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The influence of cardiovascular training methods and level of training on the fitness level of futsal referees

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ABSTRACT

This study aimed to apply cardiovascular training, specifically through intensive interval and extensive interval training methods, to enhance the fitness levels of AFP DIY futsal referees in Indonesia. The study design was quasi-experimental with a 2x2 factorial design. The research subjects were 36 male AFP DIY futsal referees aged 25-35 years. The training test instrument used the Heart Rate Recovery Test (HRRT) and the referee fitness instrument used the FIFA Assistant Referee Intermittent Endurance Test (ARIET). The software used for data analysis was SPSS version 21.0 for Windows. The results indicated that cardiovascular training methods significantly impact the fitness levels of futsal referees ($p<0.05$). The intensive interval training method positively influenced the fitness of futsal referees ($p<0.05$). Similarly, the extensive interval training method also had a positive effect on improving the referees' fitness ($p<0.05$). The group that received the extensive interval training showed greater improvements compared to the intensive interval group, with an increase of 43.48%. Furthermore, there is an interaction between cardiovascular training methods, training levels, and fitness levels ($p<0.05$). These findings offer valuable insights for futsal referees, emphasizing the importance of selecting the most effective training methods to enhance their fitness levels.

KEYWORDS

Cardiovascular Training; Fitness; Referee; Futsal

1. INTRODUCTION

Futsal is a very popular sport, garnering significant interest and sympathy from the Indonesian people. Futsal is played with 5 members on each team, and they are allowed to have reserve players (Purnomo & Irawan, 2021). Gomes et al. (2022) noted that futsal is an intermittent sport requiring high physical, technical, and tactical demands with a fast and dynamic tempo, leaving no room for mistakes. Sekulic et al. (2022) explained that futsal is a complex team sport characterized by rapid transitions between periods of high-intensity play and short rest periods. The structure of the game involves intense activities such as sprints, accelerations, decelerations, and quick changes in direction, enabling players to gain or retain possession of the ball. Purdadadi & Perdima (2022) explain that futsal is a ball game played by two teams, each consisting of five players. The aim of the game is to score by putting the ball into the opponent's goal, using one's feet to manipulate the ball. As with other sports, futsal has an official who regulates the course of the match, commonly referred to as the referee.

A referee is a person who has the authority to regulate the course of a sporting match. Various terms are used for referees, including umpire, judge, or linesman. Alshiblawi et al. (2022) explain that in futsal, the referee plays a crucial role in decision-making, which can influence the outcome of a competitive match. The referee in futsal is described as an individual selected by those responsible for futsal activities to manage the game according to established rules, determining the winning, losing, or drawing team (Alshiblawi et al., 2022). De Oliveira et al. (2023) stated that the referee is central to the futsal game. They further noted that if a referee does not officiate based on principles of justice and wisdom, it will affect the course of the match. Incorrect decisions made by the referee during the game can impact the final result (Downward et al., 2023).

In futsal, a high-intensity sport, referees also require endurance and good physical fitness to effectively lead a match. Physical ability or fitness is essential for becoming a futsal referee. Futsal is an intermittent sport that demands significant energy from the cardiovascular system, with alternating phases of high intensity and variable durations, as well as varying recovery periods in each match (Aksu, 2023). Skirbekk, (2023) stated that the physical abilities possessed by futsal referees should be the same or even more than the futsal players themselves, because in every futsal match the waist of the leader cannot change like a futsal team which has reserve players. Folgar (2023) explains that as a leader of matches with high intensity sports, you need abilities and physical components that support the waist in leading futsal matches.

Even though the physical ability of a futsal referee is an important component, in Indonesia, especially in the Yogyakarta area, the physical ability of referees is less than optimal. Based on data from the Futsal Referee Fitness Test conducted by AFP in October 2023, "of the total of 53 active futsal referees who took the test, 22 futsal referees (41%) were declared not to meet the physical fitness criteria." Despite this, the irony is that all the referees still have the task of officiating matches. Observations also revealed that, on average, the physical abilities of futsal referees in Indonesia are still not at their best to officiate matches. Futsal referees need the best training to achieve prime physical condition for officiating. To attain excellent physical condition, a cardiovascular training model is needed.

