

The Effect of Different Training Strategies Applied to Football Referees On Max_{VO2} and Running Performance

BARIŞ BAYDEMİR¹, HÜSEYİN Ö. YURDAKUL¹, SERKAN AKSOY²

¹ Faculty of Sport Science, Çanakkale Onsekiz Mart University, Çanakkale, Turkey

² Ayvacık Vocational School, Çanakkale Onsekiz Mart University, Çanakkale, Turkey.

Correspondence to: Barış Baydemir, Email: barisbaydemir@hotmail.com, Cell: +905439014515

ABSTRACT

Aim: In this study, the effects of high-intensity interval training and sprint training on amateur football referees running performances expressed by the FIFA Athletic Test, Cooper Test and MAXVO2 were investigated.

Methods: Football referees average age (23.88±2.10); average height (181.16±1.99) cm; body weight (74.42±2.46) kg and body mass index (22.66±.62) kg/m² calculated. They were applied high-intensity interval training and speed training 3 days a week for 16 weeks. FIFA Athletic Test and Cooper Test were applied in the pre-test and post-test to see the effect of the training process on the referees. SPSS package program was used to analyze the data. "Paired Sample t-Test" was used for the normally distributed data, and the "Wilcoxon Signed Rows Test", which is a nonparametric test, for non-normally distributed data, and the effect size was calculated. The results were evaluated according to the significance level "0.01" and "0.05".

Results: When the FIFA Athletic Test, Cooper Test, body weight, and BMI pre-test and post-test values were compared in football referees, a statistically significant difference was found between the first measurement and the second measurement (p<0.05).

Conclusion: As a result of the study, it was observed that the training sessions had a positive effect on amateur football referees' running performances expressed by FIFA Athletic Test and Cooper Test and MAXVO2. This training program is recommended for the improvement of the degree-based running performances of amateur football referees.

Keywords: Football referee, training, high-intensity interval running.

INTRODUCTION

Football is the sports branch that has the most pleasure among sports-based games and has the largest crowd of fans. Factors such as players, coaches, referees affect the pleasure of watching. For this reason, players and referees have to work to improve themselves. Coaches develop and keep up-to-date training programs to do these works in line with a plan and systematically.

With the development of training systems in football, the change in tactical understanding, the development in the football industry (field and material quality, etc.), the game has become faster to play in recent years, and at the same time, the ball's playing time has increased.

Football referees have an important place in football. Like footballers, they go out to the competition to perform their best. While it is possible for football players to close each other's mistakes and deficiencies in the team game, this is not the case for referees. In football, which is one of the most active sports branches in the world, some wrong decisions of the referees prevent the matches. These wrong decisions are made by the referees, perhaps in moments of high physical fatigue¹. Besides, high performance is expected in the matches they direct from spectators, coaches, footballers, or clubs, and this expectation creates serious stress on the referees.

Football referees have to run a lot to be close to the ball and the players and at the same time to watch the game from a more comfortable angle.

Elite football referees should have sufficient perceptual and cognitive abilities as well as a high aerobic performance like a midfield player. The best proof of this is the research done by ^{2,3,4}. In their study¹ and his colleagues determined that the average distance of the referees in the matches was 9438 ± 707m, ³ 11376 ± 1600 m, and ⁴ 10714

m. Football referees are also subject to training programs like football players. The institution that designs these trainings is the training responsible for the International Football Federation Association (FIFA) and related federations. The International Football Federation Association (FIFA) provides financial support to various research projects to ensure that referees' work on improving their performance and the correct and consistent implementation of game rules⁵. At the same time, it tries to evaluate the physical fitness of the referees and constantly improve their fitness tests.

Football referees perform high-intensity runs and acceleration and deceleration runs at different times in a competition. At the same time, it is known that football referees have a linear relationship between aerobic capacity and match performance. It is also important to improve the ability to repeat high-intensity short-term (8-15 sec) runs. Therefore, it is considered that football referees should improve their physical performances and keep them at the top level by including these high-intensity and short-term runs in their current training programs.

