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The Influence of High-Intensity Interval Training (HIIT) on VO2Max Improvement in Futsal Extracurricular Participants at SMAN 5 Malang for the 2024/2025 Academic Year

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ABSTRACT

This study aims to identify the effect of High Intensity Interval Training (HIIT) on improving VO2Max among futsal extracurricular participants at SMA Negeri 5 Malang during the 2024/2025 academic year. The research utilized an experimental method with a one-group pre-test and post-test design. The sample consisted of all 20 futsal extracurricular participants. Data were collected by measuring VO2Max performance before and after the intervention, with analysis conducted using a t-test and SPSS software. The results indicated a t-value of (6.588), which is greater than the t-table value of (1.729), with a significance level of (<0.001). This finding demonstrates a significant difference in VO2Max values before and after the HIIT intervention. The conclusion reveals that HIIT significantly impacts VO2Max improvement among futsal extracurricular participants. HIIT has proven effective in enhancing aerobic capacity through a structured, intensive training approach. This study contributes to the development of physical training programs, particularly in futsal, and serves as a valuable reference for coaches in designing effective programs to improve VO2Max.

Keywords: *High Intensity Interval Training* (HIIT), VO2Max, Futsal

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Introduction

Globally, futsal has become a popular sport organized in various schools, sports clubs, and communities worldwide through tournaments and training sessions. This sport not only promotes health and fitness but also supports the development of individual skills, especially ball control, dribbling, and quick decision-making. With a smaller field size and a heavier ball, futsal demands high technical ability and quick reflexes, making it appealing to both players and spectators. Futsal is a high-intensity intermittent sport that requires explosive and rapid movements with short reaction times, interspersed with playing periods of 3 to 6 minutes during a 40-minute match at an intensity of 85-90% of maximum heart rate [1]. Performance factors such as agility, repeated sprint capacity, aerobic endurance capacity, lower body strength, and speed are related to gameplay actions and can be influenced by the athletes' body composition.

Adequate physical fitness levels, including strength, can help athletes avoid injuries and enhance their performance [2]. Good physical condition is crucial for optimal performance in futsal, as it directly affects the ability to perform the high-intensity movements required in the sport. Futsal

demands high levels of physical fitness, particularly in terms of aerobic capacity and anaerobic ability. Maximum oxygen volume (VO2Max) is an important indicator of an athlete's physical condition, reflecting their ability to use oxygen during intense exercise. It serves as a measure of cardiorespiratory fitness and endurance capacity and is often used to evaluate an individual's exercise potential and cardiovascular disease risk. VO2Max is typically measured through cardiopulmonary exercise testing (CPX) and expressed in (mL/kg/min)[3].

VO2Max values can be categorized into different fitness levels, ranging from very poor (≤20%) to superior (≥90%) [4]. One effective approach to improving VO2Max is through High-Intensity Interval Training (HIIT) [5]. HIIT consists of high-intensity training sessions interspersed with short recovery periods, which have been proven effective in increasing VO2Max and overall aerobic capacity [6]. This method utilizes intensive training intervals to stimulate cardiovascular and metabolic adaptations that are critical for improving VO2Max. For over a century, this method has attracted scientific attention for its ability to induce significant physiological adaptations and health benefits similar to moderate-intensity continuous training (MICT), but in a more time-efficient manner [7].

In the context of applying High-Intensity Interval Training to futsal extracurricular participants at SMAN 5 Malang, no specific studies have been found discussing the effect of HIIT on its futsal players. Therefore, this study is designed to investigate and gather scientific information on the influence of High-Intensity Interval Training on futsal extracurricular participants at SMAN 5 Malang. It is hoped that the results of this study can contribute additional knowledge about the benefits of High-Intensity Interval Training (HIIT) in improving VO2Max for futsal extracurricular participants in general and provide useful guidance for training programs.

Methodology

This study employs a quantitative approach using an experimental method to explore the cause-and-effect relationship between two variables: High-Intensity Interval Training (HIIT) and the improvement of VO2Max among futsal extracurricular participants. The research was conducted at SMAN 5 Malang and began in November 2024. The research sample consisted of participants from the futsal extracurricular program at SMAN 5 Malang for the 2024/2025 academic year.

The study design used a pre-test and post-test design. Data collection involved measuring VO2Max performance before the subjects underwent treatment (pre-test). The treatment program was implemented over six weeks, consisting of three sessions per week, totaling 16 sessions. After the program was completed, the researchers conducted a final test (post-test).

Data were collected by measuring VO2Max performance before and after the treatment. Data analysis was conducted using SPSS version 30 software to perform normality tests, homogeneity tests, and hypothesis testing. A t-test was used to determine the significance of the training method's effect on improving VO2Max among futsal extracurricular participants at SMAN 5 Malang for the 2024/2025 academic year.

