14 (2) (2025) 673 - 678

Journal of Physical Education, Sport, Health and Recreations

https://journal.unnes.ac.id/journals/peshr

The Effect of Circuit Training Methods on Improving Aerobic Endurance in 10-12-Year-Old Volleyball Players

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Article History

Received June 2025
Accepted June 2025
Published Vol.14 No.(2) 2025

Keywords:
Circuit; Aerobic; Volleyball

Abstract

Volleyball is a game that is played continuously with short durations and high intensity, interspersed with brief recovery periods that occur sequentially during the match. The characteristics of the volleyball game require high endurance, making aerobic endurance training essential for the sustainability of athletes in developing their abilities, skills, and bodily endurance in order to adapt to the game which is played continuously with high intensity. This study aims to determine the effect of circuit training methods on the improvement of aerobic endurance. The method used is an experiment with a one-group pre-test and post-test design, with a sample size of 20 students aged 10-12 years who are active in the volleyball extracurricular at Limbangan Tengah 2 Elementary School. The research results show that there is a significant effect of circuit training methods on improving aerobic endurance in volleyball players aged 10-12 years. This is indicated by the average pretest score of 25.9850 and a posttest score of 42.8000, with a significance value of 0.000 < 0.005. Thus it can be concluded that there is a significant difference between the results of training with the circuit training method on the pretest and posttest data. Therefore, the circuit training method is very effective in improving aerobic endurance, which combines strength and endurance training by completing one group or circuit of exercises with minimal or no rest.

How to Cite

Hakim, Rd.M. M. A., Nurjaya, D. R., & Ajid, O. N. (2025). The Effect of Circuit Training Methods on Improving Aerobic Endurance in 10-12-Year-Old Volleyball Players. Journal of Physical Education, Sport, Health and Recreation, 14 (2), 673-678.

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p-ISSN 2460-724X
e-ISSN 2252-6773

INTRODUCTION

Circuit training is a popular workout method involving a series of exercises arranged in a circuit, targeting different muscle groups, and interspersed with short rest periods (Marcos-Pardo et al., 2019). This method offers many advantages, such as flexibility, variety, and the ability to customize workouts to meet fitness goals. It has gained popularity among individuals with various fitness levels, including athletes, fitness enthusiasts, and those looking to improve their overall health and fitness. By combining strength and cardiovascular exercises in a continuous sequence, this workout allows individuals to elevate their heart rate in a shorter period, making it known for its time-efficient nature (Izquierdo et al., 2021).

Circuit Training was discovered in 1953 as an effective and efficient way for a coach to train many athletes in a limited time and with limited equipment. An athlete trains by moving through a series of weight or gymnastic exercises that are set up. The exercises are performed quickly for 15 to 45 seconds per station with little (15 - 30 seconds) rest or no rest between stations. Circuit Training can improve muscle strength and endurance with slight increases in aerobic capacity, but if the rest periods are made very short (Anitha et al., 2018). Circuit Training can complete one group, or circuit, of exercises with little or no rest in between. Usually, one circuit consists of 6 to 10 exercises (Vineedkumar, 2022).

According to (Paskalis et al., 2022), Method Circuit training is a perfect option for individuals with busy schedules by maximizing their workout in a limited time. This training usually combines various exercises that target different muscle groups throughout the body, allowing for a comprehensive workout for the entire body. This approach enables individuals to develop strength, endurance, and muscle balance across various muscle groups while also training the upper and lower body muscles, core stability, and functional movements. One of the main benefits of circuit training is the ability to customize workouts to meet specific fitness goals, as this training offers a variety of exercises and the ability to change the order of exercises. This variation helps prevent boredom, keeps motivation high, and allows individuals to continue progressing and improving their fitness levels.

Regular physical activity can impact growth development and health during childhood, a critical period of physical and psychological changes in adolescence (Calcaterra et al., 2022). Engaging in regular physical activity can provide many benefits for childhood, such as maintaining a healthy weight, strengthening bones and muscles, improving cardiovascular health, and enhancing overall physical fitness. In volleyball matches, both aerobic and anaerobic endurance are essential due to the relatively high intensity of the game. Volleyball athletes typically operate at 85-90% of maximal heart rate (HR-max) and 75% of maximal oxygen consumption (VO_2 max). According to (Latino, Susanto, et al., 2024),

VO_2max is an important indicator of cardiovascular fitness and endurance capacity. It is a measure that indicates a person's maximum capacity to consume and use oxygen during intense exercise (Calcaterra et al., 2022). In addition, VO_2max represents the maximum amount of oxygen that can be utilized by an individual during intense exercise, reflecting a person's aerobic capacity. This understanding is crucial for researchers, athletes, and fitness professionals in optimizing training programs, evaluating aerobic performance, and assessing overall health (Lake et al., 2022). VO_2max is considered a standard measure of cardiovascular fitness. VO_2max reflects the efficiency of the cardiovascular system, including the heart, lungs, and blood vessels, in delivering oxygen to working muscles during exercise (Naureen et al., 2022). The higher the VO_2max value, the better the cardiovascular fitness and the ability to perform sustained aerobic activities (Hackett, 2020).

