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The effect of training methods and lung vital capacity on vo2max in student futsal athletes

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Abstract

Cardio-pulmonary endurance or vo2max is important for athletes in competing. This study investigates the effect of extensive, intensive interval training methods and the vital lung capacity of futsal athlete students to improve the vo2max. This type of research was quasi-experimental with a 2x2 factorial design. 24 male student futsal athletes, age 15.95±0.55, height 164.61±6.90, and weight 53.23±8.11, met the inclusion criteria, signed informed consent and participated in this study. The interventions were extensive interval training methods for running on a 20-meter track and intensive interval training for running on a 100-meter track. Treatment is done 16 times, three times a week, and progressive sets, repetitions, time, and rest. Vo2max was measured with a multistage fitness test, and lung vital capacity was measured with spirometry SP70B. Data analysis used two-way ANOVA, the data was tested for normality and homogeneity. The study showed that extensive pretest 37,53±1,37 and posttest 50,68±1,00 (p=0.05), and intensive pretest 37,04±1,45 and posttest 49,18±1,37 (p=0.05) interval training improves VO2Max, repestivully. There is no interaction between extensive and intensive training methods on lung vital capacity. The study concludes that extensive and intensive training methods are useful to improve the vo2max of students' futsal athletes. The extensive interval training method is more effective in improving vo2max.

Keywords: Futsal, training methods, endurance.

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INTRODUCTION

Futsal in competition is undoubtedly different from futsal in maintaining fitness. Futsal competition, which is a game played in 2 x 20 minutes of clean time, requires players to have good endurance (FIFA, 2022). The hallmark of futsal is that playing at a high tempo and fast

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transitions coupled with good mastery of tactics will drain a lot of energy for the players. Players are required to be active in carrying out attacks to score goals and must be strong in defence so that goals are not conceded, which is a challenge for players to have good physical condition in participating in competitions (Amani-Shalamzari et al., 2019).

Futsal players must always be alert and have good speed and physical endurance because the game is carried out in transitions and fast tempo. Futsal can train players' speed levels in the process of making decisions to carry out tactics or techniques so that players can gain complete confidence so that they can be applied when carrying out matches and obtain maximum results (Irawan, A. 2021).

Physical condition is a fundamental thing that must be mastered and owned by every futsal player, where excellent and good physical condition can support players' performance on the field. The physical condition can also affect the final result of the match, a team with good physical condition and can play optimally on the field will win because it can attack well to score goals and defend well to avoid conceding goals (Albertus et al, 2017). The physical condition that becomes one of the main parts of futsal athletes is endurance. Endurance is needed for futsal athletes to be able to play until the end of the game (Satrio & Winarno, 2019). Futsal athletes are required to have good-quality endurance. Another thing that influences this is that futsal is played on a relatively smaller field, so tactically the game is played at a high tempo and quickly (Santoso & Hariyoko, 2022).

The process of achieving good performance in futsal certainly requires a lot of practice regularly, regularly, and in the right portions. Futsal has basic important parts that every individual player must know when playing futsal. Basic techniques in futsal (Zhukova et al, 2018; Susworo Dwi Marhaendro et al, 2023) Explain that mastery of basic techniques is needed in playing futsal, including 1) the basic technique of holding the ball, 2) the basic technique of passing, 3) the basic technique of dribbling the ball, 4) the basic technique of feeding the stomach, 5)

basic technique of heading the ball, 6) the basic technique of kicking the ball. Futsal athletes must be able to control the ability of basic futsal techniques because it is very important for the development of modern futsal.

In the current development of futsal, to achieve high achievement, the players are not only required to be proficient in mastering the basic techniques of the game. However, the thing that needs to be owned by players is excellent health/fitness, which is very much supported by endurance. One part of the components of physical fitness namely cardiorespiratory endurance or what is commonly called the maximum oxygen volume capability (vo2max) (Mashud et al., 2019). Vo2max is the ability of the heart and lungs to distribute oxygen to all parts of the body over a long period, therefore vo2max is very important for each individual, including futsal athletes, because in futsal games, it is done with fast tempos and transitions. vo2max endurance plays an important role. Measuring the level of the athlete's vo2max value can be carried out using the Multistage Fitness Test (MFT) (Mahar et al., 2011).

