

The Impact of Applying High Intensity Interval Training with Integrated Volume on Improving the Endurance Athletes

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Abstract This study to ascertain how Tarung Derajat athletes' endurance was affected by using the High Intensity Interval Training technique with integrated volume. An experimental strategy using a One Group Pre-test Post-test Design was the research methodology employed. Eight athletes who met the inclusion criteria West Java SPOBDA athletes who had competed in multiple provincial championships and the exclusion criteria adults without any competitive experience and athletes who were currently injured were included in the research sample, which was selected using a total sampling technique. This study's lack of a control group makes it more difficult to establish a clear relationship. Nonetheless, the findings provide initial empirical evidence that Tarung Derajat athletes' endurance may be improved by doing High Intensity Interval Training with Integrated Volume. The Multi-stage Fitness Test was the test tool utilized. There were ten training sessions during the course of the four-week program. Utilizing the concept of progressive overload in conjunction with an integrated volume approach that integrates exercise time and intensity in each session. Data analysis included descriptive statistics, normality tests, homogeneity tests, and hypothesis testing with paired sample t-tests. The average VO₂max value increased from 44.26 to 51.05 in the post-test. The hypothesis test results showed a significance value of 0.000 ($p < 0.05$), indicating that the application of the High Intensity Interval Training approach with integrated volume increased the endurance of Tarung Derajat athletes. Thus, it can be concluded that the High Intensity Interval Training program with integrated volume increased the cardiovascular endurance of athletes.

Keywords: Tarung Derajat; High Intensity Inteval Training; Integrated Volume ; Endurance ; VO₂max



INTRODUCTION

When an athlete's performance has reached a high competitive level, they must be in good physical condition, especially in terms of endurance. This is in line with a study conducted by Liu and Jia (2023) which revealed that when taekwondo athletes are in excellent physical shape, they are able to perform the movements and deliver the performance they have been training for. Good physical condition is an important aspect that athletes must have in order to achieve their desired peak performance. One of the dominant physical conditions that a martial artist must have is good endurance (Sidik, 2019).

Tarung Derajat is an Indonesian sport created by Achmad Derajat or AA Boxer (Azhari et al., 2018; Chairad, 2014). Tarung Derajat is a full-body contact sport that requires high-intensity performance. Tarung Derajat is characterized as a martial art with fast, realistic, and rational movements, and is classified as a high-intensity sport (Punassari et al., 2023; Tampani et al., 2024). Therefore, considering the characteristics of Tarung Derajat, athletes need to be in good physical condition so that they do not experience excessive fatigue during competitions.

Currently, the effectiveness of High Intensity Interval Training is widely recognized and supported by many researchers. This is in line with previous studies that reveal that High Intensity Interval Training can increase VO₂Max and AP in athletes with minimal impact on body composition (Vasconcelos et al., 2020). Additionally, a study conducted by Wijianto, (2024) on karate athletes, although focused on karate, revealed that HIIT can improve aerobic capacity (endurance) due to the characteristics of martial arts as a group of sports. Therefore, over time, the use of High Intensity Interval Training has been widely adopted as part of training methods to improve athletes' endurance (García-Pinillos et al., 2017; Herlan & Komarudin, 2020).

Although some Tarung Derajat athletes already have good physical condition, not all of them achieve ideal endurance levels due to the selection of training methods with volumes that are not yet integrated. However, most Tarung Derajat athletes have good endurance levels. These results support the idea that endurance levels have a significant influence on their future competition performance. Therefore, to maximize the physical components that still vary, a more focused and organized training program is needed. In a study conducted by Putri & Wiriawan, (2024) it was revealed that Surabaya City KONI combat athletes need to improve their VO₂max because most athletes are in the lower category (50 ml/kg/minute) and one person has a high value (61.4 ml/kg/minute). Therefore, athletes must focus on improving their endurance in order to perform optimally during competitions. A non-integrated training program can lead to damage to athletes' physiological adaptation, excessive fatigue, and even overtraining.

According to a study conducted by Relida et al., (2022) High Intensity Interval Training can improve athletes' capacity to perform explosive movements such as kicking, punching, and striking, as well as increase muscle oxygen delivery and stroke volume. This is also in line with a previous study conducted by Khapipudin et al., (2022) which revealed that High Intensity Interval Training can improve VO₂Max quality by increasing the body's metabolism through high-intensity training in each movement, but with rest between sessions to ensure that athletes do not feel overwhelmed by doing this exercise. However, most previous studies have focused on comparing exercise programs or manipulating intensity separately. Particularly in the context of martial arts that involve intermittent high-intensity efforts such as Tarung Derajat, aspects of exercise volume integration including work-rest ratios, number of sets, total session duration, and training frequency in program cycles have not been studied in depth.

