Improving physical condition of badminton athletes aged 10-12 through circuit body weight training

Mejora de la condición física de los atletas de bádminton de 10-12 años a través del entrenamiento en circuito con el peso corporal

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Abstract

Introduction and Objective: This study investigates the effect of the circuit bodyweight training method on improving physical fitness parameters such as muscle power, cardiovascular endurance, and agility. The goal is to assess how this specific training regimen influences the physical performance of badminton athletes. Methodology: An experimental design with a one-group pre-test and post-test was utilized for this research. A sample of 40 participants, selected through random sampling, underwent assessments to measure leg muscle power (vertical jump), arm muscle power (medicine ball put), cardiovascular endurance (yo-yo test), and agility (pedicure test). The data analysis was conducted using an independent sample t-test followed by a paired sample t-test to determine significant differences in physical performance. Results: The findings revealed a significant improvement in all measured physical parameters post-training, with a p-value of less than 0.05. The average leg muscle power increased from 129.20 kg/sec in the pre-test to 189.60 kg/sec in the post-test, showing a difference of 60.4 kg/sec. The arm muscle power improved from an average of 259.20 cm in the pre-test to 406.00 cm in the post-test, with a difference of 146.8 cm. Cardiovascular endurance increased from an average of 11.7 in the pre-test to 13.2 in the post-test, showing a difference of 1.5. Lastly, agility improved from an average of 29.00/s in the pre-test to 26.10/s in the post-test, with a difference of 3.00/s. Conclusion: Circuit bodyweight training significantly enhanced muscle power, cardiovascular endurance, and agility in badminton athletes. These results indicate the effectiveness of this training method in improving physical condition.

Keywords

Circuit weight training, muscle power, cardiovascular endurance, agility.

Resumen

Introducción y Objetivo: Este estudio investiga el efecto del método de entrenamiento de circuitos con peso corporal en la mejora de parámetros de la condición física, como la potencia muscular, la resistencia cardiovascular y la agilidad. El objetivo es evaluar cómo este régimen de entrenamiento específico influye en el rendimiento físico de los atletas de bádminton.

Metodología: Se utilizó un diseño experimental con un pre-test y post-test en un solo grupo para esta investigación. Una muestra de 40 participantes, seleccionados mediante muestreo aleatorio, se sometió a evaluaciones para medir la potencia muscular de las piernas (salto vertical), la potencia muscular de los brazos (lanzamiento de balón medicinal), la resistencia cardiovascular (prueba yo-yo) y la agilidad (prueba de pedicura). El análisis de los datos se realizó utilizando una prueba t de muestras independientes seguida de una prueba t de muestras apareadas para determinar las diferencias significativas en el rendimiento físico. Resultados: Los resultados revelaron una mejora significativa en todos los parámetros físicos medidos después del entrenamiento, con un valor p menor a 0.05. La potencia muscular de las piernas aumentó de un promedio de 129.20 kg/seg en el pre-test a 189.60 kg/seg en el post-test, mostrando una diferencia de 60.4 kg/seg. La potencia muscular de los brazos mejoró de un promedio de 259.20 cm en el pre-test a 406.00 cm en el post-test, con una diferencia de 146.8 cm. La resistencia cardiovascular aumentó de un promedio de 11.7 en el pre-test a 13.2 en el post-test, mostrando una diferencia de 1.5. Finalmente, la agilidad mejoró de un promedio de 29.00/s en el pre-test a 26.10/s en el post-test, con una diferencia de 3.00/s. Conclusión: El entrenamiento de circuito con peso corporal mejoró significativamente la potencia muscular, la resistencia cardiovascular y la agilidad en los atletas de bádminton. Estos resultados indican la efectividad de este método de entrenamiento en la mejora de la condición física.

Palabras clave

Entrenamiento de circuito con peso corporal, potencia muscular, resistencia cardiovascular, agilidad.

