

## EFFECT OF 6 WEEKS OF CIRCUIT TRAINING ON INCREASED VO<sub>2</sub> MAX

**Moch. Yunus**

Universitas Negeri Malang

Email: moch.yunus.fik@um.ac.id

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**ABSTRACT**

This study aimed to analyze the effect of 6 weeks of Circuit Exercise on increasing VO<sub>2</sub>max. The research design applied to this study used pre-experimental with one group pretest and posttest design. The number of subjects of this study was 24 Opel Futsal Club U-16 athletes in Lamongan Regency. The treatment in the study was in the form of circuit training, carried out as many as 18 meetings for 6 weeks with a frequency of exercise 3 times a week. The test instrument used in this study was a multistage fitness test. Technical analysis uses a t-test with the prerequisites of a normality test. The results of the study found that the VO<sub>2</sub>max mean pretest value was 39.29 ml / kg / minute and for the posttest mean results was 43.93 ml / kg / minute. The results of paired sample t-test analysis are  $0.000 < 0.05$ . Based on the results of the analysis, it can be concluded that 6 weeks of circuit training can increase VO<sub>2</sub>max significantly.

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### INTRODUCTION

Futsal is a sport that is carried out with high training intensity. Futsal requires short sprints and changes in direction relatively quickly, and alternatives with short rest periods for long games. Futsal uses an indoor field with a size of 40 x 20 m, played by 5 on 5 including kippers. Futsal playing time is 2 x 20 minutes with a break between the change of hours and the game being stopped when the ball goes off the field. Therefore, the time needed to play futsal is more than 40 minutes (Väkäkoitti, 2017). This condition requires futsal players to have the agility to change positions quickly, and must also have good cardiorespiratory endurance.

Futsal games require fast and dynamic conditions, for that in order to be able to do a fast and dynamic futsal game, good mastery of basic techniques must be needed. In addition to mastering good basic techniques, to achieve optimal performance in futsal also requires good physical condition as well. Players are required to move back and forth, left and right quickly. The futsal game takes place quickly, where all athletes are required to always be involved both when attacking and defending. Thus, it takes endurance ability as well as speed of players well (Scheunemann et al., 2020).

Endurance or endurance has a vital role in the game of futsal. Endurance can be categorized into two, namely muscular endurance and cardiorespiratory endurance. Cardiorespiratory endurance is the ability of the heart, lung and blood vessel systems to function optimally at rest and work in taking oxygen and releasing it to active tissues so that it can be used in the metabolic process of energy formation in body cells. Physiologically, the ability of maximum cardiorespiratory endurance indicates the ability to use maximum oxygen per minute which describes a person's aerobic capacity or VO<sub>2</sub>max (Rahmad, 2016). Players who have VO<sub>2</sub>max, then can produce optimal aerobic energy metabolism, so that when doing physical activity and movements in futsal can be repeated without experiencing fatigue.

VO<sub>2</sub>max describes the level of effectiveness of the body to get oxygen, then send it to the muscles and other cells and use it optimally in procuring energy aerobically, where at the same time the body removes metabolic waste that can inhibit physical activity (Al-Rahmad & Fadillah, 2016). In

order for VO<sub>2</sub>max to increase, it requires a careful, systematic, regular and ever-increasing exercise program and following accurate training principles and methods. Exercise methods to increase cardiorespiratory endurance or VO<sub>2</sub>max can use several exercise methods including: circuit, interval, and continuous training (Yunus, 2017). One of the training methods used in this study is circuit training. Circuit training is a very popular exercise method in fitness and health improvement programs, because circuit training can modulate and induce physiological benefits, such as strength and cardiovascular-respiratory adaptation (Lubauer, Belli, Peterlik, Hurle, & Lohbauer, 2022). Often we get the schedule of Futsal Tournament matches in Indonesia erratic / sudden. This condition causes the preparation of athletes in facing the competition is not enough time to compile the ideal training periodization. Exercise periodization takes a considerable amount of time to produce optimal Exercise adaptations. Often we are faced with the situation of preparing the physical condition of the athlete before the game or at the pre-match stage for only 1-2 months. Therefore, the right training method is needed to improve the physical condition of athletes in a short time, namely by using the circuit training method. According to (Handayani & Harsono, 2016), circuit training is an exercise system that can develop overall body fitness, which are elements of endurance, strength, flexibility, power, muscular endurance, agility, speed and others.

