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THE EFFECTS OF TRADITIONAL AND MODERN PRE-MATCH WARM-UP PROTOCOLS ON JUMPING ABILITY IN FOOTBALL PLAYERS

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Abstract:
This study examined the effects of traditional and modern warm-up protocols on jumping performance in U-17 football players. Twenty male athletes (mean age: 16.25 ± 0.43 years) participated in a crossover design, completing both warm-up types on separate days. The traditional protocol included sport-specific dynamic drills, while the modern protocol used activation tools like foam rollers and resistance bands. After each 30-minute session and a 15-minute rest, jumping ability was measured via the Five-Repetition Jump Test (5JT). Results showed significantly higher average and best jump heights following the traditional warm-up ($p < 0.001$), suggesting superior neuromuscular activation. These findings indicate that conventional dynamic warm-ups are more effective in enhancing explosive performance. While modern protocols may aid in proprioception and injury prevention, they appear less beneficial for immediate power output. Coaches are encouraged to consider integrating both methods to optimize pre-match preparation.

Keywords: youth athletes, pre-match preparation, plyometric performance, dynamic activation, training protocols

1. Introduction

Pre-match warm-up constitutes a critical preparatory phase in athletic performance enhancement and injury risk mitigation, particularly in high-intensity sports such as football, which involve sustained physical exertion and abrupt directional changes (Bangsbo, 1994; Ekstrand, 2013). Consistent with other team sports, football players

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engage in systematically organized warm-up protocols aimed at attaining optimal physical readiness, neuromuscular activation, and psychological focus before competitive engagement (McGowan *et al.*, 2015). The configuration and execution of these protocols exert a direct influence on sport-specific motor proficiency, thereby shaping athletes' overall in-game performance. Explosive power-dependent actions, such as vertical jumping, are particularly contingent upon the quality and design of the warm-up regimen (Fradkin *et al.*, 2010).

Traditionally, football warm-up procedures encompass low-intensity aerobic tasks and basic ball-handling drills, intended to facilitate physiological arousal and match readiness. In contrast, recent advancements in sports science have promoted the widespread adoption of modern warm-up methodologies characterized by a structured, evidence-informed foundation. These contemporary approaches incorporate activation strategies employing tools such as resistance bands, foam rollers, and stability balls to elicit targeted muscle engagement, improve postural control, and enhance overall neuromuscular coordination (Bangsbo, 1994; Bishop, 2003; McMillian *et al.*, 2006). As such, modern protocols offer a more integrative framework for pre-competition preparation (Samson *et al.*, 2012; McGowan *et al.*, 2015; Behm *et al.*, 2016).

While conventional warm-up formats are primarily aimed at elevating body temperature and initiating muscular activity through jogging and dynamic stretches (Shellock & Prentice, 1985), some scholars argue that these methods may fall short in adequately priming athletes for high-velocity, explosive actions. Beyond their thermogenic effects, warm-ups are increasingly recognized for their capacity to modulate central nervous system responsiveness. Empirical findings indicate that modern warm-up strategies may confer superior performance outcomes through enhanced neuromotor efficiency (Fradkin *et al.*, 2010). Furthermore, modern protocols are credited with advancing proprioceptive acuity, thereby refining motor control and movement precision (McMillian *et al.*, 2006). Nonetheless, conflicting evidence suggests that traditional warm-up techniques may remain superior when the aim is to optimize explosive sport-specific capacities (Taylor *et al.*, 2009).

Jumping proficiency represents a fundamental performance determinant in football, influencing success in aerial duels, headers, and transitional play dynamics (Ekstrand, 2013). This capability is especially critical among elite adolescent male athletes, who are subject to ongoing physical development and are particularly responsive to training interventions targeting power-based competencies (Faigenbaum *et al.*, 2005). Additionally, the implementation of robust warm-up protocols contributes not only to immediate match performance but also to long-term neuromotor development and injury prevention in youth populations (Behm *et al.*, 2016).

Although a growing body of literature affirms that both traditional and modern warm-up approaches may yield beneficial outcomes in football contexts, ambiguity persists regarding which strategy offers superior performance enhancements. Gabbett (2008) emphasizes the need for rigorously controlled experimental investigations to clarify the efficacy of various warm-up models, particularly within the high-stakes

demands of contact sports. Such research would offer empirical guidance for practitioners seeking to individualize pre-match routines by specific athletic demands and contribute substantively to the discourse within applied performance science.

The present study seeks to comparatively assess the impact of traditional versus modern warm-up protocols on the explosive jumping capacity of competitive football players. Grounded in prior empirical insights and theoretical rationale, the study hypothesizes that traditional warm-up methods will elicit significantly higher mean and peak scores on the Five-Repetition Jump Test (5JT) relative to their modern counterparts.

