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Application of Interval Training Method Based on Maximum Aerobic Speed Capacity on the Improvement of Anaerobic Lactic Capacity

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ABSTRACT

This study aims to determine the effect of implementing the short interval training (SIT) and long interval training (LIT) methods based on Maximum Aerobic Speed (MAS) on improving anaerobic lactic capacity in female futsal student-athletes who are members of the Futsal Student Activity Unit at the Indonesia University of Education. Data were collected in two stages: a pretest before the implementation of the training program and a posttest after completing 16 training sessions. The measurement instrument used in this study was the 35-meter Rast test. The study employed a one-group pretest-posttest design, and the data were analyzed using a paired sample t-test. The results showed an improvement in the average 35-meter Rast time from 7.95 seconds to 6.16 seconds, with statistically significant results (p = 0.749). This study provides a basis for designing more adaptive and physiologically-based training programs in sports that require explosive abilities, such as futsal.

Keywords: Interval Training; Maximum Aerobic Speed; Anaerobic Lactic

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INTRODUCTION

Interval training has long been recognized as one of the most effective training methods for improving both aerobic and anaerobic capacity. This method combines periods of high-intensity exercise with structured recovery intervals, allowing for more optimal physiological adaptations. With the increasing understanding of exercise physiology, many coaches and athletes have begun to implement interval training based on Maximum Aerobic Speed (MAS) capacity to enhance their sports performance (Yin et al., 2025). Interval training is an efficient training method because it is performed at high intensity over a short period of time interspersed with recovery; interval training involves repetition and recovery exercises (Rosdiana & Sidik, 2023).

Along with the advancement of coaching science, research on interval training has increasingly developed, particularly regarding its effectiveness in enhancing energy

metabolism and anaerobic lactic capacity. Several studies have shown that this method can have a significant impact on energy utilization efficiency and tolerance to fatigue (Wiesinger et al., 2025). However, there remains a research gap in understanding how MAS-based interval training specifically influences the improvement of anaerobic capacity, especially across different levels of athletes. Differences in physiological adaptations between individuals are one of the factors that have not been fully understood, thus further research is needed to identify more detailed responses to this method.

Previous studies have examined the effect of interval training on improving aerobic and anaerobic capacity, with results indicating that this method can provide significant benefits in enhancing athletic performance. For example, research by Bendo et al. (2025) showed that MAS-based interval training can significantly increase VO_2 max, contributing to improved aerobic endurance. Meanwhile, Eisenmann et al. (2024) found that this method also has a positive impact on muscle endurance and explosive strength in sports that rely on anaerobic lactic energy. Nevertheless, there is still limited research that specifically evaluates how MAS-based interval training can be applied to improve anaerobic capacity across various types of sports with different characteristics.

Maximum Aerobic Speed (MAS) is a physiological parameter used in designing endurance and anaerobic endurance training programs. MAS is defined as the minimum speed required to achieve maximal oxygen consumption (VO_2 max), which reflects the limit of an individual's aerobic capacity to produce energy efficiently (Darendeli et al., 2021). In the context of sports, especially those involving physical endurance such as middle-distance running, cycling, and team games, MAS serves as a key indicator in designing training intensity to improve both aerobic and anaerobic capacity (Falk Neto et al., 2024).

The study by Yu (2025) shows that interval training is a training method that combines periods of high-intensity exercise with intervals of active recovery or complete rest, aimed at improving the efficiency of the body's energy systems, particularly in enhancing aerobic and anaerobic endurance. High-intensity interval training increases the efficiency of the ATP-PCr system by enhancing the re-synthesis of phosphocreatine in the muscles after exercise periods, thereby enabling greater anaerobic energy production (Paiyarat et al., 2024).

In the context of dynamic and fast-paced sports such as futsal, the demand for the anaerobic lactic energy system becomes increasingly important. Futsal requires repeated explosive movements, both in attacking and defensive situations. The characteristics of this game, played indoors and at a high tempo, make anaerobic capacity one of the physiological foundations of athlete performance (Limbong et al., 2022). Futsal is played at high intensity, involving frequent accelerations, running, and quick changes of direction, with each player required to consistently perform both defensive and offensive actions (Sidik & Rosdiana, 2023).

Anaerobic capacity is the body's ability to produce energy in the absence of oxygen. In high-intensity, short-duration physical activities, the body relies on anaerobic metabolic pathways to meet energy demands rapidly. The two main systems in anaerobic metabolism are the ATP-PCr (adenosine triphosphate-phosphocreatine) system and anaerobic glycolysis. The ATP-PCr system provides energy very quickly through the breakdown of phosphocreatine stored in the muscles; however, its capacity is limited to only a few seconds. Once the phosphocreatine reserves are depleted, the body shifts to the anaerobic glycolysis pathway, which breaks down glucose into lactic acid to produce ATP at a high rate but causes lactate accumulation that can trigger muscle fatigue (Leone et al., 2025).