(Artawan, Meitriana, & Zukhri, 2015) based on research conducted concluded that there is an effect of providing circuit training on increasing VO<sub>2</sub>max. According to (Widyaningrum & Romadhoni, 2018), Circuit training can increase cardiovascular endurance, where with this training the process of blood distribution and return to the heart is smoother, resulting in the collapse of metabolic processes in the body. The application of circuit training in each sport needs to pay attention to the biomotor component that is dominant in the sports trained, including futsal. So that the circuit training training model between one sport and another is different (Clemente, Nikolaidis, Martins, & Mendes, 2016). The Circuit training model used by researchers is a model of modifying the shape and intensity of the exercise. The forms of exercise given are more varied, including 20 m sprint, zig-zag run, 10 m shuttle run, hexagon drill, , speed and agility, skipping and jogging and speed run.

Previous research related to the increase in VO<sub>2</sub>max due to circuit traing results vary widely. Research conducted by (Festiawan, Suharjana, Priyambada, & Febrianta, 2020), showed an increase in VO<sub>2</sub>max by 27.9%, while research conducted by (Ramadhani, 2018), circuit traing was only able to increase VO<sub>2</sub>max by 3.8%.

Preliminary research conducted by researchers on Opel Futsal Club U-16 athletes during trial matches, obtained the results of observations of many athletes who experienced fatigue.

Based on these observations, researchers assume that VO<sub>2</sub>max in Opel Futsal Club U-16 players is still a low category. Based on this, the researcher wanted to analyze the effect of 6 weeks of circuit training on increasing VO<sub>2</sub>max in Opel Futsal Club U-16 athletes Lamongan Regency.

## RESEARCH METHODS

The design in this study was a pre-experimental design with a one group pretest posttest design. The independent variable in this study was circuit training, while the dependent variable was an increase in VO<sub>2</sub>Max.

The subjects in this study used subjects as many as 24 Opel Futsal Club U-16 athletes in Lamongan Regency who were active in training. This research was conducted at the Opel Futsal Club U-16 training ground Lamongan Regency. The circuit training treatment is carried out with frequency of training 3 times a week as many as 18 meetings for 6 weeks. The test instrument in this study used a multistage fitness test. The data were analyzed using paired sample t-test technique. Analysis requirements This test technique uses a data normality test (Shapiro-Wilk technique), and the test uses a  $\alpha$  of 0.05.

## RESULTS AND DISCUSSION

### RESULT

VO<sub>2</sub>Max research data consists of pretest and posttest data. Pretest data were taken at the beginning of the research activity before the subjects were given treatment, while posttest data were

taken at the end of the research activity after the subjects were given 18 exercises. The data that have been obtained by researchers will be presented in the following table.

**Table 1. Description of VO<sub>2</sub>Max Pretest and Posttest Data**

Variable		Sum	Mean	SD	Min.	Maks.
VO <sub>2</sub> Max (ml/kg/minute)	<i>Pretest</i>	24	39,29	4,013	34,50	45,80
	<i>Posttest</i>	24	43,93	4,878	39,90	48,60

In table 1 above, the average VO<sub>2</sub>Max in the pretest is 39.29 ml / kg / minute and the VO<sub>2</sub>Max posttest is 43.93 ml / kg / minute which is greater than the pretest value. As a condition for continuing data analysis in this study, it is necessary to conduct a normality test. The normality test in this study used the Shapiro Wilk test at the significance level of  $\alpha = 0.05$

<b>Table 1. Summary of VO<sub>2</sub>Max Pretest and Posttest Normality Test Results Shapiro-Wilk</b>			
<b>Dat</b>	<b>Statistic</b>	<b>df</b>	<b>Sig.</b>
<b>a</b>			
<i>Pret</i>	0,932	24	0,171
<i>Post</i>	0,968	24	0,715

Based on table 2, the pretest normality test result was 0.171 and the posttest result was 0.715. The normality test results of the pretest and posttest data are greater than the significance level of 0.05, this indicates that the data are normally distributed.

The next rare hypothesis test was carried out using paired sample t-test analysis to analyze the difference between 2 mean scores obtained from the same subject.

