Effects of Six Weeks of Online Functional Resistance Training on Match-Related Physical Fitness Levels in Super League Soccer Referees. A pilot Study

Yeliz PEHLİVAN[1], Bülent KAYITKEN[2], Erdal BAL[3], Nedim MALKOÇ[4]

[1]Assoc. Prof. Dr., Istanbul University of Health Sciences, Hamidiye Faculty of Life Sciences, Department of Exercise and Sport Sciences, Istanbul, TURKIYE, yeliz.yol@sbu.edu.tr, Orcid: 0000-0002-0859-6238
[2]Assist Prof Dr., Istanbul Nisantasi University, School of Physical Education and Sports, Department of Exercise and Sports Sciences, Istanbul, TURKIYE, bulent.kayitken@nisantasi.edu.tr , 0009-0007-3571-3106
[3]Assoc. Prof. Dr., Istanbul University of Health Sciences, Hamidiye Faculty of Life Sciences, Department of Exercise and Sport Sciences, Istanbul, TURKIYE, erdal.bal@sbu.edu.tr, Orcid: 0000-0002-4927-3945
[4]Assoc. Prof. Dr., Istanbul University of Health Sciences, Hamidiye Faculty of Life Sciences, Department of Exercise and Sport Sciences, Istanbul, TURKIYE, nedim.malkoc@sbu.edu.tr, Orcid: 0000-0003-4599-3547

ABSTRACT

Background and Study Aim: The aim of this study was to investigate the effects of functional resistance training organized at home with few equipment (mat and resistance band) and body weight on VO2max, which is one of the indicators of high intensity shuttle run and aerobic metabolic competence, and the effects of the exercises on strength, muscular imbalance, lean body mass and fat percentage ratios of super league referees without field training.

Material and Methods: A total of 38 elite male soccer referees, including 8 FIFA-certified officials, took part in the study. Over the course of 42 days, they engaged in 24 AMRAP-style online functional resistance training sessions, incorporating metabolic conditioning. Additionally, they completed 12 injury prevention exercises, all confined within a maximum area of 9 square meters.

Results: Comparison of the participants' pre- and post-training assessments revealed statistically significant improvements in body weight, fat percentage, jump performance, multi-distance anaerobic shuttle-run, and maximal oxygen uptake (maxVO2) following the training intervention ($p<.05$)

Conclusion: The study concluded that a training programme incorporating metabolic conditioning to enhance functional strength resulted in significant improvements in the anaerobic and aerobic performance of elite athletes. Consequently, it is evident that a training programme focused on strength and conditioning, when scheduled during off-season periods of 1 to 3 months prior to the commencement of the subsequent competitive season, can serve as a straightforward and efficient approach for athletes to initiate the upcoming season in the most optimal physical condition.

KEYWORDS: Exercise Therapy; Oxygen Consumption; COVID-19; Athletic Performance.

How to Cite: Yeliz PEHLİVAN, Bülent KAYITKEN, Erdal BAL, Nedim MALKOÇ, (2025) Effects of Six Weeks of Online Functional Resistance Training on Match-Related Physical Fitness Levels in Super League Soccer Referees. A pilot Study, Vascular and Endovascular Review, Vol.8, No.17s, 63-72.

INTRODUCTION

The primary responsibility of professional soccer referees is to uphold the regulations that govern the sport, ensuring the safety of players and maintaining principles of fair play. The dynamic and rapidly evolving nature of soccer demands that referees make prompt and accurate judgments in situations involving fouls, offside positions, and scored goals, thereby upholding the integrity of the game. The effectiveness of referees' decision-making is an important element in improving the quality of football. To carry out these duties with utmost effectiveness, it is imperative that referees maintain a high level of physical fitness. Soccer referees are referred to as the 23rd player in the game of football [1]. Soccer referees are professionals who train face-to-face under the supervision of a coach, just like footballers, to increase their ability to adapt to the high-level competitions they manage.

Recent studies have examined the physiological demands placed on soccer referees during matches. Referees run 9-13 kilometers during high-level competitions [2]. The distance referees cover is often closely linked to the pace and demands of the match [3]. Referees generally perform match duties while working at 85–90% of their maximum heart rate, which equals roughly 70–80% of their maximal oxygen uptake capacity [4]. During demanding match situations, referees complete only a portion of the overall distance at high intensity. This high-intensity distance represents about 4–18% of the total match distance of 9–13 km [5], [6]. In addition, referees run at speeds between 13 and 18 km/h for approximately 11–46.3% of the total match distance [3], [5], [8]. This corresponds to 30.2% of the total competition time. Referees exhibit high blood lactate levels exceeding 12 mmol/L during competition [9]. It has been demonstrated that elite referees exhibit a highly dynamic activity profile during matches, with an average of 1,268 transitions between different exercise modes over the course of the competition. Of these transitions, 161 are classified as high-intensity activities [50]. Viewed from this perspective, elite referees engage in 15-65% of the total activity changes at running speeds that elicit blood lactate levels exceeding 4 mmol/L [51]. Given the substantial frequency of actions involving stopping, accelerating, decelerating, and changing direction, elite referees experience an exceptionally high volume of muscular engagement throughout competition. Shuttle runs and their variants, commonly referred to as "Yo-Yo base runs", are widely used in football referee training. Additionally, shuttle run simulators like YYIRT1, YYIRT2, ARIET, SDS20, and MAS30-15, which involve deceleration, acceleration, stopping, and rotations, are employed to assess the physical capabilities of referees [9]. Given the high physical demands placed on soccer referees during matches, high-intensity shuttle run exercises represent crucial training components for enhancing and evaluating the performance capabilities of referees [2,6,9,10].

Elite referees cover between 6.9% and 18.2% of the total distance covered by running backs in competition [2,5,11,12]. These running backs are classified as moderate- to low-intensity activity because their speed is less than 13 km/h [4]. Conversely, running back requires 20% more energy expenditure than normal running due to the muscular work involved [2,5,11,12]. The training mode of football refereeing is often referred to as 'high-intensity intermittent'. The average duration of high- and low-intensity efforts in elite referees is 2.3 and 2.9 seconds, respectively [9]. The ratio of these high-intensity to low-intensity activities is 1:4.3 [5,12,13]. In other words, referees perform an average of 2-3 seconds of high-intensity activity after 4-5 low-intensity activities with an average duration of 2.9 seconds. As noted above, the intermittent nature of this performance, which requires a high level of muscular effort and the ability to sustain it for 90 minutes, increases the need for improved aerobic capacity [9]. In an average competition, elite referees spend 53-65% and 28-33% of the total time above 70-90% of their maximum heart rate (MHR) and 90% MHR, respectively. This clearly indicates the high involvement of aerobic metabolism during competition [4].

