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Continuous and competitive circuit training: Methods to increase vo2max on young badminton player

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ABSTRACT

The characteristic of badminton game is a sport with high intensity and intermitten actions. It takes the ability of a high level of physical condition, especially the level of VO_2 max to reach peak performance. There are many kinds of training method to increase VO_2 max, one of them is continuous circuit training and competitive circuit training. The purpose of this study is to discover the effect of continuous circuit training and competitive circuit training and to determine a more effective method to increase VO_2 max. This study is pre-experimental study with pre-test and post-test group design. The sample consisted of 60 badminton athletes in range of 9-12 years old and all of them were male. The instrument used to measure VO_2 max level was Multistage Fitness Test (MFT). VO_2 max data before and after treatement were analyzed with descriptive statistic and t-test on 5% significancy standard. Based on the data analysis, the following results were obtained: (1) There was a significant effect on the level of VO_2 max in the continuous circuit training group with sig 0.000 values; (2) There was a significant effect on the level of VO_2 max in the competitive circuit training group with values sig 0.000; and (3) There was no significant difference between the continuous circuit training group and the competitive circuit training group. So it can be concluded that continuous and competitive circuit training can increase the VO_2 max of young badminton players.

Keywords: Continuous; competitive; circuit training; vo2max; badminton

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INTRODUCTION

Badminton is known as a sport that requires speed, powerful shooting, and agility or footwork (Wong et al., 2019). The game that originated in England in the early 19th century became very popular in several countries on the Asian and European (Pardiwala et al., 2020). In Indonesia, badminton is still one of the main sports (Wismanadi et al., 2020). There were so many achievement that have been achieved such as Olympic, Asian Games, Sea Games, and more other international events. One of those achievement was on 2021 Olympic, Indonesian women's double Greysia Polli and Apriani could get gold medal. The establishment of

many badminton clubs and the interest of sponsors to fund as the other side of support in achieving Indonesian badminton achievements so that it remains stable.

Badminton achievements, especially Bali at the XX National Sports Week 2021 in Papua, were only able to win 1 silver medal and 2 bronze medals. The silver medal winner is the first Balinese badminton player from Buleleng Regency on behalf of Komang Ayu Cahya Dewi who also won the International Championship in Bahrain. Peak achievement will be achieved if every athlete is able to become a competitive individual. Individuals who are competitive are produced from a competitive sports environment as well (Rumahpasal et al., 2020).

Although there was one of the athletes above who managed to the achievement, but if you look at the dynamics of the development of badminton sports achievements in Buleleng Regency as a whole has not been maximized. This could be seen at the Bali Provincial Sports Week from 2013, 2015, 2017, and 2019 which have not yet succeeded in winning a gold medal and lack of silver and bronze medals that have been achieved. More details could be seen in table 1 below.

Table 1. Buleleng Badminton Contingent Medal Acquisition Data

Year	2013	2015	2017	2019
Gold Medal	0	0	0	0
Silver Medal	1	1	2	1
Bronze Medal	2	1	0	2

(Source; PBSI Buleleng)

The data in table 1 shows that there are problems in the coaching and training process in Buleleng Regency. The opportunity to achieve high achievement is through the proper management and treatment of young athletes. Exercise carried out at a young age is an important period for sports development (Lumintuarso, 2020). Mistakes in managing young athletes are the root of failure in achieving achievements.