Cardiovascular or aerobic fitness is often also called maximum aerobic capacity or maximum oxygen consumption (Oxygen Uptake). When maximum aerobic capacity is reached, the energy released can also be maximum (total energy output). The metabolism of energy used during aerobic exercise is processed through burning stored carbohydrates, fat and a small portion of protein to form Adenosine Triphosphate (ATP). Cardiovascular exercise provides numerous benefits for the heart, such as strengthening the heart, reducing the risk of heart failure, and lowering blood pressure (Signoret-Genest et al., 2023). Vrcić et al. (2023) revealed that the cardiovascular system will respond to acute exercise exposure with the main aim of transporting oxygen and energy substrates to muscle tissue, as well as transporting the metabolic waste products that are formed. Adjustments made by the cardiovascular system will ensure that skeletal muscles that are actively exercising can receive the amount of blood flow according to their metabolic needs, the heat produced by the related muscles can be removed from the body through the skin, and must maintain adequate blood flow to the brain and heart itself. well.

Based on literature studies, researchers have identified issues and training models considered highly effective for improving the physical components of futsal referees. The research holds significant novelty, as few studies have focused on applying cardiovascular training to referees. While previous literature has often concentrated on futsal athletes, it has not highlighted the use of Intensive Interval and Extensive Interval training models to improve referees' fitness levels. This study aims to apply cardiovascular training, specifically through Intensive Interval and Extensive Interval training methods, to enhance the fitness levels of AFP DIY futsal referees in Indonesia.

2. METHODS

2.1. Study design and participants

The type of research employed was quasi-experimental. The population in this study consisted of active futsal referees from AFP DIY members, totaling 37 men. Using the Slovin formula with a 95% confidence level, a minimum sample size of 34 participants was determined. To account for potential data loss and to facilitate group division, the sample size was increased by 2 participants, resulting in a total sample of 36 referees.

2.2. Instruments

The data taken in this study included data on the referee's training level using the Heart Rate Recovery Test (HRRT). Furthermore, data regarding cardiovascular or VO2 Max was taken before and after treatment using the Futsal Referee Fitness Test instrument. The instrument used in this study was the Assistant Referee Intermittent Endurance Test (ARIET) instrument in Futsal Referee Fitness Test and Heart Rate Recovery Test.

2.3. Statistical analysis

Data in this study were analyzed using the T-test and F-test, two-way ANOVA, followed by the Tukey test. The software used was SPSS version 21.0 for Windows, with a significance level set at 0.05 (5%).

3. RESULTS

Table 1 presents the comparative data on the improvement in futsal referees' fitness between the pre-test and post-test, based on the training method treatment.

Table 1. Futsal referee fitness level based on training method treatment

Training Methods	**N**	**Fitness Level**			
		Pre	***Post***	**∆Mean**	**%**
Intensive Interval (Group 1 and 2)	18	27,6	36	**8,3**	**30%**
Extensive Interval (Group 3 and 4)	18	25,3	36,3	**11**	**43,48%**

Based on the results in Table 1, both training treatment groups experienced improvements. However, the group receiving the Extensive Interval cardiovascular training showed a greater

improvement, with an average score increase of 11, or 43.48%, compared to the Intensive Interval method group, which had an average score increase of 8.3, or approximately 30%."

To determine the effect of the Intensive Interval training method on the fitness of futsal referees, a paired sample t-test was used in this study. The results of the hypothesis test (t-test) are presented in Table 2 below.

Table 2. Results of the intensive interval group

Pair 1	Paired Differences					t	df	p
	Mean	Std. Deviation	Std. Error Mean	95% Confidence Interval of the Difference				
				Lower	Upper			
Speed Endurance Pre - Speed Endurance Post	-8,33	5,87	1,38	-11,25	-5.41	-6.02	17	.000

Based on Table 2 above, the mean value obtained through the t-test is 8.33, with a standard deviation of 5.87. The t-test value is 0.6002, and the tailed significance value is p = 0.000, which is less than 0.05. This indicates that the intensive interval training method has a significant effect on improving the fitness of futsal referees.