In addition, endurance training has been reported to improve individuals' aerobic capacity and other performance levels⁶. The most important improvements in the fitness and performance abilities of Elite Football players throughout the season are observed in pre-season studies⁷. Another important parameter, the repetitive sprinting ability, started to decrease towards the middle of the season⁸.

This skill is very important for referees as well as football players because they need to perform repeated sprint sequences during the match and especially in moments of fatigue⁹. Muscle glycogen depletion, hypothermia, and potential dehydration can be cited among

the causes of decreased performance in repeated sprinting ability during competition ¹⁰. Apart from these, it has been estimated that heavy training load and match frequency may cause a decrease in the performance of repetitive sprinting ability ⁸.

Research is generally done on the players and the physiological features of football. In recent years, researchers have begun to focus on the physiological characteristics of football referees and referees. Most of these studies include topics such as referee profiles, physiological and anthropometric characteristics of referees, referee movement patterns throughout the match. When the literature is analyzed, it has been determined that there are the limited number of studies on training modeling and performance of football referees ^{3,11}. For this reason, our study was conducted to investigate the effects of high-intensity interval training applied to amateur football referees on FIFA Athletic Test (6x40m and 40 x 75m) on the running performances expressed by Cooper Test and MAX_{VO2}.

MATERIAL AND METHODS

Participants: This study was carried out in the 2016-2017 football season by obtaining the necessary permissions from the Çanakkale Provincial Arbitration Board and adhering to the ethical principles by the Helsinki Declaration. 25 male soccer referees, students of Çanakkale Onsekiz Mart University, voluntarily participated in the study. Their average age (23.88 ± 2.10), average height (181.16 ± 1.99) cm, body weight (74.42 ± 2.46) kg and body mass index (22.66 ± .62) kg / m² calculated. At the end of the preparation period of the annual training programs for football referees in the 2016-2017 season, after the pre-test including the FIFA Athletic Test (6x40m and 40 x75m) and Cooper Tests on the tartan floor, the high-intensity interval training and speed training applied 3 days a week. As a result of the 16-week study, it was terminated by performing a post-test.

Procedure: Anthropometric measurements

An electronic scale with a sensitivity of 0.1 kg was used to measure body weight, and a digital height meter with a precision of 0.01 cm was used for measuring the length of the body. BMI = Body Weight / Height² formula was used ¹².

Performance Tests

FIFA Athletic Test

Category 1: Repeated Sprint Ability

The test was done on the running track (tartan floor). The start line is marked 0 and the finish line is marked as 40m. A photocell was placed 1m behind the start line and the finish line. 6x40m running time was determined as maximum 6,10 seconds for the referees and rest time between repeats was 90 seconds. The best of 6 running degrees were recorded.

Category 2: High-intensity interval running

The test was carried out on a 400m running track (tartan floor). The 400m running track is divided into 4 with 100m sections. The beginning of every 100m is 0m start, 73.5-75m finish, and the remaining 25m distance is marked as walking or jogging area. The Category 2 test started 6 minutes after the Category 1 test was over. The test was performed with the signal sounds coming from the stadium sound system. Football referees' 75m running time is 15 seconds, 25m walking or jogging time is 20 seconds. The 1st official announcement was made by the testers to the football referees who could not enter the area of 73.5-75m before the beep sound in every 75m of run. The 2nd referee was disqualified. Referees running 40x75m were considered successful.

Cooper test and MAX_{VO2} Calculation

The test was carried out on the running track (tartan floor). Football referees were taken to the test in groups of 10. The referees were rushed for 12 minutes with a whistle. The referees were stopped with a whistling sound after 12 minutes and their distance was recorded by the test judges on duty ¹³. The MAX_{VO2} values of the Football Referees were calculated with the Balke Formula written below.