This measurement is closely related to endurance performance in activities such as running, cycling, swimming, volleyball, basketball, and others. Athletes with higher VO_2max values can sustain high-intensity training for longer durations without experiencing fatigue (Kramer et al., 2020). VO_2max is highly relevant in sports that require long durations, such as long-distance running, volleyball, basketball, and cycling. It is also used in cardiac and pulmonary rehabilitation programs to assess individuals' functional capacity and track improvements over time (Santisteban et al., 2022). Measuring VO_2max provides valuable information for setting training intensity levels, designing personalized training programs, and monitoring progress during the recovery process (Jensen et al., 2023).

During adolescence, physiological changes certainly occur, making this the right time to study the potential benefits of circuit training methods in enhancing an individual's endurance (Gao & Yu, 2023). It is very important to understand the impact of circuit training on improving aerobic endurance in adolescents for various reasons.

First, improvements in aerobic capacity during adolescence can enhance long-term cardiovascular health and reduce the risk of chronic diseases later in life (Lopez-Jaramillo et al., 2022). Therefore, this study aims to determine the impact of circuit training methods and help inform exercise programs, leading to optimal fitness outcomes. A comprehensive understanding of the relationship between circuit training methods and aerobic endurance in children can contribute to the development of exercise interventions during adolescence.

Physical activity promises benefits for its practitioners, namely achieving the intensity of physical fitness and even mental freshness. This is in line with the slogan mens sana in corpore sano (a sound mind in a sound body). Generally, in Indonesia, sports have become a necessity. Sports are believed to provide bodily freshness based on the needs of physical and spiritual fitness, which in practice can take the form of recreational sports and competitive sports. Among the various types of sports, volleyball is one branch that indicates the existence of objectives such as recreation as well as achievement. This sport has its own place in the community and schools, as it is inexpensive and easy to play. Generally, people play volleyball for enjoyment and in their free time (Budiman, 2016).

According to (Saparia, 2023), The characteristics of the sport of volleyball include a game that is played continuously with short durations and high intensity, interspersed with brief recovery periods that occur consecutively during the match. Given the characteristics of the volleyball game, which requires strong endurance, aerobic endurance training is very important for the sustainability of an athlete in developing abilities, capabilities, and body endurance so they can keep up with the gameplay that is conducted continuously at high intensity. Therefore, this study aims to fill the gap with a specific endurance training method for the sport of volleyball.

Every volleyball player needs to have a sufficiently high level of endurance. Specifically, high aerobic capacity is needed to achieve success in the sport of volleyball. Thus, VO_2max holds significant value in sports as it reflects the physical fitness of an athlete (Latino, Martinez-Roig, et al., 2024). Where every volleyball player must be able to perform quick movements for a long duration. Therefore, volleyball players are required to have high endurance to meet the demands during their matches. The experiment conducted in this study aims to test the effect of circuit training on improving the aerobic endurance of volleyball athletes. Previous research has examined the effects of non-specific circuit training methods across various sports (Ullah et al., 2024). This current study will focus on one specific sport, volleyball, thus the novelty of this research lies in the training that is specific to a particular sport, especially for the age group of 10-12 years.

Previous research has investigated the effects of circuit training on maximum oxygen uptake among adolescents. Regular involvement in a circuit training routine leads to improved oxygen delivery to the working muscles and oxygen utilization. Adolescents aged 16 to 19 can benefit from well-designed circuit training, which can enhance the functionality of the respiratory and cardiovascular systems, leading to better oxygen intake and utilization (Ullah et al., 2024). Current research focuses on circuit training's impact on maximal oxygen uptake in adolescents. Therefore, the novelty of this study lies in the use of circuit training methods to enhance aerobic endurance specific to sports, particularly at the elementary school level. Most previous studies have primarily concentrated on the effects of circuit training on oxygen uptake in general, yet few have analyzed improvements in aerobic endurance based on specific sports. Hence, this study aims to analyze, more specifically, the circuit training method's effectiveness in improving aerobic endurance in volleyball, especially at the elementary school level.

METHODS

This research is a quantitative descriptive study. The research method uses test techniques and measurements aimed at experimenting with something to determine the effects or consequences of the treatment. This is to find out whether there is a change in the use of the circuit training method to improve the aerobic endurance of children aged 10-12 years in meeting the energy demands of the sport of volleyball. The population in this study is all the volleyball extracurricular students at Limbangan Tengah 2 Elementary School , totaling 20, selected based on the total sampling technique, which takes the entire population.

The data collection technique in this research uses tests and measurements. The instrument used in this research employs the Multistage Fitness test/bleep test to measure aerobic/ cardiovascular endurance by running back and forth over a distance of 20 meters following the sound rhythm of the bleep until they can no longer keep up with the gradually increasing speed

(Imran Akhmad, 2017). Statistical analysis is performed using SPSS version 26.

