2024, Retos, 51, 1220-1225

The Effectiveness Of The Circuit Bodyweight Training Method In Improving Cardiovascular Endurance
La efectividad del método de entrenamiento de peso corporal del circuito para mejorar la resistencia cardiovascular

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Abstract. Cardiovascular endurance is very important to improve so it is expected that all students have good physical freshness. This study aims to find out: (1) the effect of the circuit bodyweight training method on increasing cardiovascular endurance and (2) the difference in the effect of the circuit bodyweight training method between the treatment group and the control group on increasing cardiovascular endurance. This type of research is an experiment with one group pre-test and post-test design. The sample in this study amounted to 77 people taken using random sampling techniques. The subjects were divided into 2 groups, namely the group given treatment of as many as 36 people and the control group with as many as 31 people. The instrument used to measure cardiovascular endurance is a multistage test. The data analysis technique used is an independent sample t-test followed by a paired sample t-test. The results showed that: 1) There was a significant effect of the circuit bodyweight training method on increasing cardiovascular endurance with a significance value smaller than 0.05 ($p<0.05$). 2) There was a significant difference in influence between the treatment group and the control group on increasing cardiovascular endurance, it was proven that the average value of cardiovascular endurance in the treatment group was 760.72 while the average value of cardiovascular endurance in the control group was 623.54 with an average difference in post-test of 137.18. The treated group had better cardiovascular endurance compared to the untreated control group.
Keywords: Circuit, Body Weight Training, Cardiovascular endurance.

Resumen. Es muy importante mejorar la resistencia cardiovascular para que se espere que todos los alumnos tengan una buena frescura física. Este estudio tiene como objetivo averiguar: (1) el efecto del método de entrenamiento de peso corporal en circuito sobre el aumento de la resistencia cardiovascular y (2) la diferencia en el efecto del método de entrenamiento de peso corporal de circuito entre el grupo de tratamiento y el grupo de control sobre el aumento de la resistencia cardiovascular. Este tipo de investigación es un experimento con un diseño grupal previo y posterior a la prueba. La muestra en este estudio ascendió a 77 personas tomadas utilizando técnicas de muestreo aleatorio. Los sujetos se dividieron en 2 grupos, a saber, el grupo que recibió tratamiento de hasta 36 personas y el grupo de control con hasta 31 personas. El instrumento utilizado para medir la resistencia cardiovascular es una prueba de varias etapas. La técnica de análisis de datos utilizada es una prueba t de muestra independiente seguida de una prueba t de muestra pareada. Los resultados mostraron que: 1) Hubo un efecto significativo del método de entrenamiento de peso corporal en circuito sobre el aumento de la resistencia cardiovascular con un valor de significación menor que 0,05 ($p<0,05$). 2) Hubo una diferencia significativa en la influencia entre el grupo de tratamiento y el grupo control en el aumento de la resistencia cardiovascular, se comprobó que el valor promedio de la resistencia cardiovascular en el grupo de tratamiento fue de 760,72, mientras que el valor promedio de la resistencia cardiovascular en el grupo control fue de 623,54 con una diferencia promedio en el post-test de 137,18. El grupo tratado tuvo una mejor resistencia cardiovascular en comparación con el grupo de control no tratado.
Palabras Clave: Circuito, Entrenamiento con pesas corporales, Resistencia cardiovascular.

Fecha recepción: 19-06-23. Fecha de aceptación: 09-11-23
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Introduction

Physical freshness is an important physical aspect as the main basis for supporting every human activity. Different levels of physical freshness will affect everyone's ability to carry out activities (Hauschild & Friedl, 2017; Teresa & Henrique, 2017). In terms of physical work physiology, the element of physical freshness can be divided into two, namely physical freshness related to physical health, and physical freshness related to sports skills (Erickson et al., 2014; Yuniana et al., 2023). Physical freshness is related to health when physical activity can be done without significant fatigue. Elements of physical freshness related to health include cardiovascular endurance, muscle strength, muscular endurance, flexibility, and body composition. The element of physical freshness related to skills includes speed. power, balance, agility, coordination, and reaction speed. Physical freshness is very important for students at school because it is a strategic goal to improve the quality of Human Resources (HR). One of the most important physical components needed by students is cardiovascular endurance (Dimarucot & Macapagal, 2021; Mok et al., 2015).

Cardiovascular endurance is very important to improve so it is expected that all students have good physical freshness so that they can do physical activity for a relatively long time without significant fatigue so that they can enjoy the remaining free time. In other words, good cardiovascular endurance will affect student activities where students will be more enthusiastic in participating in learning (Donnelly et al., 2017; Marques et al., 2017). Given the importance of the role of cardiovascular endurance for students, the cardiovascular endurance of students needs to be improved. The most effective way to improve physical fitness is to exercise regularly. Sports activities that can increase physical fitness are sports that are enough to put a burden on the heart and lungs (Barnard et al., 2019; Sonchan et al., 2019).