The ability to level vo2max is used as the main indicator parameter that determines a component of the main physical condition, namely the level of cardiovascular endurance (J., Yulianto, E. et al., 2022). Cardiovascular endurance is the ability of the body to be able to move at high intensity for a long time without experiencing or feeling excessive fatigue after being able to complete certain tasks. Cardiovascular endurance is very important for futsal athletes to have, with a qualified level of cardiovascular endurance, futsal players will be stable in playing and able to overcome excessive fatigue when playing futsal with high tempo and intensity. In addition to good vo2max that athletes must have, athletes must also have good lung vital capacity volume (Lubis et al., 2022).

The vital capacity of the lungs of each individual athlete is closely related to the ability of the cardiorespiratory endurance level, in terms of cardiorespiratory endurance is also influenced and carried out jointly by

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9 (2) 2023 | 339-354

the ability of the heart, blood, blood vessels and has the ability on lung capacity (Armen, 2017). In relation to the vital capacity of the lungs in sports activities for athletes, the better the expiratory and inspiratory abilities of the respiratory organs, the respiratory system is able to meet the oxygen demand in the body so that athletes can carry out physical activities in a relatively more extended period of time (Abdullah et al., 2017). A spirometry tool can measure Lung vital capacity (Harahap & Aryastuti, 2012).

Vo2max and lung vital capacity, when viewed directly, have a relationship that can affect the physical condition of futsal athletes. vo2max is related to maximum oxygen uptake to be managed into energy to carry out physical activities for a relatively long period and to become an athlete's aerobic endurance (do Nascimento Salvador et al., 2016). While the lungs' vital capacity is the ability to inhale and exhale, it also influences the oxygen capacity in the lungs and the strength of the lung muscles (Lazovic-Popovic et al., 2016). Based on this, it can be concluded that vo2max and lung vital capacity have a relationship to see the physical condition and endurance of athletes in futsal games.

Several types of exercises can increase endurance levels, such as fartlek, hills, repetition, continuous, and interval training. When juxtaposed with existing training methods, interval training has proven to be very effective in increasing endurance levels to the highest peak of athlete performance (Festiawan et al., 2021). The extensive and intensive interval training methods are effective for increasing vo2max. They are closely related and mutually supportive between the two, but in the process, the two forms of extensive and intensive interval training models have their respective advantages and disadvantages (Siahkouhian et al., 2013). Extensive interval training is a form of exercise model used to increase aerobic endurance capacity or endurance. Extensive interval training has the characteristics of moderate load intensity of 60-80%, a large number of repetitions 20-30 times per series, short rest periods of 45-90 seconds, and a close distance of 20-50 meters. While intensive interval training is a

form of training model used to increase speed, power, ability, and endurance, which is anaerobic (Bahtra et al., 2021). Intensive interval training has the characteristics of a high load intensity of 80-90%, a small number of repetitions, 6-10 times per series, long rest periods of 90-180 seconds, and long distances of 100-400 meters. Both of these training models have the common goal of increasing speed and endurance (Suhdy, 2018).

Based on the results of direct observations on the field of State High School 1 Toili's futsal athletes in participating in 4 tournaments, the State High School 1 Toili futsal team went the furthest once in the knockout round of the top 12, and the other 3 only reached the group phase. This futsal team experienced a problem, namely limited endurance, in this case, the athletes did not have good vo2max, which was suitable for athletes in the game, where the tempo of the game started to slow down, and they were unable to last long on the playing field. The observation results found that 5 athletes had vo2max in the low category and 10 athletes in the moderate category. This shows that the endurance of the futsal athletes at State High School 1 Toili could be better in terms of vo2max endurance.

Less vo2max causes players to experience fatigue in matches and can affect other parts such as decreased concentration, decreased tempo for attacking, the accuracy of shooting the ball at goal, passing the ball, and in a weakened defence so that in the game they often make mistakes when attacking and defending (Naser et al., 2017). This caused the State High School 1 Toili futsal team to be unable to score goals, to be ineffective in defence, and ultimately to lose the game. Seeing from the problems described above and from the results of observations in the field, researchers want to conduct further research to increase vo2max to increase cardiovascular endurance, determine the effect of lung vital capacity on vo2max, and analyze the interaction between exercise methods and lung vital capacity on vo2max athlete of State High School 1 Toili futsal team.

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9 (2) 2023 | 339-354

METHOD

This research is quasi-experimental, with the independent variables the extensive and intensive interval training model, the lung vital capacity attribute variables, which are divided into two high and low, and the dependent variable vo2max. This study uses a pretest-posttest approach, the research design used in this study is a 2x2 factorial design. The experimental method is used to test the hypothesis whether there is an effect from the research results by testing the hypothesis.