2. Material and Methods

2.1 Participants

The study included 20 male football players actively competing in the Greek U-17 national league, with a mean age of 16.25 ± 0.43 years and over 10 years of training experience. The participants followed a structured training regimen consisting of five training sessions per week and one official match. To ensure the reliability of the findings, the study was conducted within a single football team, thereby maintaining sample homogeneity. All participants were in optimal health, with no history of injuries or pre-existing medical conditions. This study did not involve any medical interventions, invasive procedures, or biological sample collection. It was conducted in full compliance with the Declaration of Helsinki (2013), and written informed consent was obtained from all participants and their legal guardians before their involvement. All participants received comprehensive information regarding the study's objectives, procedures, and potential risks. Informed consent was obtained voluntarily, ensuring that each participant had a clear understanding of the study's purpose and scope. This research was exclusively focused on sports performance assessments and did not involve any biomedical risks.

2.2. Tools and Procedure

This study employed a randomized crossover experimental design to evaluate the effects of two distinct warm-up protocols on vertical jump performance in a football-specific context. The experimental procedures were carried out across two consecutive days, enabling a controlled and systematic comparison of the physiological outcomes associated with each protocol. A total of 20 male football players participated in the study and were randomly assigned into two equal groups (n = 10 per group). On the first day, Group 1 followed a modern warm-up protocol, while Group 2 performed a traditional warm-up. The groups then switched protocols on the second day, ensuring that every participant underwent both warm-up conditions.

The crossover methodology was purposefully selected to allow each participant to serve as their control, thereby minimizing inter-individual variability and enhancing the internal validity of the results. By eliminating between-subject differences, this approach increased the statistical power and reliability of performance comparisons.

Furthermore, environmental variables—including ambient temperature, humidity, and wind conditions—were rigorously controlled and maintained constant throughout the testing period to eliminate their potential confounding influence. All testing sessions commenced at the same time on each day, and the total duration of testing was standardized to mitigate the effects of circadian rhythm on physiological output.

Each warm-up protocol lasted precisely 30 minutes and was followed by a 15-minute passive rest interval, by UEFA's official match regulations, which simulate the standard pre-kickoff delay experienced during competitive matches. This interval allowed participants to complete their typical pre-match routines, thereby enhancing the ecological validity of the experimental setting.

After the warm-up and rest period, participants performed the Five-Repetition Jump Test (5JT), a validated measure of lower-limb explosive power that reflects the eccentric-concentric neuromuscular demands characteristic of football performance. The 5JT was executed using the Opto-Jump Next RX 30 system (Microgate, Bolzano, Italy; software version 1.10.19.0). Athletes were instructed to complete five consecutive maximal-effort vertical jumps while keeping their hands on their hips to eliminate arm swing assistance. Both the average jump height across the five trials and the maximum individual jump height were recorded and analyzed.

2.2.1 Modern Warm-up Method

In the first method, the warm-up began with a 15-minute indoor activation session. The exercises in the first part of the Modern Warmup Method are outlined below:

1) **Activation Exercises:** Foam rollers were used on the hamstrings, gastrocnemius, quadriceps femoris, pubis, and gluteus maximus muscles, targeting both the left and right legs. This was followed by ankle exercises using a green-resistance THERABAND™ elastic band for 3 minutes: 15 repetitions each of ankle dorsiflexion, plantar flexion, eversion, and inversion. Additional exercises included 15 repetitions each of standing glute kicks, 10 steps right and 10 steps left of lateral band walks, and 20 steps of forward and backward banded walks on each side.
2) **Gym Ball Exercises:** For 3 minutes, exercises included 15 reps each of Stability Ball Hamstring Roll-Ins, back extensions, and abdominal exercises with a gym ball.
3) **Bosu Ball Exercises:** A 2-minute balance exercise was conducted, which included standing on the Bosu ball for 15 seconds on the left foot and 15 seconds on the right foot. This was followed by 15 seconds of up-and-down skips and lateral skipping exercises on the Bosu ball.
4) **Hurdle Exercises:** For 2 minutes, participants performed hurdle drills over four 70 cm hurdles spaced 70 cm apart. Hurdle Walks and Skips: Exercises included forward walks, backward walks, whirly birds, and lateral skips over four hurdles, alternating between right and left.

