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Application of Long Interval Training Method Based on Low Maximum Aerobic Speed Capacity to Improve Anaerobic Capacity

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Abstract

This study aimed to analyze the effect of long interval training based on low maximum aerobic speed (MAS) on anaerobic capacity. The study employed an experimental method with a one group pretest–posttest design. The participants were 40 undergraduate students of Physical Conditioning Coaching at the Indonesian Education University, aged 18–21 years (mean age 19.33 years), selected using purposive sampling. Anaerobic capacity was measured as a single construct consisting of alactic and lactic anaerobic components, assessed using a 20 m sprint, 4 m × 5 shuttle run, 150 m sprint, and Running-Based Anaerobic Sprint Test (RAST) through the fatigue index. The training intervention consists of long interval training conducted over 16 sessions, with one session per day. The data were analyzed using SPSS version 20 through descriptive statistics and paired sample t-test at a significance level of 0.05. The results showed an increase in the mean anaerobic capacity score from pretest to posttest; however, the paired sample t-test revealed no statistically significant difference between measurements ($p > 0.05$). These findings indicate that long interval training based on low MAS tended to improve anaerobic capacity, although the effect was not statistically significant. Further studies with larger sample sizes, longer training duration, and controlled experimental designs are recommended to clarify the effectiveness of this training method.

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INTRODUCTION

High-performance sports are a crucial part of the development of modern civilization and play a strategic role in improving the quality of human resources. In the context of sports development, improving athlete performance is inseparable from the implementation of planned, systematic, and scientifically based training programs. One of the main components of performance development is physical training, which includes developing aerobic and anaerobic capacity as determinants of athlete success in high-intensity activities (Muminović, 2022).

Anaerobic capacity is the body's ability to produce energy without relying on oxygen through the phosphagen system and anaerobic glycolysis. This capacity plays a crucial role in various sports that require high power output over short to medium durations, such as sprints, team sports, and interval-based sports (Fajrin, 2018; Noordhof, 2013). Athletes with good anaerobic capacity are able to maintain optimal performance, delay fatigue, and increase recovery efficiency during high-intensity physical activity.

In planning and controlling exercise intensity, maximum aerobic speed (MAS) is an important indicator. MAS is defined as the minimum speed required for a person to achieve maximum oxygen consumption (VO_2max) and is often used as a basis for compiling interval training (Dellal, 2011; Léger & Boucher, 1988). Individuals with low MAS exhibit limitations in oxygen utilization efficiency, leading to a more rapid reliance on anaerobic energy systems during high-intensity activities. This condition can potentially lead to premature fatigue and limit physical performance if not balanced with appropriate training methods (Berthoin, 1995).

One training method considered effective for improving physical capacity is long interval training. This method involves long, high-intensity work intervals interspersed with active recovery periods, thus optimally stimulating cardiovascular and metabolic adaptations (Helgerud, 2001; Helgerud et al., 2019). In addition to contributing to increased aerobic capacity, long interval training also involves the anaerobic energy system, especially in the final phase of each work interval, thus potentially increasing fatigue tolerance and energy efficiency (Gibala, 2012).

Several previous studies have shown that interval training can improve athletes' aerobic and anaerobic capacity. However, most studies have focused on short interval training or sprint interval training, while studies specifically examining the effects of long interval training on individuals with low maximum aerobic speed capacity are still limited (Fang & Jiang, 2024; Støren, 2021). This situation indicates a research gap that requires further study, particularly regarding the effectiveness of long interval training in increasing anaerobic capacity in groups with limited aerobic capacity.

Based on this description, this study aims to analyze the effect of applying a long interval training method based on low-speed maximum aerobic capacity on increasing anaerobic capacity. The results of this study are expected to provide scientific contributions to the development of sports coaching science and serve as a practical reference for coaches and sports coaching students in designing more effective training programs that are tailored to individual physiological characteristics.

METHOD

This study uses an experimental method with a one-group pretest–posttest design to analyze the effect of long interval training based on low maximum aerobic speed (MAS) on anaerobic capacity (Sugiyono, 2018). The research subjects were 40 Bachelor of Physical Sports Coaching students from the Indonesian University of Education aged 18–21 years (average 19.33 years), who were selected using a purposive sampling technique (Pratama & Imanudin, 2018).

Anaerobic capacity was measured as a single construct encompassing both alactacid and lactacid anaerobic components, using the 20-meter sprint test and the 4-meter × 5-repetition shuttle run, as well as the 150-meter sprint and the Running-Based Anaerobic Sprint Test (RAST) via the fatigue index (Mackenzie, 2005; Mubarrok, 2018; Wood, 2013).

Long interval training was administered to all subjects over 16 sessions, with a frequency of one training session per day. Pretest and posttest data were analyzed using SPSS version 25 (Fadluloh et al., 2024), through ANOVA test and t test according to the research design, with a significance level of 0.05(Sugiyono, 2013).

RESULTS AND DISCUSSION

Table 1. Descriptive Analysis Test

	N	Min	Max	Mean	Standard Deviation
Pretest	8	1800	2630	2339.38	268,094
Post Test	8	2145	2675	2403.13	192,018

Based on the **Table 1** analysis results, the pretest data has an average value of 2339.38 with a standard deviation of 268.094, while the posttest data had an average value of 2403.13 with a standard deviation of 192.018. The increase in the average value in the posttest indicates a change in the measurement results after the treatment was given, while the decrease in the standard deviation value indicates that the posttest data is more homogeneous than the pretest data.