Introduction

Sports achievements are inseparable from the element of good physical condition. To achieve high achievement in competitive sports, an athlete needs excellent physical condition according to the needs and demands of the sport (Cowden, 2017; Kuczek, 2013; Ring & Kavussanu, 2018). Physical condition greatly determines the quality and ability of a player because, with a good physical condition, a player can concentrate fully on the game. Physical condition is the most important factor in an exercise program aimed at achieving high ability (Andreato et al., 2017; Slimani et al., 2016). One of the sports that requires optimal physical condition is badminton. Badminton is a game sport that has complex movement skills (Ab Rashid et al., 2022; Ahmed et al., 2022; Bravo-Sánchez et al., 2021). The results of the literature review state that badminton has movement characteristics such as sudden stops, jumps, running while changing directions quickly without experiencing fatigue, and a stable balance (Ihsan et al., 2023). Therefore, physical condition is an important point for badminton athletes. The components of physical conditions involved in badminton are speed, agility, muscle power, cardiovascular endurance, balance, strength, and coordination. The predominant physical components in badminton are muscle power, cardiovascular endurance, and agility (Adirahma et al., 2024). This is also supported by previous research (Pratama, 2020) revealed that the biggest contribution when doing a smash is the power of the leg muscles. If the athlete has good leg power, he will get maximum smash results.

In badminton the athlete has to jump to be able to smash, this means that the muscles that work must be able to contract optimally in a very short time. Next Chen et al., (2022) revealed that the form of badminton game also prioritizes long or real shots, which are based on the cardiovascular endurance factor. Other literature suggests that agility should consider not only speed, but the ability to reduce speed, change direction, and renew in response to stimuli (Susiono et al., 2024). By having good agility, athletes will be able to act quickly in the face of stimuli, in this case, attacks from opponents. Therefore, an athlete's agility must be trained to display maximum performance. Agility in badminton is useful for players to be able to move quickly in various directions, both to chase or defend the shuttlecock so that it does not fall on their court or to counter attacks (Savla et al., 2020). However, in reality, based on the results of observations made by researchers in January 2024 at the Jember Regency Badminton building, East Java Province, the coach revealed that the ability to smash and move quickly in pursuit of shuttlecocks is still relatively low, and several athletes experience fatigue. This is due to the lack of muscle power, agility, and cardiovascular endurance training in badminton athletes, even though if a badminton athlete can master good smash techniques, it will be easier to get points. If an athlete has good agility, it will be easier to control the shuttlecock, and if he has good cardiovascular endurance, he will not easily experience fatigue during the game. Researchers obtained the latest data on the field from badminton coaches when athletes conducted a leg power test with a vertical jump test showing that the average jump height was 10 cm, the cardiovascular endurance test using the yo-yo test obtained an average result of 14, and the agility test using a special pedicure test measuring badminton sports obtained an average result of 25 seconds/s, the result was included in the poor category. The ongoing training program is also still lacking in training athletes' limb strength. More training is practice, service techniques, strength, balance, and coordination exercises. So the balance and strength of badminton athletes are not balanced with muscle power, cardiovascular endurance, and agility. If this continues to be left unchecked, it will affect the decline in athletes' achievements.

Based on the results of the previous literature, there have been several physical exercise methods to increase muscle power, endurance, and agility. Physical training programs that previously did more squat jumps, box jumps, push-ups, pull-ups, jogging, interval training, and zig-zag running, but there are no more varied and innovative physical training methods. One of the exercises provided to maximize power, endurance, and agility is by practicing the circuit bodyweight training method. The circuit bodyweight training method is an exercise system that can simultaneously improve the whole body, namely endurance, strength, flexibility, power, muscle endurance, agility, speed, balance, and several other components of physical conditions (Yuniana et al., 2024). Circuit bodyweight training is a combination of aerobic and endurance exercises using one's body weight which is done in a short time and can be done anywhere (Paoli et al., 2013; Yadav & Sardar, 2017; Yuniana et al., 2023). Their initial circuit training series consisted of several stations arranged in a circle to train muscle groups alternately from station to station (Romero-arenas et al., 2013). Circuit training is a form of conditioning that combines high-intensity endurance and aerobic training. It is designed to be easy to follow and targets the building of

muscle power, endurance, and agility. Based on the problems that have been raised previously, the researcher aims to analyze the effectiveness of circuit body weight training on increasing muscle power, endurance, and agility of badminton athletes.