According to Muller et al. (2024), anaerobic capacity can be measured through various laboratory methods and field tests to assess the efficiency of anaerobic energy production as well as the body's recovery rate from fatigue accumulation caused by anaerobic metabolism.

One of the factors that contributes to the improvement of anaerobic lactic capacity is the training method used. Anaerobic endurance, often referred to as stamina, has a higher level of resilience compared to aerobic endurance. Based on this, this study aims to determine the effect of implementing the short interval training (SIT) and long interval training (LIT) methods based on Maximum Aerobic Speed (MAS) on improving anaerobic lactic capacity in female futsal student-athletes who are members of the Futsal Student Activity Unit at the Indonesia University of Education.

METHOD

This study uses a quantitative approach with an experimental method. The research design employed is a one-group pretest-posttest design, involving a single group without a control group. This design allows the researchers to compare performance before and after the treatment to observe the direct impact of the intervention provided.

Table 1. One-Group Pretest-Post-tests Design

Pre-test	Treatment	Post-test
O1	X	O2

Population is a group of individuals or objects with specific characteristics to be studied (Candra Susanto et al., 2024). The population in this study consisted of 24 female student-athletes from the UPI Futsal Student Activity Unit (UKM), aged between 18 and 21 years old. The 24 athletes were divided into three groups: The Short Interval Training group consisted of 8 athletes (5 with high MAS and 3 with low MAS), the Intermediate Interval Training group consisted of 8 athletes (4 with high MAS and 4 with low MAS), and the Long Interval Training group consisted of 8 athletes (4 with high MAS and 4 with low MAS). The research subjects for interval training with MAS capacity on anaerobic lactic were 16 athletes, with 8 athletes from the Short Interval Training group and 8 athletes from the Long Interval Training group. In accordance with the researched problem, the tests used to collect data were a pre-test and a post-test, using the Rast Test method. The selection of the Rast test instrument was based on its anaerobic lactic characteristics. RAST (Running-Based Anaerobic Sprint Test) is a field test designed to evaluate anaerobic power and capacity.

The data obtained were analyzed quantitatively using descriptive and inferential statistical approaches. Descriptive analysis was used to present the mean, standard deviation, minimum, and maximum values from the pretest and posttest results. Subsequently, a normality test was conducted using the Shapiro-Wilk test to ensure the data were normally distributed, considering the small sample size. To test the significance of the difference between the pretest and posttest, a paired sample t-test was employed, with a significance level of 0.05. All analysis procedures were carried out using SPSS 22 software to ensure the accuracy of statistical calculations (Fadluloh et al., 2024).

RESULTS AND DISCUSSION

Table 1. Descriptive Analysis Test

	N	Minimum	Maximum	Mean	Std. Deviation
pre_test	16	6437,00	8022,00	7165,2500	404,90386
post_test	16	3586,00	4164,00	3917,3750	152,00959
Valid N (listwise)	16				

Based on the results of the descriptive analysis in Table 1, the pre-test data show the lowest value of 6,437.00 and the highest value of 8,022.00, with an average value of 7,165.2500 and a standard deviation of 404.90386. Meanwhile, the post-test results show the lowest value of 3,586.00 and the highest value of 4,164.00, with an average value of 3,917.3750 and a standard deviation of 152.00959. These results indicate a difference between the pre-test and post-test after the treatment was administered over 16 sessions.

Table 2. Normality Test

Tests of Normality			
	Shapiro-Wilk		
	Statistic	df	Sig.
pre_test	0,970	16	0,846
post_test	0,965	16	0,749

The normality test was conducted using the Shapiro-Wilk test for small samples (n < 50). Based on the results in Table 2, the Shapiro-Wilk significance value for the pretest was 0.846 and for the posttest was 0.749. Since both significance values are greater than 0.05, the data are normally distributed. This indicates that the data are suitable for testing using parametric tests such as the paired sample t-test.

Tabel 3. Paired Samples Test

Paired Samples Test				
		Paired Differences		
		Mean	Std. Deviation	Sig.
Pair 1	pre_test - post_test	3247,875	296,31917	0,000

The results of the paired sample t-test in Table 3 show that the mean difference between the pretest and posttest was 3,247.875. The significance value (Sig.) was 0.000, which is less than 0.05. Therefore, statistically, there is a significant difference between the pretest and posttest results.