It has been reported that maxVO2 levels in trained athletes can decrease by 6-20% even over an 8-week period [16-20]. During the same period, blood and plasma volumes were found to decrease by 4% and 3.1% respectively [21]. On the other hand, acquired capillary density was found to decrease within 2 to 3 weeks [22]. In highly trained athletes, an increase in blood lactate responses to submaximal exercise has been observed at both absolute and relative exercise intensities during a 9–12 week period of rest [18,19,23,53], and lactate accumulation has been found to begin at much lower percentages of maxVO2 [18,23,55]. It has also been found that slow-twitch (ST) and fast-twitch (FT) muscle fibril cross sections, FT:ST area ratios and total muscle mass are reduced in trained athletes [24-28]. However, there may be periods of reduced training volume and sometimes intensity due to overuse and other sports injuries, pandemics, illness, competition-related travel, climate, off-season, end of season or many other factors. Without allowing the development of detraining conditions, a very high reduction in training volume of 60-90% can be achieved. It has been suggested that training adaptations may be maintained for some time under these conditions [27,29-32]. Functional strength training can be considered an important focus in the preparation of football referees for the refereeing profession by increasing their ability to perform the physical demands of their role while minimizing the risk of injury. In contrast to traditional strength training, this approach contributes to improving referee performance and athleticism by mimicking the movements required during matches. Despite the importance of conditioning and training, there is debate about the adequacy of current training programs and the need for further research into effective strategies for improving referee performance. As soccer players' athleticism continues to increase, refereeing standards and practices should also increase and demand continuous evaluation and innovation in referee preparation. Therefore, this research aims to examine whether six weeks of online functional resistance training improves match-related physical fitness levels in Super League soccer referees.

MATERIAL AND METHODS

Study Design, Place, Duration, and Ethical Approval

This study used an experimental pilot design. The intervention was conducted online over six weeks (January 2023 – February 2023). Ethical approval was granted by the *Scientific Research Ethics Committee of Medical Research on Humans* (Approval No.: 2022/8), and written and verbal informed consent was obtained from all participants. The study followed the principles of the *Declaration of Helsinki*.

Participants

A total of 47 male soccer referees volunteered for the study. All referees were classified as FIFA 1st Class, and 8 of them were FIFA international referees. During the training period, 9 referees withdrew, leaving 38 participants for final data analysis. Baseline characteristics of the participants were as follows:

- Mean age: 35.6 ± 5.01 years
- Height: 184.65 ± 4.42 cm
- Body weight: 80.88 ± 7.12 kg
- Body fat percentage: 12.9 ± 3.08%

Inclusion Criteria

- Male soccer referees currently active in professional leagues
- FIFA 1st Class or higher certification
- Able to attend online functional resistance training sessions

Exclusion Criteria

- Recent musculoskeletal injury (within 3 months)
- Cardiovascular or metabolic limitations
- Attendance less than 85% of sessions

Sample Size Calculation

Sample size was calculated using G*Power (v.3.1) based on an effect size of 0.45, power of 0.80, and $\alpha = 0.05$. The minimum required sample size was 34 participants [57] but 47 were recruited to account for possible dropouts.

Training Intervention

Participants performed a six-week online functional resistance training program (three sessions per week). Sessions included lower-body strength, core stability, plyometrics, and agility work aimed at improving match-related fitness.

Statistical Analysis

Data were analysed using SPSS v25.0. Normality was tested using the *Shapiro–Wilk test*. Pre- and post-test differences were analysed with a *paired sample t-test*. A significance level of $p < 0.05$ was used.

Study Design

The study employed a descriptive, cross-sectional research design with a non-probability sampling approach. The sample was selected using a convenience or accidental sampling method.
The sample size was calculated using the G*Power software (version x.x).
The following formula for calculating sample size for comparison of two means was used:

$$N = \frac{2(Z_{\alpha/2} + Z_{\beta})^2\sigma^2}{d^2}$$

Where:

- $Z_{\alpha/2}$= standard normal value for 95% confidence (1.96)
- Z_{β}= standard normal value for 80% power (0.84)
- σ= standard deviation from previous study [57]
- d= expected effect size between pre and post test (0.45)

The minimum required sample size was 34 participants, but 47 were recruited to account for dropouts.

To maintain standardized anthropometric data collection, all referees underwent consecutive measurements at 7:00 AM prior to breakfast, with 3-minute intervals between participants. Additionally, the remaining assessments were conducted at 30-minute intervals within the dedicated fitness facilities of the Turkish Soccer Federation's National Teams Campus, in an area specifically designated for this purpose. Additionally, the referees' meal schedule, including breakfast, lunch, and dinner, was coordinated to align with their individual test times. Following the anthropometric assessments (height, body weight, body mass index (BMI), and body fat percentage), the referees participated in the Multi-Distance Anaerobic Shuttle-Run (MDASR**)**, completing the test in small groups of 2 to 4 referees. Subsequent to the measurement of anthropometric parameters and the completion of the MDASR, the referees were granted a period of 48 hours rest and did not engage in further training. Following the warm-up protocol, the referees underwent the maximal oxygen uptake (maxVO2) assessment detailed in Table 1. For those referees who subsequently participated in the maximal oxygen uptake assessment, their resting blood lactate levels were measured prior to the application of the standardized warm-up protocol outlined in Table 2, conducted under the supervision of the coaching staff. Upon reaching complete exhaustion and completing the test, the participants' blood lactate levels were measured within 1 minute. Recovery blood lactate values were taken at the 10th minute following the end of the test. They were asked to rate their level of difficulty during the MaxVO2 test according to the fatigue scale (RPE10). The participants who underwent $MaxVO_2$ tests performed "double leg vertical jump", "single leg forward jump", "single leg forward triple jump" and "single leg cross jump" tests for a minimum of 48 hours and a maximum of 72 hours. The mean resting heart rates of the referees were recorded during the night with the before testing days. The assessment tests were administered before and after the online training program.