Based on the test results, the significance value of the pretest and posttest data showed a Sig. value > 0.05. This means that the pretest and posttest data were normally distributed, thus meeting the basic assumptions for continuing with parametric statistical testing, namely the Paired Sample t-Test.

Based on the results of the Paired Sample t-Test, a significance value (Sig. 2-tailed) of 0.539 was obtained, which is greater than 0.05. Thus, it can be concluded that there is no significant difference between the pretest and posttest scores. This means that the treatment given has not had a statistically significant effect on the measurement results.

This study aimed to examine the effect of long interval training based on low maximum aerobic speed (MAS) on anaerobic capacity using a one-group pretest–posttest design. The results of the descriptive analysis showed an increase in the mean anaerobic capacity score from pretest to posttest, indicating a positive trend following the training intervention. However, the paired sample t-test revealed that this increase was not statistically significant. These findings suggest that while long interval training may contribute to improvements in anaerobic capacity, the magnitude of adaptation achieved in this study was insufficient to produce statistically detectable changes, particularly within the given training duration and sample characteristics (Kenney et al., 2020).

From a physiological perspective, long interval training is primarily designed to enhance aerobic power and cardiovascular efficiency through sustained high-intensity workloads interspersed with recovery periods. Although this training model can indirectly stimulate anaerobic metabolism, especially during the latter stages of prolonged intervals, its primary adaptations tend to favor aerobic-related mechanisms rather than maximal anaerobic energy production (Helgerud et al., 2001; Støren, 2021). This may explain why the observed improvements in anaerobic capacity were modest and did not reach statistical significance.

The increase in mean posttest values suggests that repeated exposure to long interval training may have enhanced the subjects' tolerance to fatigue and energy utilization efficiency. Previous studies have reported that prolonged high-intensity interval exercise can improve metabolic buffering capacity and delay fatigue onset, which are indirectly related to anaerobic performance (Gibala, 2012; McArdle et al., 2015). However, these adaptations often require higher training volumes or longer intervention periods to manifest as significant improvements in measurable anaerobic outcomes.

Another important consideration is the use of low MAS as the basis for training intensity. Individuals with low MAS generally exhibit limited oxygen delivery and utilization capacity, which may cause earlier reliance on anaerobic pathways during exercise (Berthoin, 1995; Dellal, 2011). While this condition theoretically supports anaerobic system stimulation, previous research indicates that athletes or physically active individuals with low aerobic capacity may require gradual and progressive overload to elicit substantial anaerobic adaptations (Noordhof, 2013). The fixed duration of 16 training sessions in this study may not have been sufficient to generate optimal physiological stress for significant anaerobic development.

The absence of statistically significant results may also be influenced by inter-individual variability in training response. Exercise adaptation is known to be highly individual, depending on genetic factors, training history, recovery quality, and neuromuscular efficiency (Kenney et al., 2020). (Fang & Jiang, 2024) emphasized that interval training responses vary considerably across individuals, particularly when anaerobic capacity is assessed using composite test batteries, as was the case in this study.

Methodologically, the one-group pretest–posttest design limits the ability to attribute observed changes solely to the training intervention. Without a control group, external factors such as daily physical activity, recovery status, and academic workload may have influenced the results (A. Bompa T, O & Buzzichieli, 2019). Similar studies employing controlled experimental designs have demonstrated clearer effects of interval training on anaerobic performance when compared with control or alternative training methods (Fang & Jiang, 2024; Støren, 2021).

Despite the lack of statistical significance, the descriptive improvements observed in this study align with previous findings that long interval training can contribute to overall physical conditioning and energy system efficiency (Helgerud et al., 2019). Therefore, long interval training should not be dismissed as ineffective for anaerobic development, but rather viewed as a complementary method that may require integration with short interval or sprint-based training to maximize anaerobic adaptations (Gibala, 2012).

In summary, the findings of this study indicate that long interval training based on low MAS tends to improve anaerobic capacity, although the effect was not statistically significant. These results highlight the importance of training specificity, adequate intervention duration, and appropriate experimental control in detecting meaningful physiological adaptations. Future studies are recommended to employ longer training periods, larger sample sizes, and comparative designs to further clarify the role of long interval training in anaerobic capacity development (Kenney et al., 2020; Bompa & Haff, 2019).

CONCLUSION

The results showed an increase in mean anaerobic capacity values from pretest to posttest, indicating a positive adaptation trend following the training intervention. However, statistical analysis revealed that these improvements were not statistically influential, suggesting that long interval training based on low MAS alone may be insufficient to elicit substantial anaerobic capacity enhancements within the applied training duration.

Although no influential effect was observed, the descriptive improvements indicate that long interval training has the potential to support fatigue tolerance and overall energy system efficiency. Therefore, this method may function as a complementary training approach rather than a primary strategy for anaerobic development. Future studies should apply controlled experimental designs, larger sample sizes, longer intervention periods, and more anaerobic-specific training combinations to better determine the effectiveness of long interval training in improving anaerobic capacity.

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