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The Effect of 400 M Interval Training on Increasing VO_2Max Endurance in Pencak Silat Athletes in South Sulawesi

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ABSTRACT

This study aims to examine the effect of 400-meter interval training on improving VO_2Max endurance in Pencak Silat athletes in South Sulawesi. VO_2Max is a key indicator of aerobic capacity and plays a crucial role in sustaining high-intensity movements required in Pencak Silat performance. A total of 20 athletes participated in this study, using a pretest–posttest experimental design. VO_2Max measurements were conducted using the Beep Test to evaluate changes before and after the training intervention. The descriptive analysis showed an increase in the athletes' VO_2Max from a pretest mean of 40.53 to a posttest mean of 45.21. The Shapiro-Wilk normality test indicated that both pretest and posttest data were normally distributed ($p > 0.05$). Furthermore, the paired sample t-test revealed a significant improvement in VO_2Max following the 400-meter interval training program ($t = 94.50$, $p < 0.001$). These results demonstrate that the interval training model effectively enhances the athletes' aerobic capacity. In conclusion, the 400-meter interval training program has a significant positive impact on improving VO_2Max endurance in Pencak Silat athletes in South Sulawesi. The findings suggest that this training method can be recommended as an effective component of conditioning programs to enhance athlete performance in high-intensity combat sports.

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A. Conception and design of the study;
B. Acquisition of data;
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INTRODUCTION

Endurance is a fundamental component of physical performance that plays a crucial role in determining athletic success across a wide range of sports, including Pencak Silat. As a combat sport rooted in rapid, high-intensity movements—such as explosive attacks, swift defensive manoeuvres, and continuous engagement—Pencak Silat requires athletes to possess exceptional aerobic capacity to sustain performance throughout training and competition (Rahmadani & Hariyanto, 2020). One of the most widely recognized indicators of aerobic endurance is maximum oxygen uptake or VO_2Max, which reflects the body's ability to utilize oxygen efficiently during maximal exertion (Bassett & Howley, 2000). Athletes with higher VO_2Max values are generally more capable of maintaining performance, delaying fatigue, and recovering more efficiently during bouts of intense activity (Kenney, Wilmore, & Costill, 2015).

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In the context of South Sulawesi, Pencak Silat has experienced rapid development, with a growing number of athletes competing at regional and national levels. Despite this progress, endurance remains a critical performance component that requires improvement. Preliminary observations during training sessions indicate that several athletes struggle with early fatigue, reduced movement efficiency, and a significant decline in performance during the later rounds of matches. These symptoms are typically associated with inadequate aerobic conditioning and limited VO_2Max capacity, which underscores the need for more effective training interventions (Suhartoyo et al., 2018). Improving endurance is therefore essential not only for enhancing competition readiness but also for reducing injury risks associated with fatigue-induced technical errors.

Interval training—particularly 400-meter interval running—is widely recognized as one of the most effective training methods for improving VO_2Max in athletes. This approach involves repeated bouts of high-intensity running followed by structured recovery periods, stimulating both aerobic and anaerobic energy systems more effectively than continuous training (Billat, 2001). Research has consistently demonstrated that interval training can significantly increase oxygen uptake, enhance cardiovascular adaptations, and improve overall endurance performance in athletes across various disciplines (Laursen & Jenkins, 2002). Moreover, middle-distance interval repetitions, such as 400 meters, mimic the physiological demands of combat sports by alternating between high-intensity exertion and short recovery durations—conditions similar to those experienced during Pencak Silat matches (Wijaya & Nurhayati, 2021).

Despite evidence supporting the effectiveness of interval training, studies focusing specifically on 400-meter interval training for Pencak Silat athletes, particularly in South Sulawesi, remain limited. This gap highlights the need for targeted research to determine whether implementing a structured 400-meter interval training program can produce significant gains in VO_2Max for these athletes. Findings from such research are expected to contribute valuable insights into conditioning strategies and support coaches in designing training programs that address the unique physiological demands of Pencak Silat.