Anthropometric Measurements

The study utilized skinfold caliper measurements to assess the participants' anthropometric characteristics. Skinfold testing is a method employed to estimate the amount of body fat present [56]. Skinfold caliper measurements were used to assess the participants' anthropometric characteristics. This technique provides a quick, cost-effective, and easily administered method to estimate body composition by measuring skinfold thickness and applying the equations developed by Andrew Jackson and Michael L. Pollock in 1985. Body density was then calculated using the Jackson and Pollock 7-site formula (abdomen, midaxilla, triceps, pectoral area, quadriceps, subscapular area, thigh, and suprailiac) [33], and the Siri equation was used to determine the percentage of body fat [34].

$$BFP_{male} = 1.112 - (0.00043499 \text{ x sum of skinfolds}) + (0.00000055 \text{ x square of the sum of skinfold sites}) - (0.00028826 \text{ x age})$$

Siri equation is [34];

$BFP_{Siri} = \left(\frac{4.950}{p} - 4.500\right) x100$ where ρ represents the density ing/cc.

$_{Max}VO_2$ Measurements

The referees' maximal oxygen uptake was measured using the Fitmate Pro device (Cosmed, Italy), in accordance with the direct maximal measurement protocol. As outlined in Table 1, the maximal oxygen uptake assessment protocol incorporated standardized warm-up and measurement processes. Measurements were conducted both prior to and following the training sessions. In maximal oxygen uptake assessments, the following criteria were used as references: a rating of perceived exertion score of 9/10, a respiratory quotient above 1.1, a maximum heart rate reaching 95% or more of the individual's predicted maximum, and a plateau in oxygen consumption.

Table 1: Test flow chart, warm-up and MaxVO₂ test loads and application process

Measurements of resting blood lactate and skinfold skinfold thickness before breakfast, between 07:30 and 08:30 in the morning. **Test Process;** **1 – Blood Collection** **2 – Walking / Running** 1 minute 4.0 km / h - Incline 1 1 minute 5.0 km / h - Incline 1 1 minute 6.0 km / h - Incline 1 1 minute 7.0 km / h - Incline 1 1 minute 8.0 km / h - Incline 1 **3 – Stretching (7-10 minutes)**	**4 – MaxVO$_2$test** 1 minute 5.0 km/h – Incline 1 1 minute 6.0 km/h – Incline 2 1 minute 7.0 km/h – Incline 4 1 minute 8.0 km/h – Incline 6 1 minute 9.0 km/h – Incline 8 1 minute 10.0 km/h – Incline 10 1 minute 11.0 km/h – Incline 12 1 minute 12.0 km/h – Incline 14 1 minute 12.0 km/h – Incline 16 1 minute 12.0 km/h – Incline 18 The speed continues to increase in this way without increasing the incline. **5 – Lactate measurement at the end of the test** **6 – 10th-minute lactate measurement of recovery**

Blood Lactate Measurement Procedure
The lactate Pro 5 (2020-Kyoto JAPAN) was utilized for the analysis, and the fingertip blood collection method was employed. The participant's finger was cleaned and then punctured with a lancet, and after the initial blood flow was discarded, the remaining blood was dropped into the lactate analyser kit.

Single Leg One and Three Step Forward, Single Leg 3 Step Cross, Jump/Skip Tests
The "single leg jump/jump" tests, which were performed to determine the lower limb explosive power and muscular endurance performance and to measure the performance difference between the two limbs, were performed on a meter that was marked on the ground beforehand. All jumps and hops were recorded with a video camera to analyze the movement technique.

Multi-Distance Anaerobic Shuttle-Run (MDASR) Protocol
The study involved a shuttle run protocol that was used to assess the training and performance progress of soccer referees. This test was administered before and after a period of online training (home training), with the same conditions recreated for the post-training assessment. The shuttle run protocol was employed to evaluate the referees' development through objective measurements.

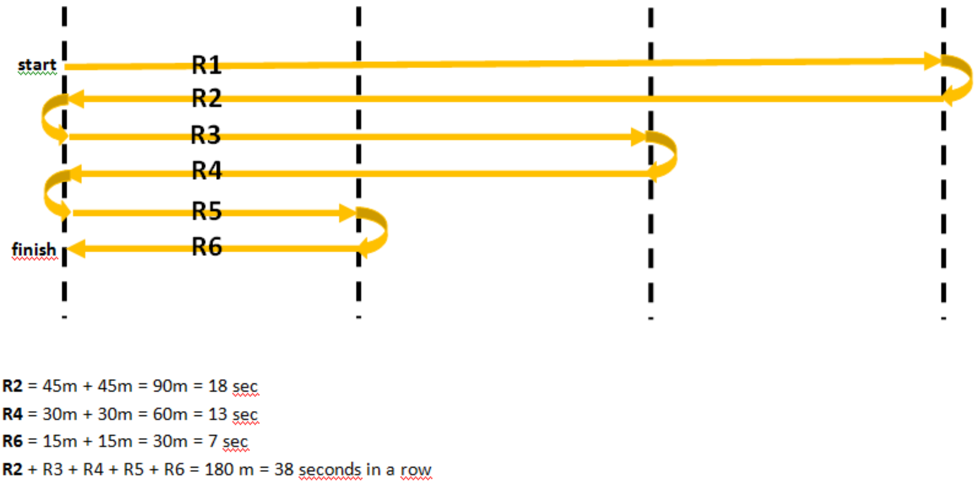

Figure 1: Multi-Distance Anaerobic Shuttle-Run Protocol

The study involved a 180-meter shuttle run test with a three-stage protocol. The test consisted of 6 high-intensity acceleration phases, 5 high-intensity deceleration phases, and 5 high-intensity 180-degree rotation maneuvers, all completed within a 38-second timeframe. This 180-meter distance was considered one set, and participants were required to complete six sets continuously, maintaining the designated pace. If a participant failed to reach a designated line when signaled, it was recorded as an error. If the participant missed the line a second time, the last successful run was recorded. Within each set, the final 180-meter segment was considered an exceptional run. If the participant arrived on time for all the other phases of the set but failed to reach the line in R6, it was counted as an error. Any errors in the other phases were considered direct failures. If there were no errors in the previous stages and the difference in the R6 run was no more than 1 meter, the run was still considered successful. Even with no previous errors, if the distance to the line was greater than 1 meter when the signal was received in R6, it was counted as an error, and the last successful step was recorded. The purpose was to avoid participants deliberately slowing down in the final, most demanding segment of the test.

Training Periodization

Figure 2 indicates that during a 42-day period, the referees participated in 24 online functional resistance training sessions using an AMRAP format, as well as 12 injury prevention exercises. AMRAP (As Many Repetitions as Possible) is a training method where an individual performs a specific exercise or set of exercises for a set time, completing as many repetitions as possible without stopping. It emphasizes maximum effort, improving endurance, strength, and mental focus by pushing the body to maintain performance within a limited time frame. These training activities were confined to a maximum area of 9 square meters. The injury prevention exercises consisted of foam rolling, trigger point therapy, and mobility and stability exercises focused on muscular strengthening. The initial phases of the training program featured movements of relatively easy to moderate difficulty, according to the consensus view. However, with PHASE 4, the AMRAP methodology was incorporated. As shown in the provided table, this AMRAP training commenced on the 13th session. The AMRAP training sessions started at 20 minutes in duration and were progressively increased to 30 minutes, with this 10-minute increment being implemented gradually over the course of 14 AMRAP workouts. As the training phases advanced, the exercises evolved from basic functional resistance movements like "air squats" and "pushups" employed in Phase 1, to more complex functional resistance exercises that necessitated increased flexibility and muscular strength.

