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Endurance Training for Volleyball Athletes: The Efficacy of Tabata and Circuit Training Models

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Abstract

Volleyball matches can be very long, especially if the two teams are evenly matched. Physical endurance is essential to maintain high performance during matches that may last up to five sets. Athletes who have good endurance can continue to move, jump, and perform fast movements throughout the game without experiencing excessive fatigue. Tabata training and circuit training are two types of training that focus on improving physical fitness with different methods, such as training duration and training format. The aim of this study was to examine the effect of tabata training and circuit training on increasing the endurance of volleyball athletes. In this research, researchers applied an experimental method with a pre-test post-test control group design. The research samples consisted of 30 athletes from the Tectona club in Cianjur Regency. The instrument for measuring the endurance of volleyball athletes was the yoyo test. Samples were receiving treatments 3 times a week with a total of 18 meetings. Hypothesis testing used paired sample-test and independent sample-test analysis. The research results showed that both tabata training and circuit training had an effective influence in increasing endurance of volleyball athletes, but the circuit training showed a more effective result compared to the tabata training. The study concludes that both of the training models have positive effects on increasing endurance of volleyball athletes, but the circuit training model has a more effective influence on increasing endurance.

INTRODUCTION

Volleyball is a sport that involves the utilization of all body parts to propel a ball over a net and into the other team defensive territory. Volleyball has evolved into a competitive sport where individuals strive to attain notable accomplishments. Volleyball is currently undergoing a transitional phase, evolving from a recreational activity to a highly competitive endeavor focused on achieving success. Consequently, considerable efforts are being made to improve performance through rigorous training programs in institutions and volleyball clubs. Numerous elements contribute to the achievement of optimal performance in ball sports. According to Schmolinsky in Sidik (2010), several factors influence the conditions that contribute to achievements, encompassing both internal and external elements.

Internal elements, such as body and physical constitution, technics, tactical and psychological factors have a significant impact on achieving peak performance. Meanwhile, external factors include systems, scenarios, situation of competitions, training, competition facilities, and infrastructure. Physical fitness is one of the most important internal aspects in attaining success in volleyball. Physical preparation is essential for a team optimal performance during the preparation phase (Syamsi et al., 2021).

With good physical condition, an athlete will easily learn the basic techniques of playing volleyball. The physical condition component is the most important part in all sports, especially to support other aspects, such as technique, tactics, and mental aspects. Physical fitness of athletes plays a pivotal role in facilitating their performance during competitions, enabling them to achieve optimal results. Given the importance of physical condition, a coach must begin to prioritize and cultivate the specific components of physical fitness that are essential for athletes to enhance their performance in volleyball. There are various physical condition components that must be developed, including speed, strength, endurance, flexibility, and muscle endurance (Sidik, 2010). Essentially, all components of physical condition are important for athletes, but there is one component of physical condition that is particularly dominant and significant that must be cultivated in the volleyball sport, namely endurance.

Endurance can be classified into two distinct categories, namely aerobic endurance and anaerobic endur-

ance. Aerobic endurance refers to the utilization of oxygen as the primary energy source. Aerobic endurance, sometimes referred as aerobic fitness, pertains to physical activities that need the utilization of oxygen over an extended duration. Examples of such activities include long-distance running, cycling, and other sports (Argasmita et al., 2007). In contrast, anaerobic endurance refers to the ability to do physical activities without the presence of oxygen. Without using oxygen, the body can maintain a certain level of intensity for only a short time. However, anaerobic endurance can be trained and developed to meet the metabolic demands of different high-intensity sports (Crossfit Journal, 2013).

Aerobic and anaerobic endurance are extremely important in volleyball games due to the high intensity of the game. Volleyball players typically exert 85-90% of maximum heart rate (HRmax) and 75% of maximum oxygen consumption (VO₂max) (Alvarez et al., 2015). As a result, it is important for every volleyball athlete to possess a high level of endurance. The second external aspect is the training system or training methods used by coaches to increase their athlete physical endurance. There are numerous training methods that can be implemented, including interval training, fartlek, tabata, and circuit training. This study will exclusively focus on examining the tabata training method and the circuit training approach.