MAX_{VO2}=33,3+(X-150)x0,178. (X = Distance run in one minute)

Training Protocols

At the end of the preparation period of the annual training programs, football referees were given high-intensity interval training and speed training for 90 ± 10 minutes (including warm-up phase, main phase, and cooling phase) 3 days a week on the tartan floor of Çanakkale Onsekiz Mart Stadium. Football referees only received high-intensity interval training or speed training in one unit training. Training days are designed according to the match days of football referees. No practice training (Hiit and speed training) was placed before and after match days. In the 16-week program, equal distribution of HIIT and speed training was provided (20 HIIT, 20-speed training). During the study, no injuries were detected in football referees.

"Test of Normality" was applied for the normality of the distribution of the data obtained before and after the study. "Paired Sample t-Test" and "Wilcoxon Signed Rows Test" from nonparametric tests were used to determine whether there was any difference between the data taken before and after the study. The effect size was calculated by dividing the difference between the mean scores of the measurements by the standard deviation of the series. Effect size (d value): Over ± 1 was evaluated as very large, 0.8 large, 0.5 medium, 0.2 small effect. The results were evaluated according to the significance level "0.05" and "0.01".

Table 1. Training and Test Schedule of Football Referees

Day Week	Monday	Tuesday	Wednesday	Thursday	Friday	Saturday	Sunday
1	Active Resting	Pre-Test	Off	Speed Training	Off	Hiit	Off
2	Active Resting	Speed Training	Off	Hiit	Off	Speed Training	Off
3	Active Resting	Hiit	Off	Speed Training	Off	Hiit	Off
4	Active Resting	Speed Training	Off	Hiit	Off	Speed Training	Off

5	Active Resting	Hiit	Off	Speed Training	Off	Hiit	Off
6	Active Resting	Speed Training	Off	Hiit	Off	Speed Training	Off
7	Hiit	Active Resting	Speed Training	Off	Hiit	Off	Match
8	Active Resting	Speed Training	Off	Hiit	Off	Match	Active Resting
9	Hiit	Active Resting	Speed Training	Off	Hiit	Off	Match
10	Active Resting	Speed Training	Off	Hiit	Off	Match	Active Resting
11	Speed Training	Off	Hiit	Off	Speed Training	Active Resting	Match
12	Active Resting	Speed Training	Off	Hiit	Off	Match	Active Resting
13	Hiit	Off	Speed Training	Off	Hiit	Active Resting	Match
14	Active Resting	Speed Training	Off	Hiit	Off	Active Resting	Match
15	Active Resting	Hiit	Off	Speed Training	Off	Match	Active Resting
16	Speed Training	Off	Active Resting	Post-Test	Off	Active Resting	Match

RESULTS

In the study, as a result of the normality test conducted to determine the distribution of the data obtained, it was determined that the football referees' age, height, weight, BMI, FIFA Athletic Test (6x40m), FIFA Athletic (40x75m) pre-test data, Cooper test and MAX_{VO_2} values showed normal distribution. Athletic Test (40x75m) post-test data did not show normal distribution ($p > 0.05$). The data obtained in the study are given in Table 1.

Bodyweight, BMI, FIFA Athletic Test (40x75m), Cooper test and MAX_{VO_2} values obtained from the pre and post-tests of football referees as a result of the "Paired Samples t-Test" conducted to determine the difference between the average values before and after the different training strategies applied to football referees, there was a statistically significant difference in their mean ($t = 11.622$, $p < 0.01$; $t = 10.723$, $p < 0.01$; $t = -14.942$, $p < 0.01$; $t = -$

4.688, $p < 0.01$; $t = -4.681$, $p < 0.01$). The effect size (d value) calculated as a result of the test: The Cooper test showed a large level, and other parameters had a very large level of effect. This shows that different training strategies applied to referees have a significant effect.