Figure 2. The applied training periodization

PHASE – 1	Day – 1	Day – 2	Day – 3	Day – 4	Day – 5	Day – 6
Push Up Superman Power Crunches Air Squat	All Exerc. 10-9-8-7-6 reps.	Rest Day	All Exerc. 11-10-9-8-7 reps.	Rest Day	All Exerc. 12-11-10-9-8 reps.	Rest Day

PHASE – 2	Day – 7	Day – 8	Day – 9	Day – 10	Day – 11	Day – 12
Push Up Power crunches Superman Power Crunches Superman Air Squat Jumping Jack (x2)	All Exerc. 10-9-8-7 reps.	Rest Day	All Exerc. 10-9-8-7-6-5 reps.	Rest Day	All Exerc. 11-10-9-8-7-6 reps.	Rest Day

PHASE – 3	Day – 13	Day – 14	Day – 15	Day – 16	Day – 17	Day – 18
Squat Jack Reach Push up Superman Power Crunches(x2) Hip Raises Power Crunches(x2)	All Exerc. 10-9-8-7-6 reps.	IPE & MW 1	All Exerc. 11-10-9-8-7 reps.	Rest Day	All Exerc. 12-11-10-9-8 reps.	Rest Day

PHASE – 4		Day – 19	Day – 20	Day – 21	Day – 22	Day – 23	Day – 24
Touch to Ground	10 – 12 reps	continiously 20"	IPE & MW 2	continiously 22"	Rest Day	continiously 24"	IPE & MW 3
Push Up	10 – 12 reps						
TRX Row	10 – 12 reps						
Touch to Ground	10 – 12 reps						
Power Crunches	16 – 20 reps						

PHASE – 5		Day – 25	Day – 26	Day – 27	Day – 28	Day – 29	Day – 30
Squat to jump squat	10 – 12 reps	continiously 24"	IPE & MW 4	Rest Day	continiously 26"	IPE & MW 5	Rest Day
Superman	10 – 12 reps						
Air Squat	10 – 12 reps						
Push Up	10 – 12 reps						
Power Crunches	16 – 20 reps						
Jumping Jack	16 – 20 reps						

PHASE – 6		Day – 31	Day – 32	Day – 33	Day – 34	Day – 35	Day – 36
Criss Cross Squat	10 – 12 reps	continiously 26"	Rest Day	continiously 26"	Rest Day	continiously 26"	IPE & MW 6
Push up	10 – 12 reps						
Touch to ground	10 – 12 reps						
Asissted Budha Push Up	2 – 4 t reps						
Criss Cross to Alt Knee up	10 – 12 reps						
Touch to ground	10 – 12 reps						
Superman	10 – 12 reps						

PHASE – 7		Day – 37	Day – 38	Day – 39	Day – 40	Day – 41	Day – 42
TRX Deep Squat to Row	10 – 12 reps	continiously 26"	IPE & MW 7	continiously 27"	Rest Day	continiously 28"	IPE & MW 8
Push Up	10 – 12 reps						
Alt Lunge	16 – 20 reps						
TRX high Pull & Row	10 – 12 reps						
Plank	60 seconds						
Air Squat	16 – 20 reps						

PHASE – 8		Day – 43	Day – 44	Day – 45	Day – 46	Day – 47	Day – 48
TRX Chest Press	10 – 12 reps	continiously 28"	IPE & MW 9	continiously 29"	Rest Day	continiously 30"	IPE & MW 10
Alt Lunge	10 – 12 reps						
TRX Row	10 – 12 reps						
Walking Lunge	16 – 20 reps						
Asissted Budha Push Up	3 – 6 reps						
Leg Raises	16 – 20 reps						

PHASE – 9		Day – 49	Day – 50	Day – 51	Day – 52	Day – 53	Day – 54
TRX Chest Press	10 – 12 reps	Rest Day	IPE & MW 11	Rest Day	continiously 30"	Rest Day	IPE & MW 12
Push up	10 – 12 reps						
Alt Lunge	10 – 12 reps						
TRX Row	10 – 12 reps						
Walking Lunge	16 – 20 reps						
Asissted Budha Push Up	4 – 7 reps						
Leg Raises	16 – 20 reps						

Note: IPE: Injury prevention exercises **; MW** mobilite workout.

Statistical Analysis

The study data were analyzed using SPSS Statistics for Windows version 22. To assess the normality of the related data, the researchers performed the Shapiro-Wilk test. After the normality assessment, the parametric data were analyzed using the T-Test, while the nonparametric data were analyzed using the Wilcoxon Sign Test, to determine if there was a significant difference between the measurements obtained from the group. The group data were presented as the mean and standard deviation. A p-value of less than 0.05 was considered statistically significant.

RESULTS

The study involved male soccer referees with a mean age of 35.6 ± 5.01 years. Their average height was 184.64 ± 4.41 cm, and their mean body weight was 80.88 ± 7.12 kg. Comparing the pre- and post-training assessments of the participants revealed a statistically significant reduction in body weight (p=.017) and fat percentage (p=.001) following the training intervention, while their lean body mass remained unchanged (Table 2).

Table 2. Comparison of the physical and physiological parameters of the participants

Variable	Pre-Test (Mean ± SD)	Post-Test (Mean ± SD)	t-value	Effect Size (Cohen's d)	p-value
Body Weight (kg)	80.88 ± 7.13	80.06 ± 7.48	2.49	0.36 (moderate)	0.017*
Fat Rate (%)	12.93 ± 3.08	11.87 ± 2.63	3.56	0.52 (moderate–large)	0.001**
Lean Body Mass (kg)	67.95 ± 5.80	68.18 ± 6.35	1.01	0.15 (small)	0.318

Significant at p < 0.05
Highly significant at p < 0.01

Paired samples t-test was applied to assess pre- and post-test differences. Table 2 compares participants' physical and physiological parameters before and after the intervention. Body weight shows a slight decrease from 80.88 kg to 80.06 kg, with a statistically significant p-value of 0.017, indicating a meaningful reduction. Fat rate drops from 12.93% to 11.87%, showing a significant improvement in body composition (p = 0.001). Lean body mass increases slightly from 67.95 kg to 68.18 kg, but this change is not statistically significant (p = 0.318). Overall, the table indicates a reduction in body fat and weight, with no significant change in lean mass.