Tabata training aims to improve both aerobic and anaerobic systems. Tabata training is essentially HIIT (High Intensity Interval Training) with high intervals and intensity (Setiawan et al., 2020). Meanwhile, in practice, tabata training takes four minutes with eight intervals (Fazriyati et al., 2013). Each interval lasts for 20 seconds at high intensity. With a total time of four minutes, athletes train physically at high intensity for 20 seconds then recover for 10 seconds continuously. Tabata activities are beneficial to burn fat, increase metabolism before and after training, improve the aerobic and anaerobic systems, improve an athlete mental health, are effective and efficient in execution, and can be employed in a variety of physical activities. Despite a large body of literature claiming that tabata has numerous health benefits, tabata activities are relatively uncommon in Indonesia. Aside from that, the research results of Foster et al. (2015) reveal that there are no specific benefits to high-intensity training methods, as

has been widely adapted from the research results of Tabata et al. (2019), that the reason of its unpopularity is because tabata is less enjoyable. Due to the inconsistent results of tabata research and the existence of a gap, the researchers believe it is vital and interesting to explore the tabata training method in greater depth.

Circuit training is the second training approach. Circuit training is a training technique that incorporates a series of distinct exercises performed consecutively and continuously over one round/circuit (Patah et al., 2021). Circuit training is a type of exercise that is meant to enhance time efficiency while also providing higher and faster physiological effects (Skidmore et al., 2012).

The circuit training method is one of the finishing activities of all the exercises prescribed in the program. When one circuit is finished, the athlete either begins the initial exercise or proceeds to the next circuit. In traditional context, the interval between exercises has been quite brief, typically involving rapid transitions to the next post. Circuit training is the most effective strategy to improve mobility, strength, and stamina. The circuit training method is identical to the use of posts, where each post contains a form of exercise that must be completed by each athlete. Research by Vega, et al (2013) shows that the circuit training program is effective for increasing and maintaining muscle and cardiovascular endurance among school children. Over the last few years, circuit training has become a widely used form of exercise (Sonchan, Moungee & Sootmongkol, 2017). Despite the considerable growth and widespread use of the circuit training approach in various countries, prior studies investigating its impact on the improvement of cardiovascular endurance in young individuals did not yield significantly meaningful results. Furthermore, prior research has primarily focused on extracurricular activities rather than on physical education learning context (Vega et al., 2013).

Upon examining the challenges encountered by researchers, it had been observed that the volleyball athletes in Tectona club exhibited suboptimal levels of physical endurance. This was evident when the athletes frequently encountered considerable exhaustion even though the game had only lasted 7 to 10 minutes. Given the rise of these issues, researchers were motivated and recognized the significance of undertaking this study. If a solution is not immediately found for this problem,

the athlete performance will not improve. Referring to the problem background and analysis, this research aimed to find out the effect of using the tabata training and circuit training method to improve the endurance of volleyball athletes.

Previous studies have not conducted a comparative analysis of these two training approaches in terms of their efficacy in enhancing the endurance of volleyball athletes. Existing literature shows that the tabata technique has the potential to improve endurance (Olson, 2014; Tabata, 2019; Miyamoto-Mikami et al., 2015). Similarly, it has been demonstrated in various studies that the use of the circuit training method can lead to improvements in endurance (Paoli et al., 2013; Sari et al., 2021; Taskin, 2019). Hence, the primary objective of this study was to examine the contrasting impacts of implementing the tabata training method and the circuit training method on enhancing the endurance capacities of volleyball athletes.

METHODS

The researchers used experimental approach in this study. According to Fraenkel (2012), experimental research is the only method that effectively examines hypotheses about cause-and-effect relationships. Furthermore, Suherman and Rahayu (2015) state that experimental research is distinct from other types of study since it is the only method that directly attempts to manipulate the dependent variables.

Participant

The study utilized a sample of 30 athletes who were affiliated with the Tectona club located in Cianjur Regency. The researchers employed a non-probability sampling technique using saturation samples, referring to a sampling technique when all members of the population were included as samples (Sugiyono, 2016). Therefore, the entire population of 30 athletes at the Tectona volleyball club in Cianjur Regency were involved as samples in this study. The reason for this was due to the relatively small population.

Materials and Apparatus

The Yoyo test was employed to assess the endurance levels of volleyball athletes, with the primary objective of quantifying an individual endurance capacity. This instrument had substantial resemblance to the

bleep test, with the sole distinction residing in the implementation of a recovery or active rest interval. In this study, the yoyo test was conducted in an outdoor setting, utilizing a rectangular area measuring 2 meters in width and 20 meters in length as shown in Figure 1. The increase in speed was controlled by audio bleeps (Mohr & Krustup, 2013). The scoring process involved tallying the total count of levels and successful returns achieved by participants.