Providing athletes with appropriate endurance training methods is an important aspect in achieving peak performance in the future. This also affects the training stimulus, which represents the interaction between training volume (km per week), training frequency, and training intensity designed to improve the physiological factors that determine performance and performance in long-distance runners (Casado et al., 2023). This has a significant impact on the influence of providing training methods that are appropriate to the characteristics of the sport and the physiology of the athlete on the athlete's future performance. Providing the wrong training program will have an impact on the athlete's performance on the field and also on their physiological condition.

The integrated training approach is one of the most well-known training strategies and is supported by various studies. This is in line with previous studies that reveal that integrated training strategies are increasingly relevant, as they enable the synergistic development of various motor and physiological qualities necessary for optimal performance (X. Liu et al., 2025; Scano et al., 2024). This training approach involves a smart combination of physical training within a periodization planning framework, tailored to the specific characteristics of rugby.

There have been many studies discussing the effectiveness of High Intensity Interval Training, but most studies only focus on one aspect. Meanwhile, the effectiveness of High Intensity Interval Training designed with integrated volume and later adjusted specifically to the physiological demands of Tarung Derajat competition is still rarely studied. This is also in line with a study conducted by MacInnis & Gibala, (2017) which revealed that further research is needed to determine the effects of these training variables on peripheral and central adaptations to training, especially interval training. Specifically, we cannot determine whether interval training should be performed at a higher frequency or for a longer duration.

The impact of systematically applying training volume in High Intensity Interval Training techniques on Tarung Derajat athletes has not been discussed in existing research, which generally focuses only on training intensity. The effects of High Intensity Interval Training with integrated volume on improving the endurance of Tarung Derajat athletes have not been empirically studied. Therefore, there is still no comparative research examining the volume of High Intensity Interval Training on improving endurance in the sport of Tarung Derajat. This necessitates further study to determine the most effective training approach for improving the endurance of Tarung Derajat athletes.

A four-week session of High Intensity Interval Training cycling appears to maintain running and cycling performance during tapering, between seasons, or during modified training phases, such as injuries that require changes in exercise mode or volume (Mallol et al., 2019). Researchers compared two variables, namely high-volume and low-volume training, in triathletes.

Therefore, there is a novelty in this study, namely the combination of the two volumes, which will be carried out using an integrated training approach that is compiled into a single training program. This study aims to determine the significance of the effect of applying the High Intensity Interval Training method with an integrated volume on improving the endurance of Tarung Derajat athletes. This study highlights the importance of adjusting training volume to the characteristics and physiological needs of Tarung Derajat athletes, in addition to examining the impact of High Intensity Interval Training on endurance, which was conducted over a period of 4 weeks.

METHOD

This study used a quantitative method with a quasi-experimental approach and a one-group pretest-posttest design. This design involves one group that is given a pretest, treatment, and posttest to determine the effect of the treatment on the variables studied (Fraenkel et al., 2017). The population in this study consisted of eight Tarung Derajat SPOBDA West Java athletes, so the sampling technique used total sampling. Male and female athletes who were at least 15 years old and had competed in provincial-level competitions made up the study's sample. In order to ensure uniformity in the subjects' exposure to competitive circumstances, inclusion criteria were developed based on competition experience in formal events. Athletes who were injured at the time of data collection and those with no prior competition experience were excluded. These exclusion criteria were established in an effort to reduce confounding variables and biases that might compromise the validity of the study's findings. This study also took into account the potential influence of external factors that could affect the measurement results, such as the athletes' physical and mental health, training frequency and intensity, dietary habits, and sleep

quality. The validity of the study's conclusions was enhanced by standardizing the process of controlling for external variables specifically, by providing the same instructions to all participants and collecting data under relatively controlled conditions.

The research procedure began with a pretest to measure the athletes' VO₂Max levels. Next, a treatment in the form of High Intensity Interval Training was given for 4 weeks with a total of 10 sessions. The intensity zones adhere to ACSM recommendations (85%-95%). Following the High-Intensity Interval Training approach, each interval lasts 25-40 seconds (Wen et al., 2024). The distance is 10 meters, and the rest period is decided by the time it takes for the heart rate to recover to normal. In this study, training volume was defined as the total training load (repetitions + sets + time) utilizing shuttle runs, punching, and kicking exercises to incorporate several biomechanical characteristics (endurance, speed, agility, and coordination). In this integrated training approach, a training load progression was used that increased gradually over ten sessions (increasing from the initial phase to the middle phase, followed by a reduction during the last two sessions as part of a tapering program). After the treatment was completed, a posttest was conducted to determine changes in the athletes' endurance. The instrument used to measure endurance was the Multistage Fitness Test (MSFT) with a validity value of 0.77 and reliability of 0.98 (Rohmah & Hamdani, 2022). Data analysis was performed using descriptive statistics, the Shapiro–Wilk normality test, and the Levene homogeneity test using SPSS 25. Hypothesis testing was performed using the Paired Sample t-test with a significance level of 0.05.