However, the reality is that the ability of cardiovascular

endurance is still not optimal for sport science students. Based on observations made by researchers on April 1, 2023, at the Sports Hall of Yogyakarta State University, a lecturer who teaches physical condition revealed that the Vo2Max ability of sport science students is still low, this is because the exercise program to improve cardiovascular endurance is not effective and is still inappropriate. Researchers obtained the latest data from physical condition lecturers during the cardiovascular endurance test using a multistage test obtained a Vo2Max value of 22.7, the results were included in the category of less once. Previous sports were only more about muscle strength, agility, and speed training, so cardiorespiratory endurance was neglected. If this continues to be allowed, it will certainly have a bad impact and there will be a decrease in physical condition and fitness when attending sports lectures for sport science students.

Based on the results of previous literature, there are already several methods of physical exercise to increase cardiovascular endurance. Physical training programs that previously did more, cycling, swimming, and interval running, and some used external weights, but there is no more varied physical exercise method, namely physical training using your body weight which is divided into several posts or called circuit bodyweight training. Nasrulloh et al., (2022) mentioned that weight training can be done using weights from one's body weight (body weight) or using external weights, namely free weights such as dumbbells, barbells, and machines (gym machines). Training using deep weights tends to be easier to do anywhere because the loading system only uses its weight. Body weight training is weight training that emphasizes more on how to exercise using deep weights or your body weight.

Circuit bodyweight training is an exercise system that can simultaneously improve the entire body, namely endurance, strength, flexibility, power, muscular endurance, agility, speed, balance, and several other components of physical condition (Hartati et al., 2020; Yuniana et al., 2023). Circuit bodyweight training is a combination of aerobic and endurance exercises using one's body weight that is done in a short time and can be done anywhere (Nasrulloh et al., 2021; Teofa et al., 2022). Their initial circuit training series consisted of several stations arranged in circles to train muscle groups alternately from station to station (Nasrulloh et al., 2022; Romero-arenas et al., 2013). Circuit training is a form of conditioning that combines high-intensity resistance and aerobic training (Martins et al., 2020). It is designed to be easy to follow and targets strength-building as well as muscular endurance (Linhares et al., 2022). Based on the problems that have been developed previously, the purpose of this study is to determine the difference in the effect of the circuit method of body weight training between the treatment group and the control group on cardiovascular endurance.

Research Methods

Study Design

This study used a type of quasi-experimental research with a pre-test design and a post-test control group design. This experimental study used 2 different groups, namely the treatment group and the control group not given treatment. This type of quasi-experimental research means that researchers are not able to control all variables that can influence them. Therefore, the researchers did not control for physical activity outside the exercise program, we did not monitor specifically.

Subject

The population in this study was sports science students. The sample in this study amounted to 77 people taken using the purposive sampling technique. This study applied inclusion criteria to determine the sample of this study, which is based on certain criteria desired by the researcher, including male sample, sample aged 18-22 years, sample willing to follow the exercise program given, sample able to follow all exercise programs that have been prepared by the researcher. The exclusion criteria in this study are things that cause samples not to meet the criteria to be sampled, such as samples in a sick state. The sample was divided into 2 groups, namely the group that gave treatment to as many as 36 people and the control group as many as 31 people. This research has received approval from all samples who have filled out a statement of ability to become a research sample and have met the requirements of the research code of ethics

Procedure

Data collection techniques in this study are tests and measurements. The instrument used to measure cardiovascular endurance is a multistage test (Yan et al., 2016). The first stage of the research procedure is to conduct a pre-test to find out the initial data of cardiovascular endurance using a multistage test after that circuit weight training is given 16 times a meeting with a frequency of 3 times a week, and an increase in sets is carried out after the 9th meeting or week 4. Bompa & Buzzichelli, (2019)It is said that an enhanced set of exercises during 4 weeks of exercise can improve cardiovascular endurance. After 16 appointments, researchers took final test scores or post-tests to measure cardiovascular endurance after treatment.