The application of the correct training method is the main demand so that the development of badminton in young players can produce athletes who excel in the future. Characteristics of badminton is a sport with high intensity, and intermittent actions (Phomsoupha & Laffaye, 2015), so a high level of physical condition is required. In the past, badminton matches prioritized beauty and deceit, while now badminton has turned to a game that relies on speed and strength (Wismanadi et al., 2020). Physical condition becomes the initial capital and as the foundation for following further exercises (Festiawan et al., 2020). Cardiovascular endurance is the ability of the heart, lungs and blood vessels to function optimally during long-term activities without experiencing significant fatigue (Candra, 2020). Cardiovascular endurance, which in other terms is called VO_2 max (Smirmaul et al., 2013) is a component of physical condition that must be trained properly. VO_2 max is one component of the dominant physical condition and really supports the athlete's performance when practicing or competing (Yanti et al., 2022). VO_2 max itself is defined as the maximum amount of oxygen that can be used by the body during exercise (Taufik et al., 2021). VO_2 max provides a measure of the maximum volume of oxygen consumed by the body through the respiratory system and transported through the bloodstream for use in releasing energy in cells (Khan et al., 2019). It was also explicitly stated that VO_2 max capacity was used as a basic element in the training process (Coppola & Raiola, 2019). Physical exercise programs that are arranged systematically will have an impact on other aspects. "The stronger the physical foundation the greater the potential for developing technical, tactical, and psychological attributes" (Bompa & Buzzichelli, 2019). Before determining and arranging an exercise program to increase VO_2 max, it should be note that there are several factors that can affect the VO_2 max level. These factors include age, gender, fitness, and type of exercise (Ibikunle & Enumah, 2016).

Various training methods is to train and increase VO_2 max such as; interval training, continuous training, weight training, circuit training, and so on. Among these training methods, circuit training has a variety of training forms that are able to combine and package forms of exercise for all components of physical fitness in one form of training, so that circuit training meets the demands of multilateral sports activities that are in accordance with coaching needs and sports for kids. Circuit training is known as a combination of resistance training and high intensity (Patah et al., 2021). Circuit training is an exercise method that can improve overall physical fitness such as power, endurance, strength, agility, speed, and other components of physical condition

(Festiawan et al., 2020). The circuit training method can be in the form of running up and down stairs, running sideways, running backwards, throwing the ball, hitting the ball with a racket, jumping, various forms of weight training, and so on (Harsono, 2018). The forms of circuit training are usually in a circle, so this exercise is called circuit training. The hallmark of circuit training is an exercise consisting of several items with a short rest period even without a break with the aim of increasing VO_2 max (Almy & Sukadiyanto, 2014). Circuit training functions to make it easier for coaches and athletes to carry out various exercise and focus on the targets set by the coach (Putra et al., 2020). The advantage of circuit training is that it effectively improves various components of physical condition simultaneously, such as strength, gait, and cardiovascular endurance (Ballesta-García et al., 2020).

Several types of exercises in the circuit training method include continuous circuit training and competitive circuit training. Continuous circuit training is an exercise that focuses on training sessions of long duration, carried out continuously without a rest (Wewege et al., 2017). While competitive circuit training is an exercise that is carried out or designed in a game so that athletes in carrying out these exercises compete to be the fastest in completing the training circuit (Kumar & Jyothi, 2020). In previous findings it was stated that the implementation of continuous circuit training for 18 weeks was effective in increasing strength, gait, cardiovascular endurance, and improving the body mass index of women with an age range of 55-85 years (Ballesta-García et al., 2020). Circuit training is also able to increase cardiovascular endurance of soccer players who are students of Bina Darma University (Satria, 2019). Increased cardiovascular endurance and a significant effect on body mass index also occurred in soccer players aged 16-17 years at SSB Baturetno Bantul after being given circuit training for 22 meetings (Almy & Sukadiyanto, 2014). Based on previous findings, there are new things revealed in this study. The novelty in question is a sample of 9-12 years old male gender in badminton. Then, the circuit training method chosen is continuous and competitive which is given for 24 meetings. Futhermore, the purpose of this study is to apply these two methods in training young badminton players in Buleleng Regency to increase VO_2 max and to determine which method is more effective in increasing VO_2 max.

METHOD

Participants

This research is a pre-experiment with pretest and posttest group design (table 2). Sixty male badminton athletes were the samples of this study (table 3). All samples live in the Singaraja City, Bali. Simple random sampling was chosen in determining the sample of this study. Randomly, samples were grouped into continuous circuit training (age = 11 ± 0.8 years; height = 143 ± 6.5 cm; weight = 37.3 ± 3.7 kg) and competitive circuit training (age = 11.2 ± 1.0 years; height = 141.4 ± 6.7 cm; weight = 43.4 ± 5.0 kg).