**Table 3 Paired Sample t-Test Results**

<b>Paired Sample t-Test</b>	<b>Mean</b>	<b>SD</b>	<b>T</b>	<b>df</b>	<b>Sig.</b>
<i>Pretest/Posttest</i>	-1,570	0,869	-8,076	19	0,000

Based on table 3, from the analysis of the paired sample t-test, a Sig result of 0.000 was obtained. The results of the analysis found that Sig 0.000 < 0.05., then the null hypothesis stating that there was no increase in VO<sub>2</sub>Max due to circuit training for 6 weeks in Opel Futsal Club U-16 athletes Lamongan Regency was rejected.

## DISCUSSION

VO<sub>2</sub> max can also be interpreted as a person's maximal ability to consume oxygen during physical activity at an altitude equivalent to sea level. VO<sub>2</sub> max Reflect. pulmonary, cardiovascular, and hematological conditions in oxygen delivery, as well as oxidative mechanisms of muscles that perform activities. During the first minutes of exercise, oxygen consumption

Increase until finally a steady state is reached where oxygen consumption is in accordance with exercise needs. Along with this steady state there is also an adaptation of pulmonary ventilation, heart rate, and cardiac output. A good VO<sub>2</sub>Max level is indispensable in achieving optimal

performance in a player. Good VO<sub>2</sub>Max can also reduce the risk of injury to players during training and matches. A good VO<sub>2</sub>Max can be obtained through programmed exercises. The impact of sports training will increase the body's metabolism. Increased metabolism will be followed by increased consumption of O<sub>2</sub>. O<sub>2</sub> consumption is used in the mechanism of aerobic energy formation so that energy needs for these activities can be met (Yunus, 2017).

Physiologically, exercise exerts physical stress on the body that can produce an adaptive response. The recommended physical exercise is as long as the body is able to adapt to the excessive load on the body (overload principle). Training at a high enough intensity can induce specific adaptations that allow the body to function more efficiently (Ferrer & McArdle, 2010). Adaptation to the 'slow answer' is a change in the structure and function of body organs that are more sedentary due to physical exercise carried out regularly in a certain period of time. Adaptation will only arise if the training load given the intensity is sufficient and lasts long enough.

There are several methods to increase cardiorespiratory endurance or VO<sub>2</sub>Max, one of which is circuit training. Circuit training is an exercise method that will include exercises for 1) muscle strength, 2) muscle endurance, 3) flexibility, 4) agility, 5) balance, and 6) cardiopulmonary endurance (Hanggoro, Kridalukmana, & Martono, 2015). The implementation of circuit training is that athletes move from one training station to another in a planned sequence and in the shortest possible time. Circuit training is categorized on the basis of the number of training items per set: 1) short circuit training, consisting of 6 training items; 2) normal circuit training, consisting of 9 training items, and 3) long circuit training, consisting of 12 training items (Budiwanto, 2012). In general, there are two types of circuit training, namely 1) circuits with specified loads and 2) circuits with individual loads (Khotimah, 2011: 22).

The provision of a routine training program was carried out during the study with an intensity ranging from 65% to 85% of the maximum pulse rate of the players. Exercise intensity is very important to encourage changes in cardiorespiratory levels (Ferreira, 2013: 1). The initial intensity given to the subject aims at the adaptation of the exercise so that the body responds well to the exercise program. This circuit training program in addition to increasing training load and intensity also pays attention to sufficient recovery for athletes to have enough rest time between sets. In the preparation of this training program, athletes are given a recovery time of 1: 1 and 1: 2 according to the time of each set. So the player carries out 1 time then the player has a recovery time of 2 times that time. Increased training load and decreased recovery time are based on the principle of increased load (Kroneman et al., 2013). Budiwanto (2012) explained that "in order for physical formation training to be achieved in accordance with the objectives, the exercise must be done regularly, steadily, continuously without intermittent with the right load in accordance with the exercise plan". The circuit training program given by researchers is carried out regularly, and repeatedly for 6 weeks with a frequency of 3 times per week as many as 18 meetings with increased loads regularly already refer to theory.