As a result of the "Wilcoxon Signed Rows Test" conducted to determine the difference between the average values before and after the different training strategies applied to football referees, a statistically significant difference was observed in the FIFA Athletic Test (6x40m) values of the football referees ($z = -4.286$, $p < 0.05$). The difference values in favor of negative rows show that different training strategies applied to football referees have a significant effect on FIFA Athletic Test (6x40m) degrees.

Table 2. Test of Normality

Shapiro-Wilk				
Variables	Test Sequence	Statistic	df	Sig.
Age (year)	Pre-test	.939	25	.143
	Post-test	.939	25	.143
Height (cm)	Pre-test	.920	25	.050
	Post-test	.920	25	.050
Weight (kg)	Pre-test	.952	25	.271
	Post-test	.886	25	.009
BMI (kg/m ²)	Pre-test	.976	25	.794
	Post-test	.976	25	.800
FIFA Athletic Test (6x40m)	Pre-test	.908	25	.027
	Post-test	.938	25	.136
FIFA Athletic Test (40x75m The number of repetitions)	Pre-test	.914	25	.038
	Post-test	.308	25	.000*
Cooper Test (m)	Pre-test	.948	25	.230
	Post-test	.939	25	.140
MAX_{VO_2} (ml.kg/dk)	Pre test	.946	25	.208
	Post-test	.940	25	.146

* $p < 0.05$

Table 3. Physical Characteristics of Football Referees

Variables	N	Test Sequence	Min.	Max.	Mean±SS
Age (year)	25	Pre-test	19	27	23.88±2.10
		Post-test	19	27	23.88±2.10
Height (cm)		Pre-test	178	184	181.16±1.99
		Post-test	178	184	181.16±1.99
Weight (kg)		Pre-test	70	81	74.42±2.46
		Post-test	69	80.10	72.82±2.27
BMI (kg/m ²)		Pre-test	21.38	23.92	22.66±.62
		Post-test	20.90	23.70	22.18±.58

FIFA Athletic Test (6x40m)	Pre-test	5.93	7.01	6.16±.23
	Post-test	5.59	5.95	5.79±.10
FIFA Athletic Test (40x75m The number of repetitions)	Pre-test	28	36	33.40±2.21
	Post-test	39	40	39.92±.27
Cooper Test (m)	Pre-test	2700	2910	2822±58.59
	Post-test	2820	2920	2880±.27
MAX _{VO2} (ml.kg/dk)	Pre-test	46.65	49.76	48.46±.86
	Post-test	48.43	49.91	49.31±.40

Table 4. Paired Sample t-Test

Variables	N	Test Sequence	Mean±SS	sd	t	p	d
Weight (kg)	25	Pre-Test	74.42±2.46	44	11.622	.000	2.32
		Post-Test	72.82±2.27				
BMI (kg/m ²)	25	Pre Test	22.66±.62	44	10.723	.000	2.144
		Post-Test	22.18±.58				
FIFA Athletic Test (40x75m The number of repetitions)	25	Pre-Test	33.40±2.21	44	-14.942	.000	-2.988
		Post-Test	39.92±.27				
Cooper Test (m)	25	Pre Test	2822±58.59	44	-4.688	.000	-0.937
		Post Test	2880±27.29				
MAX _{VO2} (ml.kg/dk)	25	Pre Test	48.46±.86	44	-4.681	.000	-0.936
		Post Test	49.31±.40				

Table 5. Wilcoxon Signed Rows Test

Pre-Post FIFA Athletic Test (6x40m)	N	Row Mean	Sum of Row	z	p
Negative Rows	24	12.50	300	-4.286	.000
Positive Rows	0	.00	.00		
No difference	2				

* Based on negative rows

DISCUSSION

In this study, the effects of high-intensity interval training and speed training on amateur football referees' running performances expressed by FIFA Athletic Test (6x40m and 40 x 75m), Cooper Test and MAX_{VO2} were investigated. As a result of specific training (high-intensity interval training and sprint training) applied to football referees for 16 weeks, a statistically significant difference was observed in the body weight, BMI, FIFA Athletic Test (40x75m), Cooper test and MAX_{VO2} values of football referees. In the calculated effect size (d value), as a result of the Cooper test, a large level and a very large level effect was observed in the other parameters (Table 3). There was also a statistically significant difference in FIFA Athletic Test (6x40m) values (Table 4).