The analysis of the participants' jumping performance measures before and after the training program revealed statistically significant improvements across all assessed parameters (p=.001) (Table 3).

Table 3. Comparison of the jumping performances of the participants

	OSJF (LEFT) (cm)	OSJF (RIGHT) (cm)	TSJF (LEFT) (cm)	TSJF (RIGHT) (cm)	FTSCJ (LEFT) (cm)	FTSCJ (RIGHT) (cm)
Pre-Training	191.05±13.30	196.57±14.31	619.94±38.63	644.02±43.96	575.47±45.39	593.97±41.65
Post-Training	199.15±16.66	208.15±16.47	653.81±42.42	676.13±50.69	601.97±44.69	625.97±43.38
% Difference	4.19	5.89	5.46	4.96	4.60	5.38
p Value	**0.001**	**0.001**	**0.001**	**0.001**	**0.001**	**0.001**

OSJF: One-step Jumping Forward, **TSJF:** Three-step Jumping Forward, **SLCJ:** Single Leg Cross Jump, **FTSCJ:** Forward Three-Step Cross Jump

Comparison of the participants' jumping performance measures between the dominant and non-dominant feet, both before and after the exercise program, demonstrated statistically significant differences across all assessed parameters (p=.001) (Table 4). The study population was limited to male soccer referees designated as FIFA Category 1, as there were no female referees in this category.

Table 4. Comparison of the jumping performance of the participants with the dominant and non-dominant foot before and after the exercise

Variable	Pre-Test (Mean ± SD)	Post-Test (Mean ± SD)	% Difference	p-value
OSJF (Dominant) (cm)	**197.55 ± 2.30**	**208.71 ± 2.68**	**5.64**	**0.001****
OSJF (Non-Dominant) (cm)	**190.07 ± 2.10**	**198.60 ± 2.65**	**4.49**	**0.001****
TSJF (Dominant) (cm)	**645.21 ± 7.13**	**676.52 ± 8.19**	**4.85**	**0.001****
TSJF (Non-Dominant) (cm)	**618.76 ± 6.14**	**653.42 ± 6.89**	**5.60**	**0.001****
SLCJ (Dominant) (cm)	**590.81 ± 7.07**	**625.50 ± 7.10**	**5.87**	**0.001****
SLCJ (Non-Dominant) (cm)	**578.63 ± 7.25**	**602.44 ± 7.23**	**4.11**	**0.001****

OSJF: One-step Jumping Forward, **TSJF:** Three-step Jumping Forward, **SLCJ:** Single Leg Cross Jump

While there was a statistically significant difference in the MDASR test (p= .003) and MaxVO$_2$ (p=.001) values of the participants before and after the exercise, resting lactate, blood lactate taken immediately after the test and 10 min after the test. No statistically significant difference found in the blood lactate values taken after surgery (Table 5).

Table 5. Comparison of participants' MDASR test, MaxVO2 and metabolic responses

	MDASR (m)	MAXVO$_2$ (ml/kg/min)
Pre-Test	**800.52 ± 26.17**	**52.45 ± 3.27**
Post-Test	**751.57 ± 23.95**	**51.30 ± 3.62**
p-Value	**0.003**	**0.001**

RESTLAC: Rest Blood Lactate, **TESTLASTLAC:** Blood lactate taken after the test is over, **TEST10MINLAC:** Blood lactate taken 10 minutes after the test, **MDASR:** Multi-Distance Anaerobic Shuttle-Run

There was no statistically significant difference between the level of difficulty (RPE) perceived by the participants before the training and the level of difficulty in the warm-up after the training (p=.432). However, a statistically significant difference was found between the pre-warm-up RPE value asked before the training and the RPE value after the training (p=.001). There was no statistically significant difference between the pre-training RPE value and the post-training RPE value (p=.456) (Table 6).

Table 6. Comparison of participants' pre-training and post-training RPE values

	RPE WARM-UP (PRE)	RPE WARM-UP (POST)	RPE-TEST (FINAL)
Pre-Training	1.53±0.65	5.32±0.60	9.71±0.42
Post-Training	1.63±0.79	4.66±1.20	9.64±0.50
p Value	0.432	**0.001**	0.456

RPE: Perceived difficulty level

DISCUSSION

In this study, the effects of functional resistance training organised at home with a few equipment (resistance band and mat) and body weight on strength, muscular imbalance, lean body mass and fat percentage ratios and aerobic capacity of Super League soccer referees during the pandemic period without field training were investigated.

In this study, although a statistically significant decrease was found in the maxVO$_2$ parameter of the referees after training, this difference was only 2.24%. On the other hands, body weight and fat percentage values of referees decreased statistically significantly after training.

There are periods when soccer players or soccer referees stay away from the field due to various reasons, such as injury, punishment, nature of the league, weather or pandemic. Such situations are important for the athlete's performance. Because the longer this period is, the more likely it is that there will be a decrease in performance due to detraining. Researchers have found that detraining is associated with a decrease in maximal muscle strength, muscle peak power production muscle size and muscle neural drive and aerobic capacity and a decrease in muscle function [35-38]. In such a situation, when the athlete returns to the field, his performance decreases and the risk of injury increases at the same time.

In contrast to this study, Maciejczyk et al. [39] found that high body mass, i.e. high body fat or high lean body mass, decreased maxVO$_2$. Dominski et al. [40] reported in a study that reaction times were positively correlated with body fat. Similarly, Violanti et al. [41] found a positive correlation between fat percentage and the time taken to perform a 2.4 km run in a study. Bhutani et al. [42] found in a study that weight gain and body mass index increased during the pandemic period. Researchers have shown that during the English Premier League, field umpires covered a total distance of 11,770 ± 808 m in high-speed running (> 19.8 km-s-1) and sprinted at a speed of over 25.2 km-s-1 [43]. In the top two Danish leagues, field umpires performed 1269 activity changes per match [9] and in the first part of the Italian championship, the field umpire was found to run backwards and sideways for 13.2% of the match duration [11]. Although assistant refereeing is characterized by short, intense forward and lateral running interspersed with long, low activity periods [9], field referees spend more time walking, running and sprinting than assistant referees. In addition, it has been observed that referees in higher categories have a lower body weight and fat percentage than referees in lower categories [44,45,52].