Results

The VO2Max test results of the futsal extracurricular participants, conducted on 20 participants, provided the following statistical outcomes for the pretest and posttest:

Table 1. Pre-test and Post-test VO2Max Statistical Results

Information	Pre-Test	Post-Test
Mean	40,25	42,43
Median	40,35	42,41
Mode	39,9	39,2
Std. Deviation	6,87	6,47
Minimum	26,4	29,5
Maximum	51,1	53,7

Based on the data in Tabel 1. Shows improvement increase in VO2Max of futsal extracurricular participants of SMA Negeri 5 Malang in the 2024/2025 Academic Year, from the pre-test data, an average of 40.25 was obtained and in the post-test the average reached 42.43. The amount of change can be observed from the average difference of 2.18. Data analysis was conducted to evaluate

normality, homogeneity, and conduct hypothesis testing (t-test). The results of the analysis can be seen as:

Normality Test

Results of analysis with SPSS series 30 to determine whether the data is normally distributed or not, it can be checked on Tabel 2.

Table 2. VO2Max Data Normality Test

VO2Max	P Value	Sig 5%	Information
Pre-Test	0.534	0.05	Normal
Post-Test	0.855	0.05	Normal

Based on the results in Tabel 2, the data pre-test and post-test shows a P-value (Sig.) > 0.05, making the research variables normally distributed.

Homogeneity Test

The results of the data homogeneity calculation using SPSS series 30 are as in Tabel 3.

Table 3. VO2Max Data Homogenity Test

Research Result	Df	F Tabel	F Hitung	*P*	Information
VO2Max	1:38	4.10	1,071	0.307	Homogeneous

From the results in Tabel 3. Data VO2Max of futsal extracurricular participants of SMA Negeri 5 Malang for the 2024/2025 academic year the F Hitung (1.071) < F Tabel (4.10) was obtained. From the results obtained, it can be concluded that the variance is homogeneous.

Hypothesis Testing

The next stage is hypothesis testing to assess the effect of the applied training method on increasing VO2Max through a t-test. The results of the t-test can be found in Tabel 4.

Table 4. Hypothesis of VO2Max Data

Research Result	Df	F Tabel	F Hitung	*P*	Sig 5%
VO2Max	19	1,729	6,588	<0.001	0.05

From the results of the t-test, it can be seen that t hitung (6.588) and t tabel (1.729) with a significance value of <0.001. Therefore, the t hitung (6.588) > t tabel (1.729) and the significance level (<0.001) < (0.05) are obtained, so it can be concluded that there is an effect of HIIT training on increasing VO2Max.

Dicussion

High-Intensity Interval Training (HIIT) is a training technique aimed at improving heart and lung health, consisting of a series of high-intensity exercise sessions performed in short durations, interspersed with active recovery phases involving lower-intensity exercises [8]. This program is designed to stimulate the heart to function optimally, thereby enhancing oxygen utilization and improving the body's metabolic processes. HIIT facilitates various physiological adaptations that support an increase in VO2Max, such as an increase in the number of mitochondria in skeletal muscles, improved oxygen delivery to body tissues, and enhanced cardiovascular function. The improvement in VO2Max through HIIT is influenced by several physiological changes in the body. One such change is an increase in stroke volume (SV) and heart contractions. During exercise, the heart adapts by strengthening its contraction power. Research conducted by de Mello, Righi, Schuch, Signori, and da Silva [9] revealed that interval training with higher intensity and longer duration is more effective for significantly increasing VO2Max. An increase in stroke volume, leading to higher cardiac output, occurs during high-intensity training. A continuous increase in training intensity causes the heart to adapt by improving stroke volume and the strength of cardiac output [10].

Increased heart rate and stroke volume during exercise result in a gradual increase in cardiac blood flow. This triggers the respiratory system to supply more oxygen to active muscles, particularly in the lower body. This enhanced oxygen delivery causes blood vessels in muscles to dilate, while those in other organs constrict, optimizing blood flow to muscle fibers. As oxygen delivery to tissues improves, VO2Max also increases, reaching its maximum capacity [11]. Running movements and arm stabilization during HIIT further increase oxygen demand, accelerating the oxygen diffusion process. Improved diffusion in the lungs enhances ventilation, leading to increased breathing frequency and depth.

Together, these processes contribute to a maximal increase in VO2Max.

Several studies have demonstrated the impact of High-Intensity Interval Training (HIIT) on improving VO2Max. Research by Wajib, Aditya, Sihombing, and Mes [12] confirmed that HIIT significantly and efficiently increases VO2Max in athletes. Their findings show that this training method enhances an athlete's maximal oxygen capacity, with greater improvements observed as exercise intensity increases. Additionally, research by Festiawan, Suharjana, Priyambada, and Febrianta [13] indicated that HIIT has a more significant effect on VO2Max improvement compared to Fartlek Training.

Based on the presented findings and explanations, it can be concluded that the HIIT program significantly impacts VO2Max improvement, particularly among futsal extracurricular participants at SMAN 5 Malang during the 2024/2025 Academic Year. Therefore, HIIT can be considered an effective and efficient training method for enhancing VO2Max capacity.

Conclusions

Based on the results of data analysis, explanation, research result test, and analysis, it can be concluded that there is an effect of High Intensity Interval Training on increasing VO2Max of futsal extracurricular participants at SMA Negeri 5 Malang in the 2024/2025 Academic Year.

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