Table 2. Pretest and Posttest Group Design (Sugiyono, 2016)

Sample	Pretest	Treatment	Posttest
N	O_1	X	O_2
N	O_3	X	O_4

Notes:
N = Simple Random Sampling; X = Treatment in the experimental group; O_1 = Continuous circuit training group pre test; O_2 = Continuous circuit training group post test; O_3 = Competitive circuit training group pre test; O_4 = Competitive circuit training group post test

Table 3. Characteristic of The Samples

	Continuous Circuit Training (n=30)	Competitive Circuit Training (n=30)
Age (years)	11±0.8	11.2±1.0
Height (cm)	143±6.5	141.4±6.7
Weight (kg)	37.3±3.7	43.4±5.0

Instrument

Before and after being given treatment in each group, VO_2 max of all samples was measured using a Multistage Fitness Test (MFT). MFT is a test that has been proven valid (0.93) and reliable (0.87) to be used

in the field to measure aerobic fitness and predict VO_2 max (Paradisis et al., 2014). MFT implementation procedure starts with all testee running back and forth between two lines for a distance of 20 meters, which is indicated by a clear sign. Running speed in this test is standardized with a "bip" sound played on a laptop and connected via Bluetooth to a portable speaker. The test is stopped if the testee cannot reach the line twice in a row according to the "bip" sound signal, or the testee stops voluntarily. The score given is in accordance with the level at the final stage that can be achieved by the testee. Table 4 shows the different levels, the number of shuttles per level, and the running speed required for each level (Lockie et al., 2021).

Table 4. MFT Level, Number of Shuttle per Level, and Time and Running Speed for Each Shuttle

Level	Shuttle	Time per Shuttle (s)	Running Speed ($m.s^{-1}$)
1	7	9.00	2.22
2	8	8.00	2.50
3	8	7.58	2.64
4	9	7.20	2.78
5	9	6.86	2.91
6	10	6.55	3.05
7	10	6.26	3.19
8	11	6.00	3.33
9	11	5.76	3.47
10	11	5.54	3.61
11	12	5.33	3.75
12	12	5.14	3.89
13	13	4.97	4.02
14	13	4.80	4.17
15	13	4.65	4.30
16	14	4.50	4.44
17	14	4.36	4.59
18	15	4.24	4.72
19	15	4.11	4.87
20	16	4.00	5.00
21	16	3.89	5.14

Procedure

Training are done for 8 week which is consist of 24 training section. There are 3 training section in a week. There are 10 posts, for continuous circuit training and competitive circuit training, with a break between sets of no more than 2 minutes. The continuous circuit training program can be seen in the table 5 and the competitive circuit training program can be seen in the table 6. Continuous and competitive circuit training groups did the exercises in the same place, namely at GOR PBSI Buleleng, Bali. Sixty samples that have been divided using simple random sampling technique, measured the level of VO_2 max using MFT. Furthermore, the sample is given 24 time exercise. At the 25 meeting, the sample again measured VO2max using MFT to see the extent of the effect of each treatment/exercise.

Table 5. Continuous Circuit Training Program

Week	Day	Intensity	Post	Set	Rest (minute)
I	Tuesday	70% HRmax	10	3	2
	Wednesday	70% HRmax	10	3	2
	Saturday	70% HRmax	10	3	2
II	Tuesday	75% HRmax	10	4	2
	Wednesday	75% HRmax	10	4	2
	Saturday	75% HRmax	10	4	2
III	Tuesday	80% HRmax	10	5	2
	Wednesday	80% HRmax	10	5	2
	Saturday	80% HRmax	10	5	2