There are details of the Circuit Weight Training training program using internal weights as follows:

Table 1.
Training program session 1-8 Circuit Weight Training

No.	Exercise	Set	Reps	Breaks between posts	Breaks between sets
1.	Shuttle run	2	12 times	20 second	120 second
2.	Frog Jump	2	12 times	20 second	
3.	Side Jump	2	12 times	20 second	
4.	Half Squat	2	12 times	20 second	
5.	Lateral Run	2	12 times	20 second	
6.	Bench Jump	2	12 times	20 second	
7.	zig-zag Run	2	12 times	20 second	
8.	Jogging	2	-	20 second	

Table 2.
Training program session 9-16 Circuit Weight Training

No.	Exercise	Set	Reps	Breaks between posts	Breaks between sets
1.	*Shuttle run*	3	15 times	20 second	120 second
2.	*Frog Jump*	3	15 times	20 second	
3.	*Side Jump*	3	15 times	20 second	
4.	*Half Squat*	3	15 times	20 second	
5.	*Lateral Run*	3	15 times	20 second	
6.	*Bench Jump*	3	15 times	20 second	
7.	*zig-zag Run*	3	15 times	20 second	
8.	*Jogging*	3	-	20 second	

Statistical analysis

The data analysis technique used in this study using SPSS 22 uses an independent sample t-test and continues with a paired sample t-test. Previously, prerequisite tests were carried out for normality and homogeneity tests

Results

a. Normality Test

A normality test is performed to test whether the data has a normally distributed distribution or not. The calculation of data normality is carried out using the Kolmogorov-Smirnov test. The normality test results are shown in the table below.

1) Treatment Group

Table 3.
Pre-Test and Post-Test Data Normality Test Treatment Group

Data	Significance	*P*	Information
Pre-cardiovascular endurance test	0,05	0,641	Usual
Post-cardiovascular endurance test	0,05	0, 765	Usual

Based on a statistical analysis of normality tests that have been carried out using the Kolmogorov-Smirnov test, the pretest and post-test data of the treatment group were obtained from the results of the normality test of the $p > 0.05$ significance value data, which means that the data is normally distributed, it can be concluded that all pre-test and post-test data in the treatment group are declared normal.

2) Control Group

Table 4.
Control Group Pre-Test Data Normality Test Result

Data	Significance	*P*	Information
Pre-cardiovascular endurance test	0,05	0,246	Usual
Post-cardiovascular endurance test	0,05	0,189	Usual

Based on the statistical analysis of the normality test that has been carried out using the Kolmogorov Smirnov test, the control group's pretest and post-test data obtained from the normality test results of $p > 0.05$ significance data, which means that the data is normally distributed, it can be concluded that all pre-test and post-test data in the control group are declared normal.

b. Homogeneity Test

The homogeneity test is 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 the treatment group and the control group of this study are as follows:

Table 5.
Test results of homogeneity of pre-test and post-test data

	Group	F count	*p*	Information
Pre-cardiovascular endurance test	Treatment	1,144	0,289	Homogeneous
	Control			
Post-cardiovascular endurance test	Treatment	0,196	0,659	Homogeneous
	Control			

Results of homogeneity test to test the similarity of variance of pre-test post-test data between the treatment group and the control group. Since the significance value is greater than 0.05 ($p>0.05$), it can be stated that the pre-test and post-test data between the treatment group and the control group are homogeneous.

c. Test Effectiveness

1) Independent Sample t-Test Results

a) Pre Test

The results of the independent sample t-test on the pre-test data compared between the treatment group and the control group are as follows:

Table 6.
Results of Independent Sample T-test Data Pre-Test

Data	Group	*Mean*	t count	*p*	Information
Cardiovascular endurance	Treatment	596,77	0,251	0,803	Significant
	Control	588,25			

Based on the results of the Independent Sample t-test analysis, cardiorespiratory endurance data obtained a calculated t-value of 0.251 with a significance value of 0.803. Because the significance value of 0.803 is greater than 0.05 ($p>0.05$), it can be concluded that there is no significant difference in cardiorespiratory endurance between the treatment group and the control group at the time of the pre-test. This means that both groups had the same cardiorespiratory endurance before being treated in the treatment group.

Based on the results of the analysis, the average value of cardiovascular endurance in the treatment group was 596.77 while the average value of cardiovascular endurance in the control group was 588.25. This means that the treatment group had a better cardiovascular endurance average compared to the control group that did not receive treatment.

b) Post Test

The results of the independent sample t-test on the post-test data compared between the treatment group and the control group are as follows:

Table 7.
Results of Independent Sample T-test Data Post-Test

Data	Group	*Mean*	t count	*p*	Information
Cardiovascular endurance	Treatment	760,72	3,975	0,000	Significant
	Control	623,54			

Based on the results of the Independent Sample t-test analysis, cardiorespiratory endurance data obtained a calculated t-value of 3.975 with a significance value of 0.000. Because the significance value of 0.000 is less than 0.05 ($p<0.05$), it can be concluded that there is a significant difference in cardiorespiratory endurance between the treatment group and the control group.

Based on the results of the analysis, the average value of cardiorespiratory endurance in the treatment group was 760.72 while the average value of cardiorespiratory endurance in the control group was 623.54. This means that the treatment group had better cardiorespiratory endurance compared to the control group that did not receive treatment.