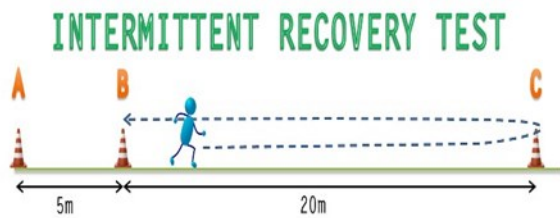


Figure 1. Yoyo Test

The treatment in this study was to divide the entire sample into two groups, namely the tabata training method and the circuit training method, which were carried out over 18 sessions with a frequency of 3 days per week.

Procedures

The study had a total of 20 sessions, which were categorized into two assessments (pretest and posttest) and 18 training sessions. During the conduct procedure, the researchers ensured that the samples were willing to participate in this research. The processes employed in this study were determined by the training methods utilized. These procedures are outlined in Table 1 and 2.

Table 1. Tabata Training Research Method Procedure

Session	Tabata Training Method	Set/Repetition
1	Pre-Test	
2 - 19	<ol style="list-style-type: none"> Squat. Push-up. Dynamic lunges. High knee. Spider crawl. Leg lifts. Plank. Mt. Climber. Bicycle crunches. Russian twist. 	The duration of training 4 minutes, with each movement session lasted 20 seconds and 10 seconds' rest.
20	Post-Test	

Table 2. Circuit Training Research Method Procedure

Session	Tabata Training Method	Set/Repetition
1	Pre-Test	
2 - 19	<ol style="list-style-type: none"> Jump Rope Sit-Ups Hundle Hop Push-Ups Jack-Knife Jump-squat Inverse Sit-Ups Comando dance 	A single session lasted for 30 seconds. A rest period of 15 seconds was allocated for transitioning between movements. A rest period of 45 seconds was allocated to each set. The training was performed in three sets.
20	Post-Test	

Design or Data Analysis

After obtaining the raw data from the research subjects, the next step was analyzing the raw data utilizing the SPSS version 25 software. The first step involved determining the mean and standard deviation. The second step was to examine the normality and homogeneity values. Further, the hypothesis testing employed the statistical techniques of paired sample t-test analysis and independent sample t-test.

RESULT

The results of data analysis show that all participants experienced a significant increase. This suggests that the inclusion of tabata training and circuit training has a significant influence on the development of athlete endurance. For more details, it is described in Table 3.

Table 3. Descriptive Statistics

	Training	N	Mean	Std. Deviation
Pretest	Tabata	15	33.47	1.06
	Circuit	15	31.20	1.35
Posttest	Tabata	15	34.81	1.43
	Circuit	15	32.51	1.44

Data analysis showed that the pretest score for the Tabata group gained the mean = 33.47 and standard deviation = 1.06. Furthermore, the posttest score for the Tabata group results in the mean = 34.81 and standard deviation = 1.43. Meanwhile, the pretest score for the Circuit group revealed the mean of 31.20 and standard deviation = 1.35. Furthermore, the posttest score for the

Circuit group had a mean of 32.51 and standard deviation of 1.44.

The results of the hypothesis test are presented in Table 4 and 5.

Table 4. Paired Sample T-Test

	t	df	Sig. (2-tailed)
<i>Tabata</i>	121.844	14	0.000
<i>Circuit</i>	89.259	14	0.000

Table 5. Independent Sample T-Test

	Mean	t	Sig.
<i>Tabata</i>	1,34	2.05	0.000
<i>Circuit</i>			

The test results indicate that both the tabata training method ($p = 0.000$) and circuit training ($p = 0.000$) exhibited significant values below the threshold of 0.05. It can be inferred that both the tabata training model and circuit training had a significant impact on enhancing the athlete endurance.

There was a difference between the tabata training model and the circuit training model. The average N-Gain value of the tabata training model (1.34) was higher than the average N-Gain value of the circuit training model (1.31). As a result, the tabata training technique appears to be more effective in increasing the endurance of volleyball athletes.

DISCUSSION

The Efficacy of Tabata Training

The first finding in this research shows that tabata is a training method that has a significant impact on increasing the endurance of volleyball athletes. This is due to the tabata training approach is structured and combines high intensity movements in relatively short intervals. According to Schoenfeld and Dawes (2009), tabata is a cardiorespiratory exercise system that combines high intensity movements in relatively short intervals, alternated with periods of rest or low intensity movements that allow for an active recovery phase between intervals.