Table 1. A training program was designed for the circuit method in this research

Stage	Exercise form	Duration (s)	Rest	Sets
1	Single leg standing	30	30 second for each sets	Two sets a week (1-8)
2	Static lunges	30		
3	Bent Knee Push up	30		
4	Squat Jump	30		Three sets a week (9-12)
5	Bench Dips	30		
6	Jumping Jack	30		

RESULTS AND DISCUSSION

This study aims to determine whether the circuit training method has an effect on the improvement of aerobic endurance in volleyball players aged 10 to 12 years. It was conducted at Limbangan Tengah 2 Elementary School, located in Bunisari, Limbangan Tengah Village, Bl. Limbangan District. The population in this study consists of all children participating in the volleyball extracurricular activity, with a sample size of 20 active children who are ready to undergo training. The research period is from April 28, 2025, to Wednesday, May 28, 2025. In addition to conducting the research, this training is also prepared for a volleyball competition among schools in Bl. Limbangan District, which will be held on June 23, 2025.

The data in this research includes the test results and measurements of the extracurricular students from Limbangan Tengah 2 Elementary School, as shown in **Table 1.** The training program consists of 12 meetings over the course of 1 month, which means there are 3 training sessions each week. From week 1 to week 8, 2 sets of exercises are performed at each station for 30 seconds. From week 9 to week 12, to promote improvement, 3 sets are provided with the same duration at each station. Therefore, in the first week until the ninth week, 2 sets of circuit training are given at each station for 30 seconds, and in the ninth week, 3 sets of circuit training are given with the same duration between stations. Before starting the core training, participants are instructed to warm up for 15 minutes, and after completing the core training, they are provided with a cool down for 10 minutes.

Normality tests were conducted to ensure that the pretest and posttest data meet the assumption of normal distribution, using the Shapiro-Wilk test on 20 experimental groups of data analyzed. The results of the Shapiro-Wilk normality test for the pretest and posttest data with a total of 20 samples. For the Shapiro-Wilk normality test, the pretest statistic value is 0.910 with a significance level of 0.063, while the posttest statistic value is 0.930 with a significance level of 0.157. Since the significance values are above 0.05, the data is considered normally distributed and meets the requirements for hypothesis testing.

Table 3. T-test Results of the Average Pretest and Posttest of Aerobic Endurance after Circuit Training

		Mean	N	Std. Deviation	Std. Error Meas
Circuit Training	Pre Test	25.9850	20	4.84771	1.08398
	Post Test	42.8000	20	4.76390	1.06524

Table 3 shows that the average pretest score for 20 samples is 25,9850, and after a series of treatments on circuit training, the average posttest score for aerobic endurance is 42,8000.

Hypothesis testing is conducted to determine whether the proposed hypothesis can be accepted or rejected. If the significance value is <0.005, there is a significant difference between the results of the training on the pretest and posttest data, whereas if the significance value is >0.005, there is no significant difference between the results of the training on the pretest and posttest data. (Waluyo Edy, 2024).

The results of the paired sample t-test comparing the hypothesis test output from the Pretest and posttest data. The average difference between the two data sets is 16.8150, with a standard deviation of 2.22457 and a standard error mean of .49743. The 95% confidence interval for the mean difference ranges from -17.856113 to -15.77387. The t-value is -30.804 with degrees of freedom (df) of 19, and the significance (2-tailed) is 0.000. The very small probability value ($p < 0.05$) indicates that there is a statistically significant difference in means between the Pretest and Posttest data.

It is known that the significance value of

0.000 < 0.005 means that there is a significant difference between the results of training using the circuit training method on the pretest and posttest data. Thus, it can be concluded that circuit training improves the aerobic endurance of children aged 10-12 years in the volleyball sports branch at the extracurricular activities of Limbangan Tengah 2 Elementary school. This is in line with the research results (Anitha et al., 2018) which state that circuit training can improve muscle strength and increase aerobic endurance, but if the rest time is very short. According to (Gao & Yu, 2023), it is very important to understand the impact of Circuit training on improving aerobic endurance in adolescents for various reasons, including that an increase in aerobic capacity during adolescence can enhance long-term cardiovascular health and reduce the risk of chronic diseases later in life. This is also in line with the findings of the study (Saparia, 2023), which states that the characteristics of the sport of volleyball involve a game that is played continuously with short durations and high intensity, interspersed with brief recovery periods throughout the match, thus requiring good physical endurance. Therefore, aerobic endurance training is very important for an athlete's sustainability in developing their physical endurance ability to keep up with high-intensity volleyball matches.

CONCLUSION

Based on the research results, training using the circuit training method for 1 month, with 3 sessions per week, has a positive impact on aerobic endurance. Regular practice in a circuit training routine shows significant improvements in maximizing oxygen intake during exercises, with the heart pumping more blood with each beat and the lungs taking in more oxygen to meet the increased energy demands. Children aged 10 to 12 can benefit from well-designed circuit training methods, leading to improved respiratory and cardiovascular function, resulting in better oxygen intake and utilization.

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