



The Effect of Circuit Training on Cardiovascular Endurance in Long-Term Regional Judo Training Athletes

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Abstract

Cardiovascular endurance is one of the physical condition components that is essential for judo athletes, since this sport demands repeated explosive movements with only brief rest intervals. This study aims to determine and analyze the effect of circuit training on the improvement of cardiovascular endurance (VO₂max) among long-term Pelatda judo athletes. This research employed a quantitative approach with an experimental method and a one-group pretest-posttest design. The research subjects consisted of 20 long-term Pelatda judo athletes, comprising both male and female athletes, selected using a total sampling technique. Cardiovascular endurance was measured using the Multistage Fitness Test (MFT)/Bleep Test to obtain VO₂max values. The circuit training program was conducted for 8 weeks with a frequency of 3–4 sessions per week. Data were analyzed using normality tests, homogeneity tests, and the paired sample t-test. The results showed that the athletes' mean VO₂max before the training was 40.53 ml/kg/min and increased to 44.98 ml/kg/min after 8 weeks of circuit training, an average increase of 4.45 ml/kg/min. The t-test results showed a tcount value of 9.87, greater than the ttable value of 1.729 at a 5% significance level, so that H_a was accepted and H_o was rejected. It can therefore be concluded that circuit training has a significant effect on improving the cardiovascular endurance (VO₂max) of long-term Pelatda judo athletes.

Keywords: Circuit Training, Cardiovascular Endurance, VO₂max, Judo Athletes

Introduction

Sports are a vital aspect of human life, serving to enhance physical fitness, health, and performance. In the context of competitive sports, physical conditioning is a primary factor determining an athlete's success in achieving optimal performance. Good physical conditioning not only supports technical and tactical abilities but also enables athletes to sustain their performance throughout a competition. Consequently, physical training is an integral part of an athlete's training regimen (Jurdan Martin siahaan, 2023)

One of the most critical components of physical fitness in sports is cardiovascular endurance. Cardiovascular endurance refers to the ability of the heart, lungs, and circulatory system to supply oxygen to the entire body during prolonged physical activity. A key indicator of cardiovascular endurance is VO₂max—the body's maximum capacity to consume oxygen during high-intensity activity. A higher VO₂max value indicates a superior ability to sustain physical activity without succumbing to rapid fatigue

In martial arts such as judo, cardiovascular endurance plays a crucial role. Judo is a high-intensity sport that simultaneously integrates strength, speed, and endurance. Judokas are required to execute repetitive explosive movements with relatively short rest intervals. This necessitates the simultaneous functioning of aerobic and anaerobic energy systems



to support athletic performance. Research indicates that judokas require high aerobic capacity to facilitate recovery and maintain intensity during matches.

Furthermore, high VO₂max capacity in judokas is directly linked to their ability to sustain performance and accelerate recovery following high-intensity activity. Athletes with good aerobic capacity tend to manage fatigue more effectively and can perform repetitive movements without a significant drop in performance. Therefore, improving cardiovascular endurance is a primary focus of judo training programs. (robert pratama purba, dian pujianto, 2022)

However, in practice, many athletes still exhibit suboptimal levels of cardiovascular endurance. This issue may stem from a lack of variety in training methods, as well as training programs that are not fully structured or tailored to the specific needs of the athletes. Consequently, athletes tend to fatigue more quickly during training and competition, which can ultimately impact their overall performance. (khoirul fikri, aminoto, 2025)

One training method that can be employed to enhance cardiovascular endurance is circuit training. Circuit training involves combining various exercises into a single sequence (or circuit) performed repeatedly with minimal rest intervals. This method is designed to train multiple components of physical fitness simultaneously, including endurance, strength, and agility. (Putra et al., 2024)

A primary benefit of circuit training is its ability to effectively improve cardiovascular function. It involves continuous activity that optimally stimulates the heart and lungs. Research indicates that circuit training has a significant impact on increasing athletes' VO₂max; in one experimental study, VO₂max improved by approximately 15% following a regular circuit training program. (Edi Bintoro, Adhe Saputra, 2025)

Furthermore, other studies have shown that circuit training is effective in boosting aerobic endurance among martial arts athletes. The training enhances oxygen utilization efficiency and improves the circulatory system, thereby increasing the body's resistance to fatigue. These factors make circuit training a highly relevant method for judo athletes. (Mona Damayanti, Tatang Muhtar, 2018)