The results of the study found an average VO<sub>2</sub>Max pretest value of 39.29 (less category), while the average VO<sub>2</sub>Max Posttest value was 43.93 (sufficient category). The description above, it can be seen that there is an increase in VO<sub>2</sub>Max values in Opel Futsal Club U-16 players in Lamongan Regency. Increased VO<sub>2</sub>Max value by 10.56%. The increase can be seen from the difference in the average value (mean) of the pretest and posttest. This shows the effect of circuit training given to the increase in VO<sub>2</sub>Max in research subjects. Likewise, research conducted by Bahtra, et al (2020) circuit training was able to increase VO<sub>2</sub>Max by 7.5%. The results of this study are also in line with research conducted by Balasingh & Night (2018), obtained significant VO<sub>2</sub> Max increase results. Another study conducted by Gokulkrishnan (2018) entitled Effect of circuit training and interval training on vital capacity and VO<sub>2</sub> max in women badminton players, also showed significant results of increasing VO<sub>2</sub> max due to circuit training. Research conducted by Rachmawan, et al (2016), obtained the results of an increase in VO<sub>2</sub> max of the Interval training method by 3.59%, while in the circuit training method there was an increase in VO<sub>2</sub> max by 5.69%. This is in line with research conducted by Taufik, et al (2021), it was found that the interval training method increased by 2.93%, while the circuit training method increased by 10.57%. Likewise, research conducted by Yunus and Rahajo (2022) obtained the results of an increase in Vo<sub>2</sub> max in the interval training method by 4.74% and the circuit training method by 10.07%.

In this study, researchers used 6 weeks of exercise, and it was proven by the length of exercise there was a significant increase in VO<sub>2</sub> max. This research is in line with research conducted by Hasan

(2020) who conducted research with a circuit training program with a frequency of 3X / week for 6 weeks, very significant results were obtained that there was an increase in the average VO<sub>2</sub>max. Likewise, the results of research by John, et al (2023) conducted a study on ninety obese students (69 women and 21 men) who received circuit training treatment 3X / week, for 6 weeks, with moderate intensity. The results concluded that 6-week circuit training had a beneficial but not significant effect on body image, and there were significant differences in aerobic capacity, cardiovascular parameters, and some body composition parameters. Research conducted by Taufik, et al (2021), with a sample of athletes from the Cianjur City Futsal Academy, Indonesia, through random sampling techniques, and a sample of 30 athletes. The samples were divided into two groups, which included the interval training group (n = 15) and the circuit training group (n = 15). Treatment 3x a week for 6 weeks. The conclusion of the study was that there were differences in VO<sub>2</sub>max increase from both groups Conclusion (1) there was a significant effect of circuit training and interval training on increasing VO<sub>2</sub>max, (2) circuit training was better at increasing VO<sub>2</sub>max than interval training. 6 weeks circuit training was also carried out by Vianna, et al (2020), conducting research on U15 soccer players after 4 weeks of detraining, then given 6 weeks of circuit training treatment. The conclusion is that a special 6-week circuit training for football is effective for improving the physical performance of U15 soccer players. In line with research conducted by Siskawati, et al (2022) conducted a study with 6 weeks of circuit training treatment on athletes of Laddy Phantom Fc Pontianak Women's Futsal Club with a sample of 15 athletes. The conclusion of the study is that there is an effect of circuit training on increasing the maximum oxygen volume of the Laddy Phantom Fc Pontianak Women's Futsal Athlete Club.

The results of research that has been conducted by Kisner et al., (2017). explained that the increase in VO<sub>2</sub> max after the training program only occurred for 8-12 weeks then the VO<sub>2</sub>Max value will be flat (not increased) even though it is still doing a high-intensity training program. This shows that the adaptation of exercise is greatly influenced by the length of exercise. Some previous studies have shown that the length of exercise of 4 weeks produces different conclusions. Permadi, et al (2020), have conducted research on a sample of students who participated in basketball extracurricular 15 male students. Performed circuit training three times a week for four weeks with exercise intensity 65% - 90% of maximum pulse rate, it was concluded that circuit training significantly improved cardiorespiratory ability. Sperlich, et al (2018), concluded that the intervention of 4 weeks of high-intensity circuit training could not significantly improve cardiorespiratory fitness in untrained young adults. Umar, & Tomoliyus, (2018), conducted a study on beginner basketball athletes, with a 4- and 6-week circuit periodization exercise program. The conclusion of the study was that there was a significant increase in aerobic endurance in both treatment groups, and there was a significant difference in the effect between 4- and 6-week circuit training on aerobic endurance.