The sample used in this study amounted to 24 athletes with a purposive sampling determination. Sample criteria 1) Students of State High School 1 Toili, students of grades X and XI, are members of the futsal team. 2) measure the vital capacity of the lungs, then screeching from high to low. 3) take 12 upper bounds and 12 lower bounds. The 24 selected samples were divided into four training groups comprising 6 people.

Table 1. Extensive interval training program

Day/week to	Type	Exercise activity	Set	Repetition	Rest (Sec)
1 / 1	Aerobic	Run 20 m	5	16	90
2 / 1	Aerobic	Run 20 m	5	16	90
3 / 1	Aerobic	Run 20 m	5	16	90
4 / 2	Aerobic	Run 20 m	5	16	90
5 / 2	Aerobic	Run 20 m	6	20	90
6 / 2	Aerobic	Run 20 m	6	20	90
7 / 3	Aerobic	Run 20 m	6	20	90
8 / 3	Aerobic	Run 20 m	6	20	90
9 / 3	Aerobic	Run 20 m	8	20	60
10 / 4	Aerobic	Run 20 m	8	20	60
11 / 4	Aerobic	Run 20 m	8	20	60
12 / 4	Aerobic	Run 20 m	8	20	60
13 / 5	Aerobic	Run 20 m	10	20	45
14 / 5	Aerobic	Run 20 m	10	20	45
15 / 5	Aerobic	Run 20 m	10	20	45
16 / 6	Aerobic	Run 20 m	10	20	45

Table 1 shows that the extensive interval training program is given to two exercise groups, the extensive interval training group with high vital lung capacity and the group with low vital lung capacity.

Table 2. Intensive interval training program

Day/week to	Type	Exercise activity	Set	Repetition	Rest (Sec)
1 / 1	Anaerobic	Run 100 m	4	4	180
2 / 1	Anaerobic	Run 100 m	4	4	180
3 / 1	Anaerobic	Run 100 m	4	4	180
4 / 2	Anaerobic	Run 100 m	4	4	180
5 / 2	Anaerobic	Run 100 m	6	4	180
6 / 2	Anaerobic	Run 100 m	6	4	180
7 / 3	Anaerobic	Run 100 m	6	4	180
8 / 3	Anaerobic	Run 100 m	6	4	180
9 / 3	Anaerobic	Run 100 m	8	4	135
10 / 4	Anaerobic	Run 100 m	8	4	135
11 / 4	Anaerobic	Run 100 m	8	4	135
12 / 4	Anaerobic	Run 100 m	8	4	135
13 / 5	Anaerobic	Run 100 m	10	4	90
14 / 5	Anaerobic	Run 100 m	10	4	90
15 / 5	Anaerobic	Run 100 m	10	4	90
16 / 6	Anaerobic	Run 100 m	10	4	90

Table 2 shows that the intensive interval training program was given to two exercise groups, the intensive interval training group with high lung vital capacity and the group with low lung vital capacity.

The sample used in this study met the inclusion and exclusion criteria. The inclusion criteria included 1) willingness and ability to participate in the entire research series, 2) the sample was healthy and fit, 3) active students at State High School 1 Toili, still sitting in classes X and XI, 4) willing to give informed consent. Samples were not included in this study if they had a history of respiratory disease and were experiencing an injury.

This research was started by collecting the initial data and then providing 16 training meetings, hearing the details every week 3 training meetings were carried out, and at the end of this research, the final measurement was returned (A. Suresh and M. Elayaraja, n.d., 2014). The instrument used in the implementation of this study measured the athlete's vo2max by using the Multistage Fitness Test (MFT) with a track length of 20 meters, where athletes perform according to the maximum limit they can do. Measuring lung vital capacity using spirometry model SP70B. The athlete takes a maximum breath and then exhales forcefully into the tip of the spirometry funnel. This research has received permission from the health research ethics commission at Universitas Negeri Semarang with letter number 108/KEPK/EC/2023.

Data analysis used the two-way ANOVA data analysis model or two-way ANOVA using the SPSS statistical application version 26.00. The pretest and posttest data were tested for normality using the Kolmogrov-Smirnof (sig>0.05) and homogeneity tests using Leavene's test (sig>0.05). Then the data was tested by ANOVA test of between-subject effects, the results were determined by the value (p <0.05).