For judo athletes in long-term provincial training centers (*Pelatda*), optimal cardiovascular endurance is crucial, as they are being prepared for extended periods of competition. Long-term training programs require athletes to maintain stable physical conditioning and sustain high training intensities over time. Therefore, effective and efficient training methods are needed to significantly improve the athletes' cardiovascular endurance. (Edi Bintoro, Adhe Saputra, 2025)

Preliminary observations of *Pelatda* judo athletes revealed that a number of them still experience premature fatigue during high-intensity training. Additionally, the variety of training methods currently employed remains limited and has not yet optimally utilized modern approaches such as circuit training. These findings indicate the need for further efforts to improve (achmad mukhlisin, 2025) the quality of training programs, particularly regarding cardiovascular endurance.

This issue warrants further investigation because cardiovascular endurance is a key factor influencing the performance of judo athletes. Without good physical conditioning, athletes struggle to maintain performance intensity, especially during high-tempo matches.

Based on the preceding discussion, it can be concluded that circuit training is a method with the potential to enhance the cardiovascular endurance of judo athletes. However, further research is needed to determine the extent of circuit training's impact on improving

VO₂max among judo athletes, specifically those in long-term regional training center (*Pelatda*) programs. Therefore, the researcher intends to conduct a study titled:



“An Experimental Study on Circuit Training to Improve Cardiovascular Endurance in Long-Term Regional Training Center (*Pelatda*) Judo Athletes.”

Materials and Methods

Study Design

This study employs a quantitative approach. A quantitative approach is a research method that emphasizes the collection of numerical data, which is subsequently analyzed using statistical techniques to test established hypotheses. In this study, the data consists of cardiovascular endurance (VO₂max) measurements taken from judo athletes before and after the training intervention.

The selection of a quantitative approach is based on the study's objective: to objectively and measurably determine the effect of circuit training on improving cardiovascular endurance. By using this approach, researchers can obtain results that are more accurate, systematic, and verifiable through statistical analysis.

The method used in this study is the experimental method. The experimental method is a research approach used to determine the cause-and-effect relationship between independent and dependent variables through the application of a treatment. In this study, the independent variable is circuit training, while the dependent variable is cardiovascular endurance (VO₂max).

Through the experimental method, researchers can determine the extent to which circuit training influences VO₂max improvement among judo athletes at the regional training center (Pelatda). The treatment is administered under controlled conditions over a specific period, allowing for clear observation of changes in the dependent variable.

The research design employed is the One-Group Pretest-Posttest Design. This is a form of experimental design involving a pretest administered before the treatment, followed by the treatment itself, and concluding with a posttest. This design enables researchers to compare results from before and after the treatment to determine whether an improvement has occurred.

The structure of this research design can be illustrated as follows: $O_1 \rightarrow X \rightarrow O_2$

Legend:

O_1 : Pretest (initial test to measure VO₂max)

X : Treatment (circuit training)

O_2 : Posttest (final test to measure VO₂max after the treatment)

Using this design, the observed changes between pretest and posttest scores serve as the basis for determining the effect of circuit training on the improvement of cardiovascular endurance in judo athletes. Thus, this study is expected to provide a clear picture of the effectiveness of circuit training in improving athletes' VO₂max.

Study Participants

Research subjects are the individuals who serve as the source of data in a study. In this research, the subjects are long-term Regional Training Center (*Pelatda*) judo athletes who are currently undergoing a structured and continuous training program.



The selection of these subjects is based on the consideration that long-term *Pelatda* judo athletes undergo high-intensity training and require optimal physical condition, particularly regarding cardiovascular endurance. Therefore, these subjects are considered suitable for

the research objective: to determine the effect of circuit training on improving VO₂max. The research sample consists of approximately 20 athletes, comprising both males and females aged 17–23 years. All subjects are in good health, free from injury, and actively participating in the training program throughout the study period.

The subject selection technique used in this study is total sampling, wherein the entire population is included as research subjects. This technique was employed because the population size is relatively small, allowing the researcher to include all athletes as subjects. By using total sampling, it is expected that the data obtained will be more representative and accurately reflect actual conditions.

The inclusion criteria for study participants are as follows:

1. Officially registered as a judo athlete in the long-term *Pelatda* program.
2. Active and regular participation in training throughout the entire study period.
3. Good physical and mental condition, free from injury or health issues.
4. Willingness to participate voluntarily in the study and sign an informed consent form.