When the jump performances of the participants before and after training were compared, an improvement was found in all parameters. Single-step jump can be defined as explosive strength and three-step forward jump can be defined as continuity in explosive strength. The fact that the participants repeatedly pushed their body weight upwards in "squat", "jump squat", "squat to jump squat", "alternative lunge" exercises and the application of plyometric exercises such as "touch to ground", which were repeated in the transverse plane for weeks, may have caused this result. It is possible that the effects of the same exercises were responsible for minimizing the performance decline in the "Multi-Distance Anaerobic Shuttle-Run", which is highly related to the participants' muscular strength and muscular strength endurance skills. Moreover, since the three-step cross jump also involves a partial change of direction, future researchers may investigate its relationship with change of direction performance.

In another finding, When the jump performances of the participants before and after training were compared, an improvement was found in all parameters. Single-step jump can be defined as explosive strength and three-step forward jump can be defined as continuity in explosive strength. The fact that the participants repeatedly pushed their body weight upwards in "squat", "jump squat", "squat to jump squat", "alternative lunge" exercises and the application of plyometric exercises such as "touch to ground", which were repeated in the transverse plane for weeks, may have caused this result. It is possible that the effects of the same exercises were responsible for minimizing the performance decline in the Multi-Distance Anaerobic Shuttle-Run, which is highly related to the participants' muscular strength and muscular strength endurance skills. Moreover, since the three-step cross jump also involves a partial change of direction, future researchers may investigate its relationship with change of direction performance.of the participants decreased statistically significantly after the training. In Yo-Yo R1 and R2 tests, there are 4 high-intensity 180-degree rotations, 9 accelerations, and 4 deceleration with a violent rotation after a 180-metre section. In addition to these, there are four low-intensity decelerations, which can also be defined as "stopping", without a turn afterwards. The " MDASR" with a "set" distance of 180 meters run in 38 seconds, used as a test in this study, includes six high-intensity accelerations, five high-intensity decelerations, and five high-intensity 180-degree turns. It involves much higher mechanical loads compared to the Yo-Yo R1 and Yo-Yo R2 tests. For this reason, MDASR is an example of a high-intensity, intermittent, shuttle run that requires a very high level of muscular endurance. It is argued that the adaptations obtained can be maintained for some time even when the training volume is reduced at a very high rate, such as 60 - 90%, without allowing the formation of detraining conditions [46-48].

Some studies even show that there is no decline in soccer-specific skills even under one-week full rest conditions [49]. Although universal studies do not report a decline in soccer-specific performance under short-term detraining conditions (less than 4 weeks) [49], it is difficult to speculate that the performance of the "shuttle run" similar or related runs in many sports branches will not be affected when there is no field training for a long period of time such as 2 months. However, this study has shown that top class referees maintained this performance significantly with "no field training for 2 months" and only "functional resistance exercises" performed at home. The key point here is thought to be the movement selection, training design and developmental periodization applied in the study. Movements progressed from easy to difficult, contraction cycle from concentric/eccentric balanced to eccentric dominant, training duration and weekly training frequency from low to high. The metabolic loading effect progressed from low to high. The volumetric balance of the lower trunk/upper trunk reached a dominant position in the following phases. Although the lower extremity seemed to be dominant in the last phases, the general volume of the upper extremity continued to increase when all phases were considered. On the other hand, AMRAP is mostly planned over 20 minutes with a combination of three different modes of exercise. However, since the running mode could not be used at home, only resistance exercises and a systematically increasing design were used to reach a 30-minute continuous loading level. In the first training phase of the cycle, the referees started with a total of 160 repetitions of the four movements, which is standard for everyone, resting as they wished without time pressure. At the end of the process, in the 40th training in the 9th phase, they reached several repetitions ranging from 380 to 446 per person against time pressure with 7 movements with a very high level of difficulty. The average subjective strain value of the same referees in the 40th exercise was 7.2. In this respect, it refers to intensities of 9 MET and above. Mostly, exercises with an intensity of 9 MET and above are expressed as sustainable for 10-30 minutes [46,47,54]. In other words, in fact, the referees performed loads for 24-30 minutes, especially in the last phases, close to the limits of their maximum endurance. The continuation of a load of this intensity for 24-30 minutes may have created a stimulus that supports the anaerobic threshold development criteria for the cardiovascular system. The continuously fluctuating pulse rate with 5-7 exercises and their transitions may have triggered the development of aerobic power in HIIT. However, no statistically significant difference was found in the resting lactate, blood lactate taken immediately after the test and blood lactate taken 10 min after the test.

The study shows that the training program led to meaningful improvements in jumping performance and physiological adaptations, especially in dominant and non-dominant lower-limb strength. These findings highlight the effectiveness of structured plyometric training in enhancing neuromuscular efficiency and explosive power. Unlike previous studies that examined bilateral performance only, this study provides evidence for unilateral improvements, suggesting better motor coordination and activation patterns. These outcomes may support coaches and trainers in designing sport-specific programs. However, the study is limited by its short duration and lack of a control group. Future research may extend the training period and include diverse athletic populations for broader comparisons.

CONCLUSION AND RECOMMENDATIONS

These findings suggest that functional resistance training planned in a 9 m^2 area without field training decreased body weight and fat percentage and increased jump performance in elite referees. We can say that the decrease in $MaxVO_2$ and MDASR running performance is much less than expected and advocated by the literature. Compiling the results of a similar periodization with more than one time and with different combinations in advanced-trained groups with aerobic power levels of 15 MET and above will be a guide for elite athletes and referees to make training designs that can maintain their performance in long intermediate periods, such as the end of the season.

REFERENCES

1. Eissmann HJ, D'Hooghe M. (1996). Sports medical examinations. En: The 23rd Man: sport medical advice for football referees. Leipzig: Gersöne-Druk., 1996;7-19.
2. Castagna C, Abt G, D'Ottavio S. Activity profile of international-level soccer referees during competitive matches. *Journal of Strength and Conditioning Research.*, 2004; 18(3): 486–490.