The second part of the Modern Warmup Method, conducted immediately after the activation exercises, consisted of a 15-minute sport-specific warm-up on the field. The exercises in this part are outlined below:

1) **Passing Game:** 3 minutes of passing game
2) **Possession Game:** 5 v 5 possession game on a 20m x 25m field, conducted for 5 minutes with 2 sets of 2 minutes each and a 1-minute rest.
3) **Crossing and Shooting:** 2 minutes of crossing and shooting drills.
4) **Shooting Drill:** 2 minutes of shooting practice.
5) **Sprints:** 4-repetition 8-meter sprint drill

2.2.2 Traditional Warm-up Method

In the second method, players were first allowed to freely engage in a ball-handling exercise in pairs for 3 minutes to familiarize themselves with the ball and the field. Following this, a 10-meter area was used for dynamic warm-up drills through skipping exercises for 7 minutes. The sequence of the applied drills is outlined below:

1) **Light Skip:** While jogging with a slight skip, knees are gently raised, with arms swinging rhythmically.
2) **High Knee Pull:** While walking, each knee is pulled towards the chest with both hands.
3) **Light Butt Kicks:** While jogging, heels are lifted to touch the glutes, with arms swinging in rhythm.
4) **Light High Knees:** While jogging, knees are slightly raised with each step, with rhythmic arm movement.
5) **Walking Lunge:** Hands placed behind the head, each step forward is accompanied by a knee and hip flexion until the back knee lightly touches the ground, alternating legs.
6) **Straight Leg Kick:** While walking with arms extended forward, each leg is raised until the toes touch the palms.
7) **High Glute Pull:** Each leg is pulled toward the chest from the ankle using both hands while walking.
8) **A-Skip:** Jogging with a skip, lifting one knee while the opposite hand goes up, keeping elbows bent in rhythm with the legs.
9) **B-Skip:** Similar to the A-skip, but with a forward kick after the knee is lifted.
10) **Rapid High Knees:** Knees are brought toward the chest as quickly as possible while jogging.
11) **Carioca:** Running sideways while crossing legs alternately in front of each other, performed in both directions.
12) **Power Skip:** Jogging with jumps, pulling knees toward the chest while moving arms in rhythm.
13) A 4-repetition acceleration run over a 30-meter distance was performed.

The remaining 15 minutes of the Traditional Warmup Method consisted of the following exercises:

1) **Passing Game:** 3 minutes of passing drills
2) **Possession Game:** 5 v 5 possession game on a 20m x 25m field, conducted for 5 minutes with 2 sets of 2 minutes each, followed by a 1-minute rest.
3) **Crossing and Shot Drill:** 2 minutes of crossing and shooting exercises.
4) **Shooting Drill:** 2 minutes of shooting practice.
5) **Sprints:** 4-repetition 8-meter sprint drill

2.3 Statistical Analysis

Descriptive statistics and paired t-tests were applied to the data using SPSS 14.0 software.

3. Results

Table 1: Descriptive Characteristics of the Participants (N=20)

Variable	Mean (± SD)
Age (years)	16.25 ± 0.43
Height (cm)	175.1 ± 4.69
Weight (kg)	64.45 ± 6.14
BMI	20.99 ± 1.53
Body Fat Percentage (%)	7.51 ± 2.35

Table 2: Comparison of the participants' mean values in the Five-Repetition Jump Test (5JT)

Protocol	Mean 5JT (cm) (Average)	Standard Deviation (SD)	t	p<
Modern Warm-up Protocol	35.16	3.91	11.31	0.001*
Traditional Warm-up Protocol	38.02	4.04		

p: paired t-tests
*: statistically significant

The findings related to the comparison of participants' mean values in the Five-Repetition Jump Test (5JT) are presented in Table 2.

An examination of Table 2 reveals that the paired t-test results indicate that the mean 5JT values obtained after the Traditional Warm-Up protocol (38.02 cm) were higher than those obtained after the Modern Warm-Up protocol (35.16 cm). This difference was found to be statistically significant [$t(19) = -11.31$, $p < .001$].

The findings related to the comparison of the participants' best values in the Five-Repetition Jump Test (5JT) are presented in Table 3.

Table 3: Comparison of Participants' Best Performance Averages in the Five-Repetition Jump Test (5JT)

Protocol	Mean 5JT (cm) (Best)	Standard Deviation (SD)	t	p<
Modern Warm-up Protocol	37.81	4.07	10.48	0.001*
Traditional Warm-up Protocol	40.43	4.05		

p: paired t-tests
*: statistically significant

An examination of Table 3 reveals that the paired t-test results indicate that the best performance averages in the Five-Repetition Jump Test (5JT) obtained after the Traditional Warm-Up protocol (40.43 cm) were higher than those obtained after the Modern Warm-Up protocol (37.81 cm). This difference was found to be statistically significant [$t(19) = 10.48$, $p < .001$].