There are several alternative training methods to improve muscle power, endurance, and agility for badminton athletes. One option is plyometric training, which enhances explosive strength through exercises like squat jumps and box jumps. While effective for increasing muscle power, especially in the legs for jumping and smashing, plyometrics require careful technique to avoid injury and can have a longer recovery time, limiting training frequency. Another method is High-Intensity Interval Training (HIIT), which combines short bursts of high-intensity exercise with brief recovery periods. HIIT is excellent for improving cardiovascular endurance and agility, but it may not be as focused on developing muscle power or specific agility required in badminton. Circuit bodyweight training is chosen because it simultaneously improves multiple physical components, including muscle strength, endurance, agility, and balance. It is versatile, requiring no equipment, and can be done in short, intense sessions. This method combines aerobic and anaerobic exercises, making it well-suited to the diverse demands of badminton. It offers a balanced approach, addressing all the necessary fitness components, and can be easily integrated into an athlete's training regimen.

Method

Research Participants

This research was carried out in Jember Regency, East Java in June-Agust 2024. The population in this study is all badminton athletes aged 10-12 years totaling 100 people. The sample in this study is 40 badminton athletes taken using a random sampling technique. This study has received approval from all samples that have filled out a statement of ability to be a research sample and have met the requirements of the research code of ethics.

Meusures

The instrument used to measure leg muscle power is the vertical jump, to measure arm muscle power medicine ball put, cardiovascular endurance using the yo-yo test, and agility using the pedicure test. Leg muscle power was assessed using the vertical jump test, where athletes performed three jumps, and the highest was recorded. A standardized warm-up and the same person marking the jump height ensured consistency. Arm muscle power was measured with the medicine ball put, where athletes performed three throws, and the best was recorded. The test was conducted on the same surface with uniform instructions. Cardiovascular endurance was evaluated using the Yo-Yo test, with athletes running back and forth at increasing speeds until exhaustion, and the total distance covered was recorded. For agility, the special badminton pedicure test measured athletes' speed and reaction time to directional changes, with times recorded by the same person using a stopwatch. These procedures were designed to minimize variability and ensure reliable and objective measuremen.

Design and Procedures

This study uses a type of quasi-experimental research with a pre-test design and a post-test one-group design. This experimental study used 1 group of athletes who were given the circuit bodyweight training method. The data collection technique in this study is test and measurement. After that, they were given treatment or practiced as many as 16 meetings with a frequency of 3 times a week. It ends with taking the final test score or post-test to measure muscle power, endurance, and agility after the treatment.

Table 1. Session 1-8 circuit body weight training program

No.	Exercise	Set	Reps	Breaks between posts	Recovery
1.	Reclining Triceps Press	2	10 times	20 seconds	120 seconds
2.	Lateral Plyo Squat	2	10 times	20 seconds	
3.	Floor Inverted Shoulder Press	2	10 times	20 seconds	
4.	Single Leg Dip	2	10 times	20 seconds	
5.	Split Jacks	2	10 times	20 seconds	
6.	Shuttle run	2	10 times	20 seconds	
7.	Frog Jump	2	10 times	20 seconds	
8.	Side Jump	2	10 times	20 seconds	

9.	Half Squat	2	10 times	20 seconds	
10.	Lateral Run	2	10 times	20 seconds	
11.	Bench Jump	2	10 times	20 seconds	

Table 2. Session training program 9-16 circuit body weight training

No.	Exercise	Set	Reps	Breaks between posts	Recovery
1.	Reclining Triceps Press	3	12 times	20 seconds	
2.	Lateral Plyo Squat	3	12 times	20 seconds	
3.	Floor Inverted Shoulder Press	3	12 times	20 seconds	
4.	Single Leg Dip	3	12 times	20 seconds	
5.	Split Jacks	3	12 times	20 seconds	
6.	Shuttle run	3	12 times	20 seconds	120 seconds
7.	Frog Jump	3	12 times	20 seconds	
8.	Side Jump	3	12 times	20 seconds	
9.	Half Squat	3	12 times	20 seconds	
10.	Lateral Run	3	12 times	20 seconds	
11.	Bench Jump	3	12 times	20 seconds	