Week	Day	Intensity	Post	Set	Rest (minute)
IV	Tuesday	75% HRmax	10	4	2
	Wednesday	75% HRmax	10	4	2
	Saturday	75% HRmax	10	4	2
V	Tuesday	70% HRmax	10	3	2
	Wednesday	70% HRmax	10	3	2
	Saturday	70% HRmax	10	3	2
VI	Tuesday	75% HRmax	10	4	2
	Wednesday	75% HRmax	10	4	2
	Saturday	75% HRmax	10	4	2
VII	Tuesday	75% HRmax	10	4	2
	Wednesday	75% HRmax	10	4	2
	Saturday	75% HRmax	10	4	2
VIII	Tuesday	80% HRmax	10	5	2
	Wednesday	80% HRmax	10	5	2
	Saturday	80% HRmax	10	5	2

Table 6. Competitive Circuit Training Program

Week	Day	Intensity	Post	Set	Rest (minute)
I	Tuesday	80% HRmax	10	3	3
	Wednesday	80% HRmax	10	3	3
	Saturday	80% HRmax	10	3	3
II	Tuesday	85% HRmax	10	4	3
	Wednesday	85% HRmax	10	4	3
	Saturday	85% HRmax	10	4	3
III	Tuesday	90% HRmax	10	5	3
	Wednesday	90% HRmax	10	5	3
	Saturday	90% HRmax	10	5	3
IV	Tuesday	85% HRmax	10	4	3
	Wednesday	85% HRmax	10	4	3
	Saturday	85% HRmax	10	4	3
V	Tuesday	80% HRmax	10	3	3
	Wednesday	80% HRmax	10	3	3
	Saturday	80% HRmax	10	3	3
VI	Tuesday	85% HRmax	10	4	3
	Wednesday	85% HRmax	10	4	3
	Saturday	85% HRmax	10	4	3
VII	Tuesday	85% HRmax	10	4	3
	Wednesday	85% HRmax	10	4	3
	Saturday	85% HRmax	10	4	3
VIII	Tuesday	90% HRmax	10	5	3
	Wednesday	90% HRmax	10	5	3
	Saturday	90% HRmax	10	5	3

Statistical Analysis

To see whether or not there is a significant effect of continuous circuit training and competitive circuit training on VO_2 max, the data are analyzed by using paired sample t-test with significancy level ($p < 0.05$). The test are done after normality test by using Levene's test and homogeneity test by using Kolmogorov-Smirnov test. Then, to answer whether there is a significant difference in value between groups of continuous circuit training dan competitive circuit training, the data analysis used is independent sample t-test with significancy level ($p < 0.05$).

RESULTS AND DISCUSSION

From the results of the study it is obtained data as in table 7 about the results of the data normality test and table 8 about the results of the data homogeneity test.

Table 7. Data Normality Test

Group	Pretest	Posttest
Continuous Circuit Training	0.266	0.327
Competitive Circuit Training	0.055	0.116

Table 8. Data Homogeniety Test

Data	Significancy
Pretest	0.297
Posttest	0.866

According to the data above, thus the result is the data are normally distributed and homogen. After the result showed data normally distributed and homogen, next a paired sample t-test was performed (table 9). The aim is to find out whether there is a difference in VO_2 max results befor and after doing exercise.

Table 9. Mean ± SD Variable Before & after Treatment

Variable	Test	Continuous Circuit Training (mean ± SD)	Competitive Circuit Training (mean ± SD)	sig. between group (p)
VO2max	Pre	25.40 ± 2.83	24.97 ± 2.30	0.518
	Post	27.27 ± 2.63	27.62 ± 2.77	0.618
	sig. between pre & post in each group (p)	0.000*	0,000*	

*significant ($p < 0.05$) between pre dan post test

The result of paired sample t-test with significancy level ($p < 0.05$) on table 9 shows that the significance value of the continuous circuit training group is 0.000 and the competitive circuit training group also shows a value of 0.000. So it can be concluded that there are significant differences before and after the treatment of continuous circuit training and competitive circuit training. After knowing that the two training methods have a significant effect, then to answer the next hypothesis is to do a parametric test as show in table 10 (independent sample t-test). This test aims to see if there is a defference in the mean of the two groups (continuous circuit training and competitive circuit training).