To assess the effect of the Extensive Interval Training Method on the fitness of futsal referees, a paired sample t-test was conducted in this study. The results of the t-test are presented in Table 3 below.

Table 3. Extensive interval group results

Pair 1	Paired Differences					t	df	p
	Mean	Std. Deviation	Std. Error Mean	95% Confidence Interval of the Difference				
				Lower	Upper			
Progresive Intermitten Pre - Progresive Intermitten Post	-11,00	4,35	1,02	-13,16	-8,83	-10,7	17	.000

Table 3 indicates that the extensive interval training method has a significant impact on improving the fitness of futsal referees ($p<0.05$).

To evaluate the effect of cardiovascular training methods on the fitness of futsal referees, specifically comparing Intensive Interval and Extensive Interval training methods, an independent sample t-test was conducted. The results of the t-test are presented in Table 4 below.

Table 4. Comparison of intensive interval and extensive interval training methods

Intensive Interval _ Extensive Interval	Levene's Test for Equality of Variances		T-test for Equality of Means						
	F	Sig.	t	df	Sig. (2-tailed)	Mean Difference	Std. Error Difference	95% Confidence Interval of the Difference	
								Lower	Upper
Equal variances assumed	,074	,787	-2,08	34	,045	-3,27	1,57	6,47	- ,083
Equal variances not assumed	,074	,787	-2,08	33,4	,045	-3,27	1,57	6,47	- ,081

These results show that there is a difference between Intensive Interval and Extensive Interval cardiovascular training methods in increasing the fitness of futsal referees (P<0.05). The data analysis technique used to test the proposed hypothesis is the two-way ANOVA. Based on homogeneity and normality tests, the data in this study meets the requirements for conducting a two-way ANOVA. The results of the F-test are shown in Table 5 below.

Table 5. F-Test Results

Source	**Type III Sum of Squares**	**Df**	**Mean Square**	**F**	**p**
Corrected Method	7199,264a	3	2399,755	62,269	,000
Intercept	61425,125	1	61425,125	1593,868	,000
Cardiovascular Exercise Methods	21,125	1	21,125	152,734	,000
Trainability	5886,125	1	5886,125	,548	,462
Trainability * Cardiovascular Exercise Methods	1292,014	1	1292,014	33,525	,000
Error	2620,611	68	38,538		
Total	71245,000	72			
Corrected Total	9819,875	71			

Dependence Variable: Vo2 Max

Based on Table 5, p values (p<0.05) indicate that there is a statistically significant interaction between the cardiovascular training method, the level of training, and the fitness level of the futsal referees.

4. DISCUSSION

Cardiovascular exercise can improve a person's fitness because VO2 max significantly influences cardiopulmonary endurance. This improvement can also be applied to enhance the physical fitness of futsal referees. The data from the hypothesis test indicate that cardiovascular training methods impact fitness levels, with the following details: The Intensive Interval training method increased the fitness level of futsal referees by an average of 30%. The Extensive Interval training method increased the fitness level of futsal referees by an average of 43.48%. Both training methods effectively enhance the fitness level of futsal referees.

Based on the descriptive data, the Extensive Interval training method shows a greater percentage increase than the Intensive Interval training method, with a difference of 13.48%. This is confirmed by a statistical test: the two-way ANOVA indicates an interaction between the cardiovascular training method, level of training, and fitness level. The results of the t-test for both exercises show that the t-value is greater than the t-table value (2.306), and the p-value (0.000) is less than 0.05, indicating that both training methods significantly influence the cardiovascular system of futsal referees. This is further supported by the Tukey test results, which show that the untrained group treated with the Extensive Interval training method experienced the highest effect.