These criteria are intended to ensure that study participants provide valid and reliable data meeting analysis requirements, thereby guaranteeing credible and scientifically sound research results.

Statistical Analysis

Data analysis techniques involve processing and analyzing research data to answer research questions and test hypotheses. In this study, measurements of the judo athletes' cardiovascular endurance (VO₂max)—taken before (pretest) and after (posttest) circuit training—were analyzed. Data analysis was conducted quantitatively using statistical methods. The specific steps of the data analysis were:

1. Calculating the Mean

The first step was to calculate the mean values from the pretest and posttest results. The mean value serves to provide a general overview of the athletes' cardiovascular endurance levels before and after the intervention.

2. Calculating Standard Deviation

Standard deviation is used to determine the extent to which data is dispersed around the mean. The lower the standard deviation value, the more homogeneous the data.

3. Normality Test

The normality test determines whether the collected data are normally distributed. This test is important because it is a prerequisite for applying parametric statistical tests.

In this study, the normality test can be conducted using the Lilliefors test. If the data are normally distributed, the analysis can proceed to the next step.

4. Homogeneity Test

The homogeneity test is conducted to determine whether the data exhibit equal variances (homogeneity). This test is a prerequisite for hypothesis testing.



Results

This study aims to determine the effect of circuit training on improving the cardiovascular endurance of judo athletes in the Long-Term Regional Training Program (Pelatda Jangka Panjang). The study was conducted over a period of eight weeks, with training sessions held three to four times per week. The subjects consisted of 20 judo athletes, comprising both males and females. Cardiovascular endurance was measured using the Multistage Fitness Test (MFT) to obtain VO₂Max values before (pre-test) and after (post-test) the circuit training intervention.

Tabel 1. Statistik Deskriptif

Variabel	Mean	SD
Pretest	40,53	1,12
Posttest	44,98	1,28

Based on the table above, the athletes' average VO₂Max prior to the intervention was 40.53 ml/kg/min. Following an eight-week circuit training program, the average VO₂Max increased to 44.98 ml/kg/min. This average increase of 4.45 ml/kg/min indicates a positive change in the athletes' cardiovascular endurance. The research results indicate that circuit training has a significant effect on improving the cardiovascular endurance of judo athletes in the Long-Term Regional Training Program (Pelatda Jangka Panjang). This is evidenced by the increase in the average VO₂Max value from 40.53 ml/kg/min to 44.98 ml/kg/min following the training program. This improvement occurred because circuit training is a method involving continuous physical activity with relatively short rest intervals. These conditions cause the cardiovascular system to work more effectively in distributing oxygen to body tissues, thereby increasing aerobic capacity.

These findings align with Harsono (2018), who stated that circuit training can enhance various components of physical fitness, particularly cardiopulmonary endurance. Furthermore, research by Almy and Sukadiyanto (2020) also found that circuit training significantly improves VO₂Max in athletes.

In judo, cardiovascular endurance is crucial because athletes must perform repeated explosive movements during matches. An increased VO₂Max enables athletes to sustain training or match intensity for longer periods without experiencing excessive fatigue.

The improvement in VO₂Max observed in this study demonstrates that the training program adhered to the principles of overload and progression, resulting in positive physiological adaptations within the athletes' bodies.

Based on the statistical analysis and supporting theories, it can be concluded that circuit training is an effective method for improving the cardiovascular endurance of judo athletes in the Long-Term Regional Training Program.

Acknowledgments

Based on the research findings and discussion presented, it can be concluded that:

The average cardiovascular endurance (VO₂Max) of the long-term regional training camp (Pelatda Jangka Panjang) judo athletes prior to circuit training was 40.53 ml/kg/min. The average cardiovascular endurance (VO₂Max) of the long-term regional training camp judo athletes increased to 44.98 ml/kg/min following the circuit training program. There was an increase in average VO₂Max of 4.45 ml/kg/min after completing the 8-week circuit training program. Hypothesis testing results showed a calculated t-value (t-count) of 9.87, which is greater than the critical t-value (t-table) of 1.729 at a 5% significance



level; thus, the alternative hypothesis (H_a) was accepted and the null hypothesis (H_o) was rejected. Circuit training has a significant effect on improving the cardiovascular endurance of the long-term regional training camp judo athletes.

Conflict of Interest

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