Table 10. Independent Sample T-Test

Independent Sample T-Test		Sig. (2-tailed)
VO_2 max	Delta_ continuous/competitive	0.080

Furthermore, in the independent sample t-test test for the continuous circuit training group and the competitive circuit training group in table 10 above, the sig (2-tailed) value is 0.080. Because the significancy

value is > 0.05, it can be stated that there is no significant difference between the continuous circuit training group and the competitive circuit training group.

The purpose of this study is to determine the effect of continuous circuit training dan competitive circuit training, as well as determine which method is more effective in increasing VO_2 max in athletes at an early age (9-12 years). The first finding in this study shows that there is a significant effect in the continuous circuit training group on increasing VO_2 max. Continuous circuit training when viewed from the form of exercise is an exercise that is carried out continuously in the form of resistance which consists of several components of upper body movement, lower back, abdomen, and lower body (Kumar & Jyothi, 2020). The implementation of all posts is completed without an interval phase. Previous findings stated that continuous circuit training given for 12 weeks with training sessions three times a week had a significant effect on improving blood vessel function (Ramos et al., 2015). Furthermore, circuit training using additional weight training is not only effective in increasing muscle strength and muscle endurance, but can also increase aerobic capacity (Cardozo et al., 2019). Not only has a significant effect on cardiovascular function, continuous circuit training also has an impact on body composition in adolescents who are overweight and obese (Wewege et al., 2017). Good quality cardiorespiratory fitness can also help protect mordibity and mortality, of course, by implementing aerobic exercise (Khan et al., 2019).

The second finding of this study also shows that there is a significant effect on the competitive circuit training group on increasing VO_2 max. This is in line with previous findings which stated that circuit training 3 times per week for 12 weeks is very effective in increasing physical fitness and preventing metabolic diseases in female college students (Kim et al., 2018). Competitive circuit training is a form of circuit training whose implementation is competed so that it is expected to increase the spirit of every athlete. Competitive circuit training develops local muscle strength and endurance (Kumar & Maniazhagu, 2014). The competitive circuit training work system is the same as high-intensity interval training, which is an exercise consisting of 5 to 8 posts, each of which is carried out for less than 1 minute (range of 15-40 seconds) and rest breaks of 20 seconds (Kim et al., 2018), the duration of the exercise is around 20 to 35 minute (Plevková & Peráčková, 2019) nor around 50 to 60 minute (Kim & Lee, 2019).

The third finding of this study is that there is no significant difference between continuous circuit training and competitive circuit training. Both methods have a similar training method, namely the participants perform movements in each post in less than 1 minute, moving from one post to another with little or no pause, which causes the training session time to be short but the intensity is high (Seo et al., 2019). Even circuit training method with low intensity or high intensity can increase VO_2 max if done regulary (Wen et al., 2019). It was also proven from previous findings that the circuit training method, a part from increasing VO_2 max, was also effective in increasing motivation to exercise rather than doing moderate aerobic exercise (Wilke et al., 2019).

The selection of training sessions for 8 weeks with 3 sessions a week is also recommended for increasing VO_2 max, there are even studies which stated that the duration of the training session can increase muscle strength, agility, anaerobic endurance, and cardiovascular endurance in 18 years old men (Sonchan et al., 2017). Based on the study, it is clear that continuous and competetive circuit training is very effective for training aerobic endurance and very suitable to be applied to young athletes, especially badminton at the age of 9 to 12 years. In early or young children, it is a phase or process of physical growth and development (Paramita & Sutapa, 2019).

CONCLUSION

Continuous circuit training and competitive circuit training can increasing cardiovascular endurance capacity or known as VO_2 max in young badminton athletes. But there is no significant difference between continuous circuit training and competitive circuit training. The limitation of this study is that it has not measured the hemoglobin level and nutritional status of the participants. It is hoped that further research can measure this status because there is a correlation in increasing VO_2 max. So the findings from this study can be used to improve the performance of young athletes (9-12 years) in achieving, especially in the endurance component.

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