Based on the results obtained and supported by a literature review, there is a consensus that cardiovascular exercise can improve a person's fitness. Mulser (2022) shows that cardiovascular exercise is unique in its ability to influence heart rate and fitness levels through various mechanisms, while also providing numerous health benefits. Running, another form of cardiovascular exercise that can be done anytime and anywhere, helps burn fat, reduce stress, and strengthen bones and joints (Vesterbekkmo et al., 2022). Purwantini & Lestarina (2023) also emphasize that functional training aims to enhance cardiovascular strength and capacity, optimize flexibility, balance, and coordination, increase muscle strength and endurance, and help control body weight and nutrition.

Aerobic exercise enhances the efficiency of physiological systems, such as circulation and respiration, in delivering oxygen to contracting muscles. VO2Max is recognized as an important indicator of cardiovascular disease mortality (Utamayasa et al., 2022). Tucker et al. (2022) discuss various aspects of sports cardiology, including athlete's heart and heart failure with preserved ejection fraction (HFpEF), and related issues. They explore the physiological mechanisms and adaptations that occur in response to exercise and how these changes contribute to a reduced risk of cardiovascular disease. Popovic et al. (2022) explain that both acute and chronic stressful conditions

appear to be significant risk factors for the development of cardiovascular disease. According to Arifin (2022), futsal is an intermittent high-intensity game that places significant demands on both aerobic and anaerobic pathways. Anaerobic endurance is associated with higher overall endurance, and someone with anaerobic endurance also possesses aerobic endurance.

Futsal players must understand body composition and cardiorespiratory performance, especially in competitive athletes (Komici et al., 2023). Kurtoğlu et al. (2023) revealed that structural cardiovascular abnormalities can develop over time in soccer players due to intense activity. Futsal is a sport that demands excellent endurance, which can be achieved through appropriate training methods, such as interval training, commonly referred to as cardiovascular training (Mauladi et al., 2023). According to Bentar & Irawan (2023), physical attributes like speed, agility, and endurance are essential in every match. In addition to maintaining good physical condition, futsal players must also possess strong technical skills.

Raga et al. (2023) stated that endurance refers to the ability to sustain activity over a long period or the capacity of the heart and lungs to function optimally in taking in oxygen during rest or exercise, which is then distributed to active body tissues for metabolic processes. Nursantiko et al. (2022) noted that endurance can be improved through cardiovascular training, with plyometrics, such as tuck jumps, being one of the recommended exercises. A person's endurance level can be measured by assessing VO2max, which is the maximum amount of oxygen the body can utilize during intense physical activity. Futsal is a sport that demands physical components such as strength, endurance, and fitness (Ginting et al., 2023). Arifin (2022) emphasized that futsal players aiming to compete must focus on developing aerobic capacity.

Spyrou et al. (2020) emphasized that futsal players need high endurance because endurance is a crucial biomotor component necessary for physical activity and is one of the most important aspects of physical fitness. Renaghan et al. (2023) investigated the relationship between cardiac load (total heart rate) during the previous week's training sessions, recovery, and autonomic nervous system (ANS) function among college football athletes. They hypothesized that sustained high cardiac load experienced by competing athletes would compound the impact of weekly training sessions on the ANS throughout the season. Refoyo et al. (2023) explained that ball and futsal sports involve various stress elements, such as isotonic and isometric physiology, and generally require less oxygen-carrying capacity than long-distance running or cycling. However, soccer has been shown to induce physiological remodeling similar to sports that emphasize endurance. Kurtoğlu et al. (2023)

noted that functionally, athletes can experience increases in stroke volume, diastolic cardiac filling, capillary conductance, and the oxidative capacity of skeletal muscles.

5. CONCLUSIONS

Based on the data analysis and discussion presented earlier, it can be concluded that cardiovascular training methods significantly influence the fitness level of futsal referees. Intensive Interval training effectively improves the fitness of futsal referees, as does Extensive Interval training. However, the Extensive Interval training method resulted in greater improvements, with an average increase of 43.38% compared to the Intensive Interval method. These findings offer valuable insights for futsal referees, emphasizing the importance of selecting the most effective training methods to enhance their fitness levels.

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CONFLICTS OF INTEREST

The authors declare no conflict of interest.

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