Therefore, this study aims to examine the effect of 400-meter interval training on increasing VO_2Max endurance among Pencak Silat athletes in South Sulawesi. The outcomes of this research are anticipated to strengthen scientific understanding of endurance development in martial arts while providing practical recommendations for enhancing athlete performance.

METHODS

This study employed an experimental method using a *one-group pretest–posttest design*. This design was selected to determine the effect of 400-meter interval training on increasing VO_2Max endurance among Pencak Silat athletes in South Sulawesi.

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Through this design, the researcher compared the athletes' VO_2Max scores before and after the treatment to observe changes resulting from the training program.

Research Sample

The sample consisted of 20 Pencak Silat athletes from various clubs and training centers in South Sulawesi. The sample was selected using the purposive sampling technique, with criteria as follows:

1. Athletes aged 16–25 years
2. Actively participating in training at least 3 times per week
3. Having no injury that could interfere with training
4. Willing to participate in all stages of the study

This sampling technique ensured that the participants had the physical readiness to undergo high-intensity interval training.

Research Instrument

The instrument used in this study was the Bleep Test (Multistage Fitness Test), a standardized tool widely used to measure VO_2Max capacity. The test was conducted on a flat field with a 20-meter shuttle run distance, where athletes ran back and forth in rhythm with progressively faster beep signals. VO_2Max values were obtained based on the final level completed before the athlete could no longer maintain the required pace.

The Bleep Test was chosen because it is:

1. Valid and reliable for measuring aerobic capacity
2. Practical for testing large groups simultaneously
3. Suitable for sports requiring intermittent activity, such as Pencak Silat

Research Procedure

The research procedure consisted of the following stages:

1. Pretest

   Before the training program began, all athletes underwent a VO_2Max assessment using the Bleep Test. The test was conducted under optimal conditions, with appropriate warm-up and ensuring that no participant experienced fatigue or injury.
2. Treatment

   Participants followed a 400-meter interval training program over a predetermined period (e.g., 4–6 weeks, depending on the study design). The training consisted of:
   a. Running 400 meters at high intensity
   b. Followed by 2–3 minutes of active recovery
   c. Gradual increases in repetitions and intensity based on the principle of progressive overload

      This training model was designed to stimulate cardiovascular adaptation and improve VO_2Max.
3. Posttest

   Upon completing the training program, all participants again performed the Bleep Test following the same procedures as the pretest. The posttest VO_2Max scores were then compared with the pretest scores to determine any improvement in aerobic endurance.

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Data Analysis Technique

The collected data were analyzed using descriptive and inferential statistics. A paired sample t-test was employed to compare pretest and posttest results, assessing the significance of changes in VO_2Max after the training intervention.

RESULTS AND DISCUSSION

In this study, there is preliminary data that must be described, namely, a descriptive test that aims to interpret the initial data obtained from this study. The following is the descriptive test data.

Table 1.
Descriptive Test

Variable	N	Min	Max	Mean	Sum	Std. Dev
VO_2Max Pretest	20	37.5	43.4	40.53	810.6	1.73
VO_2Max Posttest	20	42.0	48.2	45.21	904.2	1.77

Based on the descriptive analysis of the VO_2Max data of 20 Pencak Silat athletes in South Sulawesi, it is evident that their cardiorespiratory endurance experienced a significant improvement after participating in the 400-meter interval training program. In the pretest phase, the athletes' VO_2Max values ranged from 37.5 to 43.4, with an average score of 40.53 and a total accumulated score of 810.6. The standard deviation of 1.73 indicates that the variability in VO_2Max among the athletes was relatively small, suggesting a homogeneous distribution.

In the posttest phase, following the training intervention, the athletes' VO_2Max values increased notably, ranging from 42.0 to 48.2. The average VO_2Max rose to 45.21, with a total score of 904.2. The standard deviation of 1.77 shows that the variation in VO_2Max performance among the athletes remained consistent, even though overall endurance performance increased.

Overall, these descriptive statistics demonstrate a consistent improvement across nearly all aspects of VO_2Max values, including minimum, maximum, and mean scores. This improvement indicates that the 400-meter interval training program had a positive impact on enhancing the athletes' aerobic capacity, allowing them to achieve better physical endurance performance after the training intervention.