In a study with a length of exercise of 8 weeks or more showed the results of DUANGSAWANG, et al (2023), conducting a study with circuit training treatment 3x / week, for 8 weeks it was concluded that circuit training significantly increased physical fitness and VO<sub>2</sub>max in male students. Training with a duration of 8 weeks was also carried out by Ariani, et al (2022), having conducted research on male badminton athletes, aged 9-12 years, totaling 60 athletes, with 3x/minggu circuit training treatment for 8 weeks. The conclusion of the study that continuous and competitive circuit training can significantly increase VO<sub>2</sub> max in badminton athletes Park, et al (2019) concluded the effect of 12 weeks of high-intensity circuit training obtained results 1) a significant decrease in body mass index and percentage of body fat and waist circumference. 2) experienced significant improvements related to physical conditions which included: muscle strength, muscular endurance, muscle strength, flexibility, balance, and cardiorespiration endurance, and 3) experienced significant improvements in fasting lipids, glucose, insulin, and insulin resistance. Circuit training has also proven to be beneficial for our blood system. Training with a duration of 12 weeks was also carried out by Singh (2022) on badminton athletes with a sample of 45 athletes with an age range of 18-25 years. The selected subjects were divided into two experimental groups and a control group with 15 subjects in each group. Experimental group I (CTG=15) underwent circuit training, Group II (ITG=15) underwent interval training and Group III as the control group (CG=15). During the training period, both experimental groups underwent training programs for 12 weeks each (4 days/week). The conclusions from the circuit training and interval training studies had significant positive improvements in Vital capacity and VO<sub>2</sub> max levels. This is shown from the results of research by

Tsegay, et al (2021), based on research conducted by providing high-intensity circuit exercise and 3X/week moderate-intensity circuit exercise for 16 weeks to analyze red blood cells (RBC), white blood cells (WBC), Hemoglobin (Hgb), Hematocrit (HCT), Average cell volume (MCV) and Mean cell hemoglobin (MCH). The high-intensity circuit training group increased significantly in red blood cells (RBC), WBC, Hgb and MCV compared to the control group with (519,  $P=.000$ ), (91,595,  $P=.000$ ), (.903,  $P=.019$ ) and (5,668,  $P=.000$ ) respectively. Similarly, conclusions in the moderate-intensity circuit exercise group increased significantly from control groups in RBC, WBC, Hgb and MCV with mean differences of (.746,  $P=.000$ ), (1.894,  $P=.000$ ), (1.238,  $P=.000$ ) and (2.777,  $P=.000$ ) respectively. The high-intensity circuit training group decreased significantly. Gokulkrishnan (2018), conducted a study with the treatment of circuit training 4X a week, for 12 weeks on female badminton athletes with an age range of 20-24 years. The conclusion of the study is that circuit training there is a significant positive increase in vital capacity and VO<sub>2</sub> max levels. Circuit training is also beneficial for the circulation system, this is shown by the results of research conducted by Ujuagu, et al (2021). Researchers conducted a study with a sample of all 60 female teachers from 6 secondary schools in the Otuocha Educational Zone. Treat given Circuit training for 8 weeks. The conclusion of the study was a significant reduction in systolic and diastolic blood pressure from the experimental group. Khattak, et al (2020), conducted a study on 30 healthy students, aged 18-22 years. The circuit training treatment was given to the experimental group three times a week on alternate days for 12 weeks. The conclusion of the study was that there was a significant increase in cardiorespiratory endurance in the experimental group ( $p < 0.05$ ) compared to the control group. Other benefits of circuit training are also shown from the results of research conducted by Makkubhai (2023), with treatment 8 weeks of high-intensity circuit training. The conclusion of the study found that there was a significant increase in lung vital capacity and a significant decrease in body mass index and body fat. Sonchan, et al (2017) conducted a study with circuit training treatment for 8 weeks. Research conclusions show that circuit training programs improve muscle strength, agility, anaerobic capacity and cardiovascular endurance. Based on the results of the t-test analysis of the re-observation (paired sample t-test) obtained results of  $0.000 < 0.05$ . In this test, the interpretation of VO<sub>2</sub> Max increase is seen from sig. (2-tailed) is 0.000. Sig results. (2-tailed) shows that smaller than  $\alpha=0.05$ , then the null hypothesis that states there is no increase in VO<sub>2</sub>Max due to circuit training in Opel Futsal Club U-16 athletes Lamongan Regency is rejected. So it can be concluded that there is a significant difference between the initial test (pretest) and the final test (posttest), and it can be interpreted that there is a significant increase in VO<sub>2</sub> max due to circuit training in Opel Futsal Club U-16 athletes in Lamongan Regency.

## CONCLUSION

Based on the results of research and discussion that has been described, it can be concluded that six weeks of circuit training increases VO<sub>2</sub>Max significantly. Increased VO<sub>2</sub>Max value by 10.56%.

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