Statistical Analysis

The data analysis technique used in this study uses SPSS version 24, namely by conducting a paired sample t-test. Previously, a prerequisite test was carried out for normality and homogeneity tests.

Results

In the research results and discussion sections, they will be presented in order, including: Prerequisite test results, and hypothesis tests. The hypothesis test in this study will be presented according to the formulation of the problem, namely: The effect of circuit body weight training on increasing power, cardiovascular endurance, and agility in badminton athletes. In full it will be presented as follows:

Normality Test

The normality test was carried out to test whether the data had a normal distribution or not. The calculation of data normality was carried out using the Shapiro-Wilk test. The results of the normality test are shown in the table below.

Table 3. Pre-Test and Post-Test Data Normality Test Results

Data	*P*	Significance	Information
Pre-test leg muscle power	0,219		Usual
Post-test leg muscle power	0,685		Usual
Pre-test arm muscle power	0,236		Usual
Post-test arm muscle power	0,236		Usual
Pre-test cardiovascular endurance	0,493		Usual
Post-test cardiovascular endurance	0,175	0, 05	Usual
Pre-test agility	0,398		Usual
Post-test agility	0,261		Usual

Based on the statistical analysis of the normality test that has been carried out using the Shapiro-Wilk test, on all pretest and post-test data of circuit body weight training exercises obtained from the results of the normality test data of the significance value $p > 0.05$, which means that the data is normally distributed, it can be concluded that all pre-test and post-test data are declared normal.

Homogeneity Test

The homogeneity test was used to test the similarity of variance between the compared data. The results of the homogeneity test of pre-test and post-test data between pre-test and post-test with this study are as follows.

Table 4. Results of pre-test and post-test data homogeneity test results

	Group	F Count	*p*	Information
Power arm muscles	Pre Test Post Test	3,749	0,312	Homogeneous
Leg muscle power	Pre Test Post Test	3,662	0,108	Homogeneous

cardiovascular endurance	Pre Test Post Test	3,139	0,432	Homogeneous
Agility	Pre Test Post Test	3,497	0,310	Homogeneous

The results of the homogeneity test were to test the similarity of the variance of the pre-test and post-test data of circuit bodyweight training. Because the significance value is greater than 0.05 (p>0.05), it can be stated that the pre-test and post-test data of circuit bodyweight training are homogeneous.

Effectiveness Test

Table 5. Results of Paired Sample t-Test Treatment Group

Data	Group	Mean	t Count	p	Information
Power arm muscles	Pre-test Post-test	259, 20 406, 00	7,782	0,000	Significant
Leg muscle power	Pre-test Post-test	129, 20 189, 60	6,799	0,000	Significant
Cardiovascular endurance	Pre-test Post-test	11, 7 13, 2	4,122	0,000	Significant
Pre-test agility	Pre-test Post-test	29, 00 26, 00	4,003	0,000	Significant

Based on the results of the analysis of the Paired Sample t-test data on leg muscle power, arm muscle power, cardiovascular endurance, and agility, a significance value of less than 0.05 (p<0.05) was obtained, so it can be concluded that there are significant differences in leg muscle power, arm muscle power, cardiovascular endurance, and agility, during the pre-test and post-test in badminton athletes. This means that there is a significant increase in leg muscle power, arm muscle power, cardiovascular endurance, and agility, before and after the treatment.