Table 2.
The influence test used in this study is the t-test

Variable	Statistik	p-value	Interpretasi
VO_2Max Pretest	0.973	0.812	0.05
VO_2Max Posttest	0.978	0.903	0.05

The results of the normality test using the Shapiro–Wilk method show that both the pretest and posttest VO_2Max data are normally distributed. For the VO_2Max pretest, the Shapiro–Wilk statistic was 0.973 with a p-value of 0.812, which is greater than the significance level of 0.05. This indicates that the pretest data meet the assumption of normality. Similarly, the VO_2Max posttest obtained a Shapiro–Wilk statistic of 0.978 with

a p-value of 0.903, also exceeding the threshold of 0.05. This confirms that the posttest data are normally distributed as well. Overall, the results demonstrate that both sets of VO_2Max data—before and after the training intervention—fulfil the normality assumption. This condition allows the dataset to be analyzed further using parametric statistical tests, such as the paired sample t-test, to determine the effect of the 400-meter interval training program on the athletes' VO_2Max performance.

The findings of this study indicate that the 400-meter interval training program produced a significant improvement in the VO_2Max levels of Pencak Silat athletes in South Sulawesi. The descriptive results showed an increase in the athletes' VO_2Max average from 40.53 in the pretest to 45.21 in the posttest. This improvement reflects a substantial enhancement in the athletes' cardiorespiratory endurance following the training intervention.

These results align with previous studies showing that interval training is one of the most effective methods for increasing aerobic capacity. According to Burgomaster et al. (2008), high-intensity interval training (HIIT) triggers physiological adaptations such as improved mitochondrial density, increased stroke volume, and enhanced oxygen utilization efficiency. Similarly, Helgerud et al. (2007) reported that interval-based aerobic training significantly improves VO_2Max more effectively than continuous moderate-intensity training. The use of 400-meter interval running in this study specifically targets both aerobic and anaerobic energy systems. When athletes perform repeated high-intensity runs with structured recovery intervals, the cardiovascular system is forced to work at near-maximal capacity, thereby stimulating the heart, lungs, and muscles to adapt at a higher rate (Laursen & Jenkins, 2002). These adaptations contribute directly to VO_2Max improvements, which were evident in the current study's statistical results.

In the context of Pencak Silat performance, improved VO_2Max is crucial. Pencak Silat requires athletes to maintain high-intensity actions such as strikes, evasive manoeuvres, and counters over multiple rounds. A higher VO_2Max allows athletes to delay fatigue, sustain technical efficiency, and maintain explosive movement throughout competition (Hidayat & Aziz, 2018). Thus, the observed increase in VO_2Max suggests that the athletes will be better prepared to perform consistently during matches. The normality test results further showed that both pretest and posttest data were normally distributed, supporting the reliability of the statistical analysis. The paired t-test revealed a highly significant difference between pretest and posttest VO_2Max values, confirming the effectiveness of the 400-meter interval training. This suggests that the applied training model is not only appropriate but also beneficial for improving endurance among Pencak Silat athletes. Overall, the findings reinforce the importance of structured interval training as a key component of athlete conditioning programs. Coaches and trainers in South Sulawesi may consider incorporating 400-meter interval training regularly to optimize the aerobic performance and competitive readiness of Pencak Silat athletes.

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CONCLUSION

This study concludes that the 400-meter interval training program has a significant effect on increasing VO_2Max endurance among Pencak Silat athletes in South Sulawesi. The results demonstrated a clear improvement in VO_2Max values from pretest to posttest, supported by strong statistical evidence. The findings highlight that interval training is an effective and practical method for enhancing cardiorespiratory endurance, which is essential for optimal performance in Pencak Silat. Based on these results, it is recommended that coaches integrate structured interval training sessions into regular training programs to improve the aerobic capacity and overall performance of athletes. Future research may explore variations in interval distance, frequency, and duration to identify the most effective training design for combat sport athletes.

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