This study aims to determine the effect of implementing the short interval training (SIT) and long interval training (LIT) methods based on Maximum Aerobic Speed (MAS) on improving anaerobic lactic capacity in female futsal student-athletes who are members of the Women's Futsal Student Activity Unit at the Indonesia University of Education. Based on the results of the data analysis, it was found that the average value improved from 7.95 seconds in the pretest to 6.16 seconds in the posttest after the participants underwent the training program for 16 sessions. This improvement indicates a positive trend in anaerobic

lactic capacity, with statistically significant results (p = 0.846). This study provides a foundation for designing more adaptive and physiologically-based training programs in sports that require explosive abilities, such as futsal.

The performance improvement is in line with the concept that lactic anaerobic capacity is one of the most important components in athlete performance, especially in sports that require bursts of power in a short period of time (Anggraini & Widodo, 2021). The lactic anaerobic system, which produces energy without using oxygen, is indeed ideal for sports such as futsal that demand intensive and rapid activity.

The training methods used in this study are Short Interval Training (SIT) and Long Interval Training (LIT). Short Interval Training (SIT) is a more extreme form of HIIT with maximal intensity (100% of VO_2 max) over a very short duration (e.g., 10–30 second sprints), followed by longer rest periods, thus placing greater emphasis on improving anaerobic capacity (Zinner et al., 2022). Meanwhile, Long Interval Training (LIT) is characterized by high-intensity training with a relatively longer work duration, ranging from 2 to 5 minutes, at an intensity of 85–90% of maximal performance, and recovery time between 2 to 8 minutes (Brent S. Rushall and Frank S, 1990). These characteristics allow athletes to stimulate both aerobic and anaerobic energy systems simultaneously.

This is reinforced by the statement in the background that "lactic anaerobic capacity is closely related to the muscles' ability to produce energy without oxygen in a short period of time," and that "the interval method is a type of training that involves periods of high-intensity work followed by longer recovery periods. The application of this method is highly suitable for developing the capacity of the anaerobic system, particularly in futsal athletes who require high explosive power and speed over short durations." Therefore, the program used in this study is theoretically aligned with the physiological demands of futsal activities.

The results of the statistical analysis show a significant difference, with the average difference between the pretest and posttest being 3247.875. The significance value (Sig.) is 0.000, which is less than 0.05. Therefore, statistically, there is a significant difference between the pretest and posttest results. Interval training, both in short and long forms, provides significant physiological adaptation outcomes in athlete performance, particularly in both anaerobic and aerobic aspects.

The MAS-based method in endurance training is attributed to its relationship with the efficiency of the body's energy system. Athletes with higher MAS tend to have a better ability to utilize oxygen to produce energy, which contributes to improved endurance and delays fatigue caused by lactate accumulation. MAS-based training can enhance both aerobic and anaerobic metabolic efficiency, allowing for a more optimal energy transition between the two systems, as well as faster recovery after high-intensity training (Eisenmann et al., 2024). By understanding and utilizing MAS, coaches and athletes can design more effective training programs that optimize performance and minimize the risk of overtraining (Bok et al., 2023). In this study, MAS was used as the basis for determining the intensity of interval training, thus enabling more optimal adaptations in athlete groups with lactic anaerobic capacity.

In addition, it is important to note that an individual's physical ability also greatly influences training outcomes. As stated by Prakoso & Sugiyanto (2017), differences in ability mainly occur due to varying physical qualities, with internal conditions involving factors inherent within the individual. Based on the research results, interval training on lactic anaerobic capacity shows a significance value of (0.000) < 0.05, thus it can be

concluded that interval training has a significant effect on lactic anaerobic capacity in women's futsal.

In the context of futsal, lactic anaerobic capacity is crucial because the activities in the game tend to be intermittent with very short and intense bursts of energy. Futsal is a sport that requires players to actively participate in the game both defensively and offensively in a balanced manner, and it demands speed and explosive power in a short amount of time. Therefore, the development of anaerobic capacity through interval methods is contextually relevant to the needs of futsal athletes.

This study also reinforces the importance for futsal coaches to incorporate interval training into the team's regular schedule. This type of training, which combines high-intensity sprints with short rest intervals, is highly effective in improving players' anaerobic endurance. This ability is essential in futsal, where players are frequently required to sprint, cut, and change direction quickly. With an interval training program specifically designed to meet the demands of futsal, coaches can significantly enhance players' performance in terms of speed, endurance, and recovery on the court.

CONCLUSION

Thus, it can be concluded that the application of interval training methods based on Maximum Aerobic Speed (MAS) has proven effective in improving lactic anaerobic capacity in female futsal athletes. This is demonstrated by the reduction in time recorded during the 35-meter RAST test after the training program. Interval training optimally stimulates the anaerobic energy system, increases tolerance to lactic acid accumulation, and is suitable for athletes whose aerobic condition has not yet reached its maximum potential.

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