Research Ethics Statement

This study has received ethical approval from the appropriate institutional review board, and all procedures were conducted in accordance with established ethical standards, with informed consent obtained from all participants and their confidentiality strictly maintained throughout the study.

RESULT AND DISCUSSION

Result

After obtaining the data, the author processed and analyzed it. The statistical description of the research data can be seen in Table 1.

Table 1.

Descriptive Statistics Results

	N	Minimum	Maximum	Sum	Mean	Std. Deviation	Variance
Pretest	8	39,48	54,88	354,12	44,2650	5,69395	32,421
Posttest	8	45,50	62,50	408,40	51,0500	6,30306	39,729

Based on Table 1. Descriptive Test above. The results for eight athletes show an average of 44.2650, a total of 354.12, a minimum value of 39.48, and a maximum value of 54.88. The variance of 32.421 and the pre-test standard deviation of 5.69395 indicate the level of data dispersion from the mean. Conversely, the post-test results show a minimum score of 45.50 and a maximum score of 62.50, with a mean of 51.0500 and a total of 408.40. The posttest variance and standard deviation were 39.729 and 6.30306, respectively. The results indicate improvement after the implementation of High Intensity Interval Training with integrated volume, as evidenced by the higher posttest mean than the pretest mean. This is further explained in Table 2.

Table 2.
Shapiro Wilk Normality Test Results

Variabel	Statistik	df	Sig.
Pretest	0.836	8	0.068
Posttest	0.854	8	0.104

Based on Table 2. Normality test using the Shapiro-Wilk test, the significance value (Sig.) in the pretest data is 0.068 with a statistical value of 0.836 and $df = 8$, but in the posttest data, the significance value is 0.104 with a statistical value of 0.854 and $df = 8$. Because the significance values for both data sets are greater than 0.05, it can be concluded that the pretest and posttest data are normally distributed, meeting the requirements for further parametric statistical analysis. Next, we proceed to Table 3.

Table 3.
Homogeneity Test Results

Variabel	Levene Statistic	df1	df2	Sig.
Pretest-Posttest	0.141	1	14	0.713

Based on Table 3. Homogeneity test using Levene's test, the significance value (Sig.) obtained is 0.713 based on the mean, 0.799 based on the median, 0.799 based on the median with adjusted degrees of freedom, and 0.730 based on the truncated mean. All of these significance values are greater than 0.05, indicating that the pretest and posttest data have similar variances. This is continued in Table 4.

Tabel 4.
Paired Samples Test Results

Variabel	t	df	Sig. (2-tailed)
Pretest – Posttest	-28.944	7	0.000

Based on Table 4. the hypothesis test using the Paired Samples Test produced a t-value of -28.944 with $df = 7$ and a 2-tailed Sig. value of 0.000. The significance level is less than 0.05,

indicating that there is a significant difference between the pretest and posttest values. Therefore, the High Intensity Interval Training program with an integrated volume of 10 sessions given to degree fighting athletes has a significant impact on the results of improving athletes' endurance.