This finding is supported by prior study which revealed that Tabata can increase cardiorespiratory fitness (Vo2Max) 4% to 46% over a 2- to 15-week training period. Previous research had shown that tabata

training could increase VO2Max faster (Patah et al., 2021). The increase in VO2Max is a result of increasing stroke volume (the volume of blood pumped by the heart in one beat), which is induced by the cardiac muscle strong and quick contracting ability (Scott et al., 2016). Tabata can also improve mitochondrial biogenesis, such as the size and quantity of mitochondria and ATP cells, which supports increasing cardiovascular capacity at every level of exercise intensity (Tabata, 2019).

Tabata training is characterized by its brevity, typically lasting only four minutes per exercise. This makes it a great option for people who have busy schedules and find it difficult to allocate time to exercise (Hough, 2021). High intensity tabata training can increase cardiorespiratory capacity, especially lungs and heart function. Consequently, this leads to enhanced efficacy in the transportation of oxygen throughout the body during physical activity.

The Efficacy of Circuit Training

The second finding in this research shows that circuit training has a significant impact on increasing the endurance of volleyball athletes. This is because circuit training can improve VO2Max endurance (Patah et al., 2021). The utilization of circuit training method can enhance the oxygen supply to the muscles, hence enabling athletes to perform activities at an elevated intensity for extended durations. Another advantage of employing the circuit training approach is its capacity to concurrently enhance the whole physical fitness of the body, encompassing many components, such as power, endurance, speed, flexibility, stamina, and other physical attributes.

The incorporation of circuit training into volleyball matches is tailored to accommodate the specific requirements and attributes of the sport. Included within this set are several elements such as speed, agility, endurance, power, coordination, stamina, and further aspects pertaining to bodily fitness. Based on research results, it shows that circuit training is a very effective training method for increasing endurance (Yadav & Sardar, 2017). Circuit training burns more calories in lesser time by combining strength training with cardio. This may help in weight management or weight loss. Many of the exercises in circuit training focus on functional movements that help with daily activities. This has the potential to boost performance in routine tasks

(Schranz et al. 2018).

The Difference between Tabata and Circuit Training

The tabata training method and the circuit training method are two different approaches for enhancing physical endurance. The tabata method entails engaging in high-intensity interval training for a duration of four minutes. The exercise routine comprises of eight sets, each consisting of 20-second periods of high-intensity physical activity, followed by 10 seconds of rest. Due to its high intensity, tabata is effective for increasing anaerobic endurance and cardiorespiratory fitness within a limited timeframe (Olson, 214). Meanwhile, circuit training involves a number of different exercise stations carried out in a predetermined sequence (Shekhawat & Chauhan, 2012). The duration in each station often ranges from 30 seconds to several minutes, depending on the specific program. During the circuit training workout, there is generally no long rest between stations, resulting in a more consistent and potentially enduring level of intensity compared to the tabata method.

Tabata training typically focuses on high-intensity interval training, such as running, quick jump rope, or high-intensity weight training (Domaradz et al., 2020). The purpose is to stimulate metabolism and improve anaerobic endurance. Tabata training consists of a series of movements involving several muscle groups of the body that can assist build muscle endurance and develop strength (Lee et al., 2021). High-intensity exercise, such as tabata, can increase the body metabolism, causing it to burn more calories even after training (Lu et al., 2023)

Meanwhile, circuit training incorporates a variety of movements, such as weight training, cardio, strength, and flexibility (Heinrich et al., 2012), and is not usually performed at a high intensity (Wilke et al., 2019). Circuit training can be designed by integrating cardiovascular exercises, such as running in place or jump rope, between the strength training sets. This helps increase heart and lung capacity.

CONCLUSION

The findings of the conducted research indicate that the tabata training and circuit training are indeed effective training models for enhancing physical endurance. The findings of this study align with the intended

goals of the two training models. However, the tabata training model showed better results than the circuit training model in increasing the endurance of volleyball athletes. The tabata training model facilitates a focus on high-intensity interval training (HIIT), such as sprinting, quick jump rope, or high-intensity weight training. The goal is to stimulate a rise in metabolic rate and increase anaerobic endurance, hence providing a more positive increase in endurance among volleyball athletes. This research certainly has limitations. Researchers suggest employing a more comprehensive research instrument to examine the differences in utilization of the two training methods in terms of athlete psychological aspects and to collect data from coaches regarding the use of tabata and circuit training methods. Further research may consider incorporating gender and age as selection criteria for samples to enhance the comprehensiveness of data supporting the development of training models for physical endurance in volleyball athletes.

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