their feet. In order to ensure accurate measurements; a single trainer conducted the measurements of the athletes. The research included measurements of body fat ratios and body mass of athletes participating in the study Body mass index “mass (kg)/height (m)² calculated using the formula. **30-15 Intermittent Fitness Test:** The 30-15_{IFT} was applied to determine the aerobic capacity of the athletes. The test track was held in an area of 40 m in length, marked for a transition of 3 meters at the beginning and end, and 6 meters in the middle (Buchheit, Lefebvre, Laursen, & Ahmaidi, 2011). Before the test, the sound system was calibrated, and then a demo was shown to the athletes for the test protocol. In the main session of the test, the initial speed started with 8 km.h⁻¹ and continued with walking for 15 seconds after 30 seconds. Each stage of the test was realized as 0.5 km.h⁻¹ speed increase. When the athletes could not reach the marks in the determined area after increasing speeds, the test of the athlete was terminated after 3 warnings.

Conventional Warm-up: The athletes first warmed up at low intensity for 5-7 minutes in various running forms. Afterwards, the athletes performed active warm-ups for different joints for 5-7 minutes, including dynamic stretches. Behind this sequence, several sprints were executed and they were ready for testing. In order for this warm-up session to be of the same duration as the other warm-up sessions, the warm-up period was ended in 20 minutes.

FIFA 11+ warm-up sessions: In the research, the FIFA 11+ warm-up protocol was applied as stated in the literature (Bizzini et al., 2013; Sadigursky et al., 2017). This warm-up protocol was applied for 20 minutes and 3 different stages. In the first stage, the athletes applied different running forms with very low intensity. In the second stage, the athletes applied core stabilization, proprioceptive, strength and plyometric activities. At the last stage, the warm-up was ended with activities in the form of running with high intensity. After this warm-up soccer players were taken to 30-15_{IFT}.

FIFA 11+ plus Self Myofascial Release Warm-up: After the FIFA 11+ warm-up session, 2x30 seconds of SMR application was performed on the whole body (2 sets of 30 seconds to the gastrocnemius, hamstring, quadriceps, latissimus dorsi muscles). Trigger Point Grid 1.0 Foam Roller apparatus was used for the muscle surface in the warm-up applied with the self myofascial release method. The athletes performed this application with their own body weights (Beardsley & Škarabot, 2015), and immediately afterwards, the athletes were taken to 30-15_{IFT}.

Statistical Analysis

Descriptive statistics were calculated for each variable (see Table I for more information). Values were expressed as mean and standard deviations. First of all, the normality of the data was checked using the Shapiro-Wilk test ($p>0.05$). After the distribution of the data was considered to satisfy the assumption of normality, the Repeated Measures ANOVA test was used to test three different warming's. Mauchly's test was used to confirm the sphericity of the data. Pairwise comparison with Bonferroni correction was applied when any differences were detected. The significance level was accepted as $p<0.05$. Data were analyzed using IBM SPSS® software version 28.0.1.0.

Results

Table I. The mean standard deviation (SD), minimum (min.) and maximum (max.) values of the height, body weight, body mass index (BMI) of athletes