2) Paired Sample t-Test Results

a) Treatment Group

Table 8.
Results of Paired Sample T-test Treatment Group

Data	Group	*Mean*	t count	*p*	Information
Cardiovascular endurance	Pre-test	596,77	5,506	0,000	Significant
	Post-test	760,72			

Based on the results of the Paired Sample t-test analysis, cardiorespiratory endurance data obtained a calculated t-value of 5.506 with a significance value of 0.000. Because the significance value of 0.000 is smaller than 0.05 ($p<0.05$), it can be concluded that there is a significant difference in cardiorespiratory endurance during the pre-test and post-test in the treatment group. This means that there is a significant increase in cardiorespiratory endurance before and after treatment.

b) Control Group

Table 9.
Results of Paired Sample T-test Control Group

Data	Group	*Mean*	t count	*P*	Information
Cardiovascular endurance	Pre-test	588,25	1,761	0,088	Significant
	Post-test	623,54			

Based on the results of the Paired Sample t-test analysis, cardiorespiratory endurance data obtained a calculated t-value of 1.761 with a significance value of 0.088. Because the significance value of 0.088 is greater than 0.05 ($p > 0.05$), it can be concluded that there is no significant difference in cardiorespiratory endurance during the pre-test and post-test in the control group.

Discussion

The discussion of the results of this study provides a further interpretation of the results of the data analysis that has been presented.

The discussion of the results of the analysis can be further described as follows.

1. The effect of the Circuit Body Weight Training method on increasing cardiovascular endurance

Based on hypothesis testing, it is known that there is an effect of the circuit bodyweight training method on increasing cardiovascular endurance. Circuit weight training is an effective training method to develop physical fitness variables, one of which is cardiovascular endurance. These findings are in line with several previous studies (Sultana et al., 2019) They found that high-intensity circuit training can improve cardiovascular endurance in moderately fit populations. These findings are consistent with some previous evidence (Yadav & Sardar, 2017) Explained that circuit weight training for 6 weeks is an effective method to develop physical fitness variables, one of which is cardiovascular endurance. The increase in cardiovascular endurance may be due to the intensity of training, circuit weights, and movement speed. Recent findings support the hypothesis that circuit weight training methods can improve physical condition, especially in the cardiovascular endurance component (Benito et al., 2016). The use of circuit training systems affects cardiovascular endurance. Circuit training is very effective and can be applied to improve functional fitness (Romero-arenas et al., 2013). Circuit training is an excellent way to improve cardiovascular endurance. Body weight training circuit training consists of 6 to 8 exercises completed one after the other. Each exercise is performed for a specific number of reps or for a set time before moving on to the next exercise. Training within each circuit is separated by short rest periods, and each circuit is separated by longer rest periods. 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.

Circuit Weight training is an exercise system that can affect various physical and fitness components. This training method also requires balance, because in its implementation circuit training is carried out with fast movements so that the role of the knee and ankle balancing muscles is also needed to maintain balance during exercise. Circuit weight training affects cardiovascular endurance, circuit weight training can also strengthen the respiratory muscles so that it provides great benefits for the maintenance of cardiopulmonary fitness, and involves three variables at once (intensity, repetitions, duration) (Oliveira-junior et al., 2021). With circuit training athletes can manage training variations, saving time and tolerating individual differences.

In addition, doing exercises in the open air helps a person in breathing clean air, and getting a natural atmosphere.

2. The effect of differences in circuit bodyweight training methods between the treatment group and the control group on increasing cardiovascular endurance

The results of the analysis showed that there was a significant difference in influence between the treatment group and the control group on increasing the cardiovascular endurance of sports science students. The group of students who were given circuit weight training treatment was better than the control group in increasing muscle strength, muscle endurance, and balance of wrestling athletes. This is supported by the results of previous research (Azeezul et al., 2016) said that the experimental group had significant differences in all physical fitness variables when compared to the control group. It was therefore concluded that six weeks of circuit weight training can improve cardiovascular endurance. The implication of this study is to produce an appropriate and effective circuit weight training exercise program to increase the cardiovascular endurance of sports students. In other words, good cardiovascular endurance will affect student activities where students will be more enthusiastic in participating in learning.

Conclusion

Based on the results of data analysis using the Independent Sample t-test and continued with the Paired Sample t-test, conclusions can be drawn in this study: a) there was a significant increase in cardiovascular endurance before and after treatment, and there was no significant increase in the control group, b) the group given the circuit bodyweight training method treatment had better cardiovascular endurance than with an untreated control group.

Acknowledgment

This research article can be carried out well thanks to the help of various parties, therefore the researchers express their deepest gratitude to all levels of lecturers at the faculty of sports science, Yogyakarta State University.

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