3. Harley RA, Tozer K, Doust J. An analysis of movement patterns and physiological strain in relation to optimal positioning of Association Football referees. In: Spinks W, Reilly T, Murphy A, editors. Science and football IV. London: Routledge., 2007; 137-43.
4. Castagna C, Abt G, D'Ottavio S. Physiological aspects of soccer refereeing performance and training. Sports medicine (Auckland, N.Z.).,2007; 37(7): 625–646.
5. Riiser A, Andersen V, Sæterbakken A, Ylvisaker E, Moe VF. Running performance and position is not related to decision-making accuracy in referees. *Sports Medicine International Open*, 2019;3(02):E66-E71.
6. Dottavio S, Castagna C. Analysis of match activities in elite soccer referees during actual match play. *Journal of Strength and Conditioning Research.*, 2001; 15(2):167–171.
7. Helsen W, Bultynck JB. Physical and perceptual-cognitive demands of top-class refereeing in association football. *Journal of Sports Sciences*. 2004; 22(2): 79–189. https://doi.org/10.1080/02640410310001641502
8. Castagna C, Abt G, D'Ottavio S. The relationship between selected blood lactate thresholds and match performance in elite soccer referees. *Journal of Strength and Conditioning Research*., 2002; 16(4):623–627.
9. Krustrup P, Bangsbo J. Physiological demands of top-class soccer refereeing in relation to physical capacity: effect of intense intermittent exercise training. *Journal of Sports Sciences.* 2001;19(11):881–891. https://doi.org/10.1080/026404101753113831
10. Castagna C, Abt G. Intermatch variation of match activity in elite Italian soccer referees. *Journal of Strength And Conditioning Research.*, 2003;17(2):388–392.
11. D'Ottavio S, Castagna C. Physiological load imposed on elite soccer referees during actual match play. *The Journal of Sports Medicine and Physical Fitness,* 2001; 41(1):27–32.
12. Harley R, Banks R, Doust J. The development and evaluation of a task specific fitness test for association football referees. In W. Spinks, T. Reilly, & A. Murphy (Eds.), Science and football IV., Routledge, 2001; 76-80.
13. Krustrup P, Mohr M, Bangsbo J. Activity profile and physiological demands of top-class soccer assistant refereeing in relation to training status. *Journal of Sports Sciences,* 2002; 20(11): 861–871. https://doi.org/10.1080/026404102320761778
14. Hale T, Angrist N, Kira B, Petherick A, Phillips T, Webster S. Variation in Government Responses to Covid-19. Version 6.0. Blavatnik School of Government Working Paper. 2020
15. Bedford J, Enria D, Giesecke J, Heymann DL, Ihekweazu C, Kobinger, G., et. al. Covid-19: Towards Controlling of a Pandemic. *The Lancet*, 2020;395: 1015-1017.
16. Chen YT, Hsieh YY, Ho JY, Tung TY, Lin JC. Two weeks of detraining reduces cardiopulmonary function and muscular fitness in endurance athletes. *European Journal of Sport Scıence.,* 2021;22(3):399-406
17. Koundourakis NE, Androulakis NE, Malliaraki N, Tsatsanis C, Venihaki M, Margioris AN. Discrepancy between exercise performance, body composition, and sex steroid response after a six-week detraining period in professional soccer players. *PLoS ONE.* 2014;9(2):e87803. https://doi.org/10.1371/journal.pone.0087803.
18. Liao YH, Sung YC, Chou CC, Chen CY. Eight-week training cessation suppresses physiological stress but rapidly impairs health metabolic profiles and aerobic capacity in elite taekwondo athletes. *PLoS ONE*, 2016;11(7):e0160167. https://doi.org/10.1371/journal.pone.0160167
19. Mujika I, Padilla S. Detraining: loss of training-induced physiological and performance adaptations. Part II: Long term insufficient training stimulus. *Sports Med.*, 2000;30:145–54.
20. Mujika I, Padilla S. Cardiorespiratory and metabolic characteristics of detraining in humans. *Medıcıne & Scıence In Sports & Exercıse.,* 2000; 413-420
21. Mujika I, Padilla S. Detraining: Loss of training-induced physiological and performance adaptations. Part I. *Sports Med.*, 2000; 30:79–87 https://doi.org/10.2165/00007256-200030020-00002
22. Waring CD, Henning BJ, Smith AJ, Nadal-Ginard B, Torella D, Ellison GM. Cardiac adaptations from 4 weeks of intensity-controlled vigorous exercise are lost after a similar period of detraining. *Physiol Rep.,* 2015; 3(2):e12302
23. Zacca R, Toubekis T, Freitas L, Silva AF, Azevedo R, Vilas-Boas JP, Pyne DB, Castro FADS, Fernandes RJ. Effects of detraining in age-group swimmers performance, energetics and kinematics. *Journal of Sports Sciences.,* 2019; 37(13):1490-1498.
24. Bickel CS, Cross JM, Bamma MM. Exercise dosing to retain resistance training adaptations in young and older adults. *Med Sci Sports Exerc*., 2011; 43(7):1177-1187.
25. Kim D, Singh H, Loenneke JP, Thiebaud RS, Fahs CA, Rossow LM, Young K, Seo Di, Bemben DA, Bemben MG. Comparative effects of vigorous-intensity and low-intensity blood flow restricted cycle training and detraining on muscle mass, strength, and aerobic capacity. *J Strength Cond Res*, *2016;* 30(5):1453–1461.
26. Labarque VL, Eijnde BO, Van Leemputte M. Effect of immobilization and retraining on torque-velocity relationship of human knee flexor and extensor muscles. *Eur J Appl Physiol.,* 2002; 86(3): 251-257.
27. Randers MB, Nielsen JJ, Krustrup BR, Sundstrup E, Jakobsen MD, Nybo L, Dvorak J, Bangsbo J, Krustrup P. Positive performance and health effects of a football training program over 12 weeks can be maintained over a 1-year period with reduced training frequency. *Scand J Med Sci Sports.,* 2010; 20(1):80-89.
28. Vikne H, Strøm V, Pripp AH, Gjøvaag T. Human skeletal muscle fiber type percentage and area after reduced muscle use: A systematic review and meta-analysis. *Scand J Med Sci Sports.,* 2020; 30:1298–1317
29. Aubry A, Hausswirth C, Louis J, Coutts AJ, Le Meur Y. Functional overreaching: the key to peak performance during the taper? *Med Sci Sports Exerc.,* 2014; 46(9):1769-77. doi: 10.1249/MSS.0000000000000301. PMID: 25134000.
30. Bishop D, Edge J. The effects of a 10-day taper on repeated-sprint performance in females. *Journal of Science and Medicine in Sport / Sports Medicine.,* 2005; 8: 200-9. 10.1016/S1440-2440(05)80011-8.