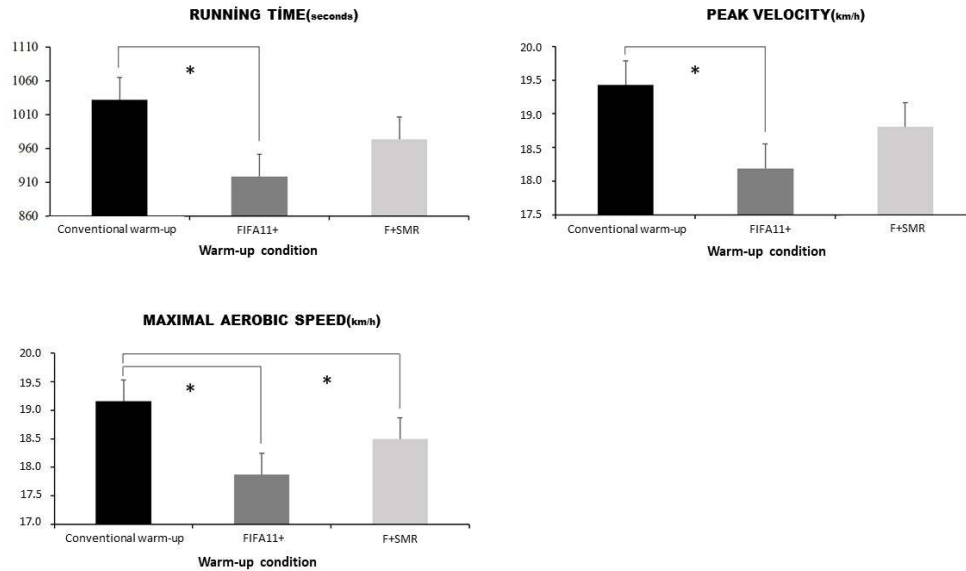
	<i>n</i>	Min.	Max.	Mean± SD
Height (cm)	16	164.00	183.00	174.12±5.89
Body Weight (kg)	16	48.00	73.00	60.87±8.09
BMI (kg.m ⁻²)	16	17.20	22.70	20.01±1.90

In Table I, the height, body weight and body mass indexes of the athletes participating in the study are given. It is seen that the mean height of the participants was 174.1± 5.89, the mean body weight was 60.87±8.09, and the mean body mass index was 20.01±1.90.

Table II. Comparison of Running Time, Peak Velocity, and Maximal Aerobic Speed values measured in different warm-up sessions.

	Conventional Warm-up ¹	FIFA 11+ ²	FIFA 11+ Plus SMR ³	F	P	Bonferroni
30-15_{IFT} Running Time	1031.94	918.62	974.00	6.82	0.004	1-2
30-15_{IFT} Peak Velocity	19.43	18.19	18.81	6.63	0.004	1-2
30-15_{IFT} Maximal Aerobic Speed	19.16	17.87	18.50	6.95	0.003	1-2,1-3

As shown in Table II, according to the Mauchly's test, the assumption of sphericity was $p=0.13$ for running time, $p=0.124$ for peak velocity, $p=0.085$ for maximal aerobic speed. A statistically significant differences were observed when comparing running time ($F(2,30)=6.817$, $p=0.004$), Peak velocity ($F(2,30)=6.634$, $p=0.004$) measured at conventional warm-up, FIFA 11+ and, F+SMR).



Graph. I, Graphical representation of the comparison of 30-15_{IFT} running time, peak velocity, maximal aerobic speeds values in different warm-up sessions (groups with a difference in Bonferroni correction were indicated with "*" sign)

The running times of the players were 12.3% higher when conventional warm-up compared to FIFA 11+ warm-up. In terms of peak velocities, 6.3% lower peak velocities were found when comparing FIFA 11+ warm-up to conventional warm-up. When the maximal aerobic running speeds of the athletes were examined, 7.1% higher values were obtained when conventional warm-up compared to FIFA 11+ warm-up and 3.5% higher when FIFA 11+ plus self-myofascial warm-up was performed.

Discussion

In this study, the acute effects of 3 different warm-up sessions (conventional warm-up, FIFA 11+ and F+SMR) on the endurance performance of the athletes were examined. According to the results of the research, it was concluded that conventional warm-up and FIFA 11+ plus SMR warm-up, respectively, had a statistically positive effect on endurance performances compared to the FIFA 11+ warm-up session. FIFA 11+ warm-up sessions are applied with the aim of minimizing the injury risks of the athletes (Sadigursky et al., 2017). There are very few studies in the literature examining the acute effect of FIFA 11+ warm-up on $\dot{V}O_{2max}$ levels. While it is stated in the studies that FIFA 11+ warm-up sessions may cause fatigue in athletes (Impellizzeri et al., 2013), it is also stated that research on how the acute performance efficiency of warm-up sessions should be implemented (Zois, Bishop, Ball, & Aughey, 2011). Upon conducting a thorough review, it becomes apparent that the studies centered around FIFA 11+ primarily focus on analyzing its impact on jump, strength, balance, and agility performances (Pankaj & Gill, 2021). In the research examining the $\dot{V}O_{2max}$ levels of the FIFA 11+ warm-up session; researchers investigated the effect of FIFA 11+ warm-up session on acute performance values in 20 amateur male soccer players aged 25.5 years. In the study, FIFA 11+ revealed positive effects on strength, power and aerobic capacity after warm-up sessions (Bizzini et al., 2013). Researchers stated that as a result of this warm-up, the heat levels of the core centers of the athletes increased by 1%, and although there is no clear information on $\dot{V}O_2$ levels, it can increase the $\dot{V}O_{2max}$ levels in parallel with increasing the resting $\dot{V}O_2$ levels