In a study with top-level football referees, computer time-motion analysis, heart rate, and blood lactate measurements of referees working in national leagues were examined. At the same time, various physiological tests were performed before and after intermittent exercise training in order to relate football referees' match performances with physical capacity and training, and as a result, it was determined that the runs during the match were related to Yo-Yo Intermittent Recovery Test and Cooper Test. They also emphasized that the ability of football referees to run high intensity during the match decreased towards the end of the matches and Yo-Yo Intermittent Recovery Test can be used to evaluate the match performance of the referees¹⁴. In their study¹⁵ investigated the effects of high-intensity interval training program on sprint ability and aerobic capacity in soccer referees. As a result of a 10-week study involving 16 elite soccer referees, it was determined that high intensity training improved sprinting ability and aerobic capacity.

In their study¹⁶ examined 470 referees working in the 1st and 2nd categories of the Spanish league between

2001-2012. As a result of the research, while determining that there has been an improvement in the body composition of the elite football referees in the past decade, they emphasized that more studies will contribute to confirm these results. In their study¹⁷ thought that the fitness performances of football referees managing elite matches were affected by age. For this purpose, they examined 36 soccer referees in 3 separate groups (young-middle-aged) and subjected them to field tests. As a result of the research, they emphasized that the age-related test standards should be determined, while expressing that the elderly referees should pay attention to the fact that young referees have developed appropriate aerobics and anaerobics in their refereeing life throughout their career, even if they have an acceptable fitness test.

Another study emphasized that after 12 weeks of high-intensity interval training in studies on football referees, they significantly improved their 7% maximum oxygen intake and sports specific test performances based on a 31% Yo-Yo Intermittent Recovery Test. In the study, the international match performances of football referees were examined and it was emphasized that the referees and assistant referees had high physical demands. It has also been reported that the intensity of each run during the game is much shorter than the test protocol, and the stimulation of the anaerobic system is much higher than the real match in the test. It was emphasized in the referee and assistant referees that the running speed changes every 4-5 seconds and this should be reflected in the test protocol¹⁴. In addition, Baydemir et al. emphasized that well-planned training has a positive effect on aerobic capacity and significantly improves maximum oxygen uptake¹⁸.

In another study, intensive intermittent training was applied to football referees during the 16-month training period and it was reported that there was a 47% increase in the Yo-Yo Intermittent Recovery test in football referees¹⁹. In their study²⁰ applied strength training to soccer referees

for 8 weeks. In the study, it was found that football referees had positive improvements in physical and physiological parameters (resting heart rate, total body fat percentage, vertical jump distance, flexibility, aerobic endurance, speed and agility).

Another study emphasized the importance of prioritizing high-intensity aerobic exercise by experts because of the high-intensity running during the match. National and semi-professional football referees have shown that the amount of high-intensity activity performed in the first half may affect physical performance in the second half and elicit several selected stepping or walking needs to prevent accumulated fatigue^{21,22}. In another study²³ examined the physical activity profiles and physiological responses of 28 soccer referees who conducted matches during the 2013 football season with the portable global positioning system (GPS). As a result of the research, they stated that football refereeing is a physically demanding task that imposes high cardiorespiratory involvement and metabolic demands.

CONCLUSIONS

Consequently, 16-week high-intensity interval training (HIIT) and sprint training applied to football referees had a positive impact on the referees' physical characteristics. Also, as a result of these training sessions, football referees' aerobic endurance running distances, MAXvo₂ values, and high-intensity interval running performances were increased positively, and recurring speedrunning times decreased positively. This research can be used as a reference for research on football referees, athletic performance experts, referee coaches, coaches to design referee training, and maximizing the referees' performances.

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