Discussion

Based on hypothesis testing, it is known that there is an effect of circuit body weight training on increasing muscle power, cardiovascular endurance, and agility of badminton athletes. Circuit bodyweight training is an effective training method to increase physical variables, one of which is muscle power. These findings are in line with several previous studies Marcos-pardo et al., (2019) revealed that they found that circuit bodyweight training can improve the ability of muscle power components with a large number of samples. These findings are consistent with some previous evidence Yuliandra et al., (2020) explained that circuit bodyweight training for 16 sessions with a frequency of 3 times a week is an effective method to increase muscle power and endurance of athletes. The increase in muscle power may be due to the intensity of the circuit weight training the speed of movement and its explosiveness. This is supported by research Romero-arenas et al., (2013) which states that body weight training circuit training is very effective and can be applied to increase power and endurance and functional fitness. Circuit bodyweight training is a weight training system using one's weight that can affect various physical and fitness components (Armanfar, 2024). Circuit weight training can cause very strong muscle contractions that are a response to dynamic loading or rapid stretching of the muscles involved (Zouhal et al., 2020). The effects caused by muscle hypertrophy will increase muscle power and muscle endurance. This statement is reinforced by the results of research from (Kaczor & Zydecka, 2020) which states that the increase in muscle power is caused by an increase in the number of contractile proteins, actin filaments, and myosin and increases the strength of connective tissue and ligaments. Exercises with maximum muscle contraction with a frequency of 3 times per week gradually for 6-8 weeks can increase muscle power by 30% (Sabillah et al., 2022). Therefore, this study was carried out by exercising 3 times per week and increasing the exercise load for 6 weeks, namely the realization of physical fitness, especially muscle power, and muscle endurance. Furthermore, recent discoveries support the hypothesis that circuit body weight training can improve physical condition, especially in the agility component.

Circuit bodyweight training is the best way to improve mobility, strength, and stamina. Circuit training Consists of 6 to 8 muscle power, explosive, and agility exercises that are completed one after the other. Each exercise is done for a certain number of reps or for a specified time before moving on to the next

exercise. The practice in each circuit is separated by a short rest time, and each circuit is separated by a longer rest time. The total number of circuits performed during a training session can vary from two to six depending on our training level (beginner, intermediate, or advanced), our training period (preparation or competition), and training goals. Muscle power and agility are very important in badminton, especially in smash techniques because without good strength and agility, a good smash technique will not be created, and vice versa with good muscle power will create a good smash technique (Sonoda et al., 2018). This is because when athletes make jumps when the smash is not fast and not strong they cannot do the smash attack optimally. The movement of the smash technique in badminton must be supported by muscle contraction, in addition to that it is a supporting factor because, in the smash technique, there is a forward body push movement (Rusdiana et al., 2021). Each individual has a different level of strength, so the results obtained in each individual's smash technique will be different. Limb power is needed in performing smash techniques in badminton, and muscle strength also has an important role in the success of smash techniques which will provide important energy for repulsion (Pratama, 2020). Large muscle power will allow a person to make a more targeted smash so that it can produce maximum achievement. In addition, cardiovascular endurance is also important in badminton, this is because, during a badminton match, it takes a long time to complete, so athletes do not easily experience defeat during the match (Obaid et al., 2022). This is in line with the research Nasrulloh et al., (2018) yang stated that in principle, a good and measured exercise program will be able to improve physical skills. Several factors may have contributed to the increase in this study, namely the increasing muscle power, muscle endurance, and agility as a result of exercise and the increasing level of muscle coordination. Furthermore, this study implies that coaches can apply the circuit bodyweight training method to badminton athletes to improve and improve the quality of muscle power, cardiovascular endurance, and agility.

Conclusions

Based on the Paired Sample t-test, the study shows significant improvements in muscle power, cardiovascular endurance, and agility after the treatment, indicating the effectiveness of circuit bodyweight training. To enhance its long-term application, it's crucial to involve key stakeholders. Coaches should be trained on the method's implementation, while sports organizations can provide necessary resources. Athletes should actively participate to ensure motivation and commitment. Regular feedback and adjustments can ensure the program remains effective, leading to sustained improvements in performance.

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