31. Izquierdo M, Ibañez J, González-Badillo JJ, Ratamess NA, Kraemer WJ, Häkkinen K, Bonnabau H, Granados C, French DN, Gorostiaga EM. Detraining and tapering effects on hormonal responses and strength performance. *J Strength Cond Res.*, 2007; 21(3):768-75. doi: 10.1519/R-21136.1. PMID: 17685721.
32. Marrier B, Robınea J, Piscione J, Lacome M, Peeters A, Hausswirth C, Morin JB, Le Meur Y. Supercompensation kinetics of physical qualities during a taper in team sport athletes. *IJSPP*, 2017; 12(9):1163-1169.
33. Nevill AM, Metsios GS, Jackson AS, Wang J, Thornton J, Gallagher D. Can we use the Jackson and Pollock equations to predict body density/fat of obese individuals in the 21st century? *International Journal of Body Composition Research*, 2008; 6(3):114.
34. Siri WE. Body Composition from Fluid Spaces and Density: Analysis of Methods. In Brozek J, Henzchel A (Eds.), *Techniques for Measuring Body Composition*, 224-244. Washington: National Academy of Sciences. 1961.
35. Andersen JL, Aagaard P. Myosin heavy chain IIX overshoot in human skeletal muscle. *Muscle Nerve*, 2000; 23:1095–1104.
36. Mujika I, Padilla S. Muscular characteristics of detraining in humans. *Med Sci Sports Exerc.*, 2001;33:1297–1303
37. Hortobagyi T, Houmard JA, Stevenson JR, Fraser DD, Johns RA, Israel RG. The effects of detraining on power athletes. *Med Sci Sports.*, 1993;25(8): 929-935.
38. Houston ME, Froese EA, Valeriote SP, Green HJ, Ranney DA. Muscle performance, morphology and metabolic capacity during strength training and detraining: a one leg model. *Eur J Appl Physiol.* 1983;51:25–35.
39. Maciejczyk M, Więcek M, Szymura J, Szyguła Z, Wiecha S, Cempla J. The Influence of Increased Body Fat or Lean Body Mass on Aerobic Performance. *PLoS ONE.*, 2014; 9(4):e95797
40. Dominski FH, Crocetta TB, Santo LBDE, Cardoso TE, da Silva R, Andrade A. Police officers who are physically active and have low levels of body fat show better reaction time. *J. Occup. Environ. Med.*, 2018; 60: 1–5.
41. Violanti JM, Ma CC, Fekedulegn D, Andrew ME, Gu JK, Hartley TA, Charles LE, Burchfiel CM. Associations between body fat percentage and fitness among police officers: A statewide study. *Saf. Health Work*, 2017;8: 36–31.
42. Bhutani S, vanDellen MR, Cooper AA. Longitudinal weight gain and related risk behaviors during the Covid-19 pandemic in adults in the US. *Nutrients.*, 2021;13(2):671.
43. Weston M, Castagna C, Impellizzeri FM, Bizzini M, Williams AM, Gregson W. Science and medicine applied to soccer refereeing an update. *Sports Med.*, 2012;42:615-631.
44. Häkkinen K, Alen M, Komi PV. Changes in isometric force and relaxation time, electromyographic and muscle fiber characteristics of human skeletal muscle during strength training and detraining. *Acta Physiol Scand.*, 1985;125:573-585.
45. Krustrup P, Helsen W, Randers MB, Christensen JF, MacDonald C, Rebelo AN, Bangsbo J. Activity profile and physical demands of football referees and assistant referees in international games. *J Sports Sci*, 2009; 27;1167-1176.
46. Foster C, Anholm JD, Bok D, Boullosa D, Condello G, Cortis C, et al. Generalized approach to translating exercise tests and prescribing exercise. *Journal of Functional Morphology and Kinesiology*, 2020;5(3):63.
47. Thompson PD, Franklin BA, Balady GJ, Blair SN, Corrado D, Estes NA, et al. American College of Sports Medicine. Exercise and acute cardiovascular events placing the risks into perspective: A scientific statement from the American Heart Association Council on Nutrition, Physical Activity, and Metabolism and the Council on Clinical Cardiology. *Circulation.*, 2207;115:2358–2368.
48. Mujika I, Busso T, Lacoste L, Barale F, Geyssant A, Chatard JC. Modeled responses to training and taper in competitive swimmers. *Med Sci Sports Exerc.*, 1996; 28(2):251-8. doi: 10.1097/00005768-199602000-00015. PMID: 8775162.
49. Joo CH. The effects of short-term detraining on exercise performance in soccer players. *Journal of Exercise Rehabilitation.*, 2016;12(1):54–59. https://doi.org/10.12965/jer.160280.
50. Lima e Silva, L., Neves, E., Silva, J., Alonso, L., Vale, R., & Nunes, R. (2020). The haemodynamic demand and the attributes related to the displacement of the soccer referees in the moments of decision/intervention during the matches. *International Journal of Performance Analysis in Sport*, *20*(2), 219-230.
51. Mallo, J., Veiga, S., Subijana, C. L. de, & Navarro, E. (2008). Activity profile of top-class female soccer refereeing in relation to the position of the ball. In Journal of science and medicine in sport (Vol. 13, Issue 1, p. 129). Elsevier BV. https://doi.org/10.1016/j.jsams.2008.09.006
52. Gürer, H., Akçınar, F., Arslan, S. C., Akçınar, S., Güllü, M., Eken, Ö., ... & Elkholi, S. M. (2024). Evaluating the impact of rock climbing on mental health and emotional well-being in adolescents. *Frontiers in Psychology*, *15*, 1426654.
53. Karaca, Y., & Ilkım, M. (2021). Investigation of the attitudes distance education of the faculty of sport science students in the Covid-19 period. *Turkish Online Journal of Distance Education*, *22*(4), 114-129.
54. Kurt, C., Tuna, G., & Kurtdere, İ. (2024). Acute Effects of Slow, Moderate and Fast Tempo Dynamic Stretching Exercises on Power in Well-Trained Male Wrestlers. *Journal of Human Kinetics*, *93*, 155.
55. Tuna, G., & Yalçınkaya, A. E. (2023). Investigating The Acute Effects of Different Warm-Up Protocols on Sprint Performance in Female Volleyball Players. *The Online Journal of Recreation and Sports*, *12*(4), 797-804.
56. R. Lopes *et al.*, "Reliability of skinfold measurements and body fat prediction depends on the rater's experience: a cross-sectional analysis comparing expert and novice anthropometrists," *Sport Sciences for Health*, Jun. 2025, doi: https://doi.org/10.1007/s11332-025-01389-8.
57. Niknam, A., Gaeini, A., Hamidvand, A., Jahromi, M., Oviedo, G., Kordi, M., & Safarpour, F. (2025). High-intensity functional training modulates oxidative stress and improves physical performance in adolescent male soccer players: a randomized controlled trial. *BMC Sports Science, Medicine and Rehabilitation*, 17. https://doi.org/10.1186/s13102-024-01037-7.