4. Discussion

This study examined the effects of different warm-up protocols (modern and traditional) on jumping ability, one of the key indicators of athletic performance. The findings revealed that the traditional warm-up protocol resulted in significantly higher average and best jump heights compared to the modern warm-up protocol. This result aligns with the findings of Fradkin *et al.* (2010), who emphasized the role of sport-specific dynamic movements in enhancing explosive power by better activating relevant muscle groups and motor units. Similarly, the results are consistent with those of Faigenbaum *et al.* (2005), who observed similar effects of warm-up protocols on children and young athletes. Within this framework, the contribution of dynamic movements in traditional warm-up protocols to explosive power required for jumping performance may better prepare football players in this age group for similar actions during matches. Additionally, the study by Kyranoudis *et al.* (2021) emphasized that pre-warm-up exercise programs, particularly those incorporating dynamic and sport-specific exercises, significantly enhance muscle performance by optimizing neuromuscular activation. These findings support the argument that traditional warm-up protocols may provide more effective preparation for explosive movements, such as jumping.

As noted in previous studies such as Bangsbo (1994), Bompa (2009), and Mohr (2003), an appropriate warm-up protocol not only enhances performance but also reduces the risk of injury in athletes. However, some studies suggest that static warm-ups can improve performance by increasing flexibility (Taylor *et al.*, 2009). Hybrid warm-up strategies that combine both dynamic and static elements may be considered in future studies to optimize jumping performance.

The findings of this study demonstrate that a structured traditional warm-up provides improvements in explosive power, which is an essential component of pre-match physical preparation. However, research by Silva *et al.* (2018) suggests that less structured and individualized warm-up protocols may also be effective in enhancing performance. This suggests that warm-up routines can be tailored to the specific characteristics and goals of the athletes.

In the literature, modern warm-up protocols have been shown to have positive effects on proprioceptive sensitivity, balance, and overall movement quality (McGowan *et al.*, 2015). Improved proprioceptive sensitivity can play a significant role in reducing the risk of sports injuries among young football players (Behm *et al.*, 2016). However, the equipment used in modern warm-up protocols, such as resistance bands, foam rollers, and balance balls, may fail to sufficiently activate the muscle groups required for

explosive movements. This could lead to reduced performance, particularly in activities requiring high levels of muscle power, such as jumping.

5. Conclusion

According to the findings of this study, the comparison of traditional and modern warm-up protocols in terms of their effects on jumping performance suggests that the traditional warm-up protocol may be more suitable for pre-match preparation in U17 male football players, particularly for skills requiring explosiveness. While the second half of both protocols shares similarities, the targeted dynamic movements included in the first 15 minutes of the traditional protocol were found to be decisive in achieving performance outcomes that demand power, such as jumping.

The findings of this study provide valuable insights for coaches, sports scientists, and athletes in designing effective pre-match warm-up routines. Warm-up protocols should be tailored to the specific requirements of the sport and the individual needs of the athletes. For activities requiring explosive power and speed, such as sprinting, dynamic warm-up exercises incorporating equipment like foam rollers, gym balls, and BOSU balls are recommended to enhance performance while minimizing muscle fatigue. Although resistance bands are effective for strength development, their use in pre-match warm-up routines should be carefully monitored. Excessive or high-intensity resistance exercises may lead to muscle fatigue and reduced sprint performance, particularly in scenarios where maximum effort is required.

Incorporating exercises targeting neuromuscular activation, such as dynamic stretching and sport-specific drills, can enhance the efficiency of the Stretch-Shortening Cycle (SSC), contributing to improvements in speed and agility. Moreover, avoiding excessive loading in warm-up routines, especially those involving resistance exercises, is crucial to prevent potential adverse effects on performance. These recommendations are particularly relevant for youth athletes, emphasizing the importance of adopting progressive and scientifically grounded approaches to preparation.

6. Practical Implications

Incorporating targeted activation exercises at the beginning of warm-up routines may optimize athletes' readiness for performance. These exercises can help prepare the neuromuscular system more effectively, particularly for movements that require explosive power.

Due to its positive effects on proprioceptive control, balance, and overall movement quality, the modern warm-up protocol can serve as a valuable tool for young athletes during developmental training periods. Over time, it may contribute to reducing the risk of sports-related injuries in this population.

Future research could explore the long-term effects of traditional and modern warm-up protocols on athletic performance and recovery. Additionally, strategies

combining the strengths of both protocols could be developed to highlight the potential benefits of hybrid warm-up approaches, offering optimized solutions for athletes' preparation and injury prevention.

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