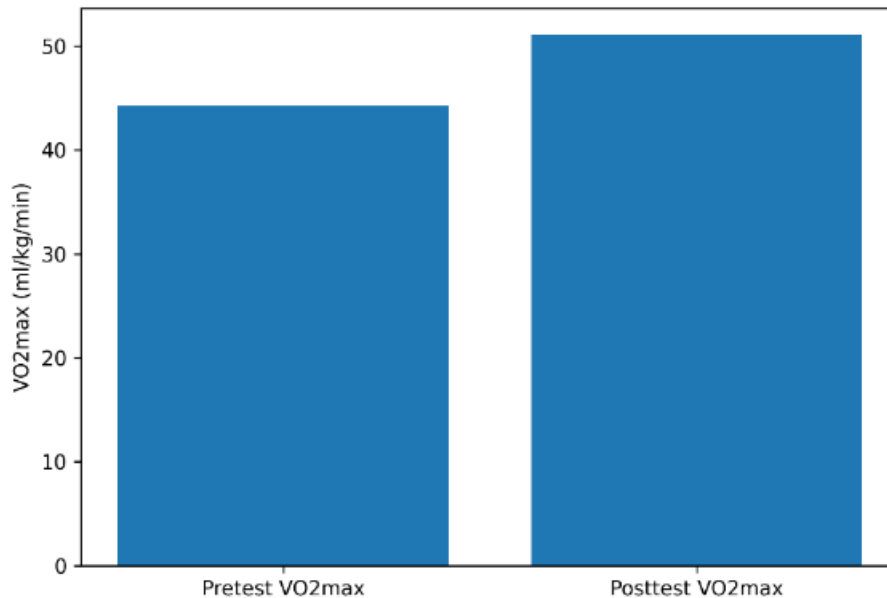


Figure 1. Pretest-Posttest Improvement

Based on the results of the study, there was an increase in the average $VO_2\text{max}$ value of Tarung Derajat athletes after participating in a High Intensity Interval Training (HIIT) program with integrated volume. $VO_2\text{max}$ is a key indicator of cardiovascular endurance that describes the body's ability to use oxygen to the maximum during intense physical activity. The pretest results showed that the average $VO_2\text{max}$ of the athletes was 44.26 ml/kg/minute, which describes the initial endurance level of the athletes before the training treatment. After participating in the HIIT training program during the study period, the average $VO_2\text{max}$ value increased to 51.05 ml/kg/min in the post-test. Thus, there was an increase of 6.79 ml/kg/min, indicating an improvement in the athletes' aerobic endurance after participating in the training program.

The increase in $VO_2\text{max}$ observed in this study was not coincidental, but rather the result of a systematic and structured training program. High-intensity interval training (HIIT) is known to be an effective method for improving aerobic capacity because it involves high-intensity activities interspersed with recovery periods (Mappaompo, 2025; Wibawa, 2025). This training pattern can stimulate physiological adaptations in the cardiovascular system, such as increased lung capacity, cardiac efficiency, and the ability of muscles to utilize oxygen more optimally during physical activity (Hellsten & Nyberg, 2016; Smith & Fernhall, 2023).

The results of this study are in line with research conducted by Mallol et al., (2019) entitled "Comparison of Low-Volume High-Intensity Interval Training and High-Volume Training on the

Endurance Performance of Triathletes.” The study showed that the application of HIIT, both high and low volume, was able to improve the endurance performance of triathletes during a four-week training period. These findings reinforce the fact that programmed high-intensity training positively contributes to improving athletes' aerobic capacity.

The main difference between this study and previous studies lies in the use of an integrated training volume approach in designing the training program. This approach refers to the concept of integrated training proposed by Bompa & Buzzichelli, (2019) which states that training must combine various training components in an integrated manner and be adapted to the periodization of athletes' biomotor abilities. In this study, the HIIT program was designed by integrating several biomotor components such as endurance, speed, agility, and coordination into a single exercise series (Rosdiana et al., 2019). The training activities used included shuttle runs, punches, and kicks, which were in line with the characteristics of Tarung Derajat.

Furthermore, the training program is designed based on the principle of progressive training load, where the intensity and volume of training increase gradually from the initial to the middle sessions. In the last two sessions, the training volume is reduced as a form of tapering to reduce fatigue and maximize the athletes' physiological adaptation process. This approach allows athletes to obtain optimal training stimulus without experiencing excessive fatigue. Endurance abilities in athletes serve to enhance cardiovascular capacity, strength, flexibility, and stamina, helping them resist fatigue during training and competition. Endurance is an athlete's ability to maintain physical effort over an extended period without quickly becoming fatigued (Tangan et al., 2017)

Overall, the results of the study show that the High Intensity Interval Training (HIIT) program with integrated volume has a positive effect on increasing the $VO_2\text{max}$ of Tarung Derajat athletes. This can be seen from the increase in $VO_2\text{max}$ values between the pretest and posttest results shown in Figure 1. The graph shows that after 10 training sessions, the athletes' aerobic endurance capacity increased significantly. Therefore, the application of HIIT with an integrated training volume approach can be an effective alternative training method for improving the cardiovascular endurance of Tarung Derajat athletes.

CONCLUSION

Research shows that the use of High Intensity Interval Training with integrated training volume significantly improves cardiovascular endurance ($VO_2\text{max}$) in Tarung Derajat athletes. Pretest and posttest data show an increase in the average $VO_2\text{max}$ value, supported by hypothesis testing with a significance level of less than 0.05. Therefore, the research hypothesis that the use of High Intensity Interval Training with integrated volume has an effect on improving the

endurance of Tarung Derajat athletes can be accepted, indicating that the training program used in this study is effective in improving the endurance of athletes.

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