after the FIFA 11+ warm-up session. In the current study, the opposite is the case. In the literature, it is stated that warm-up session in real sports fields consist of individual experiences of athletes rather than scientific foundations (Fradkin, Zazryn, & Smoliga, 2010; Kilduff, Finn, Baker, Cook, & West, 2013; McGowan et al., 2015). So far, in this research, the fact that the conventional and F+SMR warm-up sessions have statistically better endurance performance than the FIFA 11+ warm-ups has resulted in the opposite result of the discourse in the literature. As the reason for this situation, it is thought that the fact that the athletes have never done a FIFA 11+ warm-up before in the research may cause it to have no effect on the 30-15_{IFT}.

There are many studies on the acute performance of athletes after warm-up sessions with self myofascial release (Hendricks, den Hollander, Lombard, & Parker, 2020). There are studies showing that the SMR methods applied before the Wingate tests, which require performance despite fatigue, are both positive and do not affect the performance (Phillips, Diggin, King, & Sforzo, 2021). Although studies state that SMR applications of at least 60 seconds should be performed in order to be effective (MacDonald et al., 2013) those studies also reported that 30-60-90 seconds of self myofascial release applications do not have any effect on the 30-second Wingate performance results (Hansen et al., 2016). It may be thought that although it does not affect such short-term performances of very high intensity, it should have a positive effect on endurance performances that last longer. Due to SMR applications,, it is known that the arterial stiffness of the athletes decreases and their vascular functions improve (Okamoto, Masuhara, & Ikuta, 2014). It comes to mind that such a positive effect on the circulatory systems may affect the endurance performance of the athletes. In addition, in a different study, although researchers revealed that the SMR application applied in addition to the warm-up session did not contribute to leg stiffness, they stated that the mixed foam roller application contributed to the range of motions (Morales-Artacho, Lacourpaille, & Guilhem, 2017). In this study, after the SMR application, the 30-15_{IFT} results of the athletes revealed a statistical significance compared to the FIFA 11+ warm-up session only. It is thought that SMR may have eliminated the negative effect of athletes not being used to FIFA 11+ warm-up sessions. Because in the statistical results, after the FIFA 11+ warm-up session, the athletes ended the 30-15_{IFT} at lower speeds.

Conclusions

In conclusion, this study provides compelling evidence that both conventional warm-up methodologies and FIFA 11+ warm-up routines, when augmented with self-myofascial release (SMR), significantly enhance the endurance performance of U-17 male soccer players compared to the utilization of the FIFA 11+ warm-up protocol in isolation. The findings highlight the potential limitations of the FIFA 11+ protocol when used without the adjunctive use of SMR, suggesting that traditional warm-up techniques may still offer value in specific contexts. Furthermore, the study underscores the potential value of integrating SMR into warm-up routines, which aligns with contemporary research illustrating the benefits of SMR on performance outcomes. These findings offer novel insights into the optimization of warm-up routines for enhancing athletic performance, yet they should be interpreted with some caution due to the limited sample size. Therefore, the outcomes of this research should serve as a catalyst for further investigation in this domain. Future studies should employ larger, more diverse cohorts and consider various factors such as the athletes' familiarity with specific warm-up routines, different sports, age categories, and the chronic effects of these interventions. Also, given the positive impact observed with SMR, more in-depth exploration of the optimal methods, duration, and application of SMR in a warm-up context is warranted. Through continued research in this area, valuable insights can be gained to inform best practice guidelines for warm-up routines in soccer and potentially other sports, ultimately enhancing athletic performance and reducing injury risk.

Conflicts of interest - We declare that there is no conflict of interest between the authors.

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