RESULT

Table 3. Characteristics of the research sample

Variables	Extensive high lung capacity	Extensive lower lung capacity	Intensive high lung capacity	Intensive high lung capacity
N	6	6	6	6
Age (years)	16,00±0,000	16,00±0,632	16,00±0,632	15,83±0,752
Weight (Kg)	54,21±3,773	50,98±6,902	56,58±10,121	51,16±10,628
Height (Cm)	166,58±6,343	163,25±5,017	161,95±3,239	166,66±11,093

Table 3 displays data from research subjects by analyzing quantitative descriptive where this data is a special sample characteristic, such as age, weight, and height. The characteristics of the sample in this study were all male. The average age of athletes in the extensive interval training group was 16.00 ± 0.4264. Average body weight 52.60 ± 5.5662. Average height 164.91 ± 5.7240. In the intensive interval training group, the average age of the athletes was 15.91 ± 0.6685. Average body weight 53.87 ± 10.2914. Average height 164.30 ± 8.1717.

Table 4. Normality test results

Kolmogorov-Smirnov[a]				Shapiro-Wilk		
	Statistic	df	Sig.	Statistic	df	Sig.
Standardized Residual for vo2max	0,128	24	**0,200***	0,951	24	**0,279**

Table 4 shows the results of the data normality test, showing that the Kolmogorov-Smirnov significant value is 0.200 and the Shapiro-Wilk value is 0.279. Based on the results of this analysis, the sample is normally distributed because the significance level is greater than 0.05. (Sig 0.279 >0.05)

Table 5. Homogeneity test results

VO2Max			
Levene Statistic F	df1	df2	Sig.
2,60	3	20	**0,080**

Table 5 shows the homogeneity test results using the Leavene's Test with a value of 0.08. The data is homogeneous from these results because the significance level is more significant than 0.05 (sig 0.08 >

0.05). From the normality and homogeneity test results (sig> 0.05), the data meets the criteria to proceed to the two-way ANOVA analysis.

Table 6. T test results pretest and posttest

Variables	Lung Vital Capacity	N	Pretest	Posttest	Difference
Interval	Hight	6	37,97±1,66	51,21±1,15	13,24
Extensive	Low	6	37,08±0,98	50,15±0,44	13,07
Interval	Hight	6	36,98±1,42	50,00±0,88	13,02
Intensive	Low	6	37,10±1,61	48,36±1,33	11,26
Vo2max Interval Ekstensive		12	37,53±1,37	50,68±1,00	13,15
Vo2max Interval Intensive		12	37,04±1,45	49,18±1,37	12,14

Table 6 shows the results of the pretest and posttest T-test. The T-test was carried out to see the changes that occurred from the pretest and posttest results. The results showed that for the extensive interval training group with high vital lung capacity, the pretest was 37.97 ± 1.66, the posttest was 51.21 ± 1.15, and the difference was 13.24. In the extensive interval training group with low lung vital capacity, the pretest was 37.08 ± 0.98, and the posttest was 50.15 ± 0.44, a difference of 13.07. Intensive interval training group with high vital lung capacity, pretest 36.98 ± 1.42 posttest 50.00 ± 0.88 difference 13.02. Intensive interval training group with low lung vital capacity, pretest 37.10 ± 1.61 posttest 48.36 ± 1.33 difference 11.26. Vo2max extensive interval pretest 37.53 ± 1.37 posttest 50.68 ± 1.00 difference 13.15. Vo2max Interval Intensive pretest 37.04 ± 1.45 posttest 49.18 ± 1.37 difference 12.14. These results indicate that the extensive interval training method is more effective in increasing vo2max, with an average increase of 13.15>12.14.

Table 7. Data from ANOVA test results

Dependent Variable: vo2max

Source	Type III Sum of Squares	df	Mean Square	F	Sig	Result
Training methods	13,500	1	13,500	13,237	0,002	Significant
Lung vital capacity	10,935	1	10,935	10,722	0,004	Significant
Training methods*Lung vital capacity	0,482	1	0,482	0,472	0,500	Not significant

Table 7 shows the results of the two-way ANOVA statistical test with the analysis of the test of between-subjects effects showing the results of the significance value between the training method and vo2max is 0.002. This value is smaller than 0.05, thus there is an influence

between the training method and vo2max 0.002 <0.05. The result of the significance value between lung vital capacity and vo2max is 0.004. This value is smaller than 0.05, so there is an influence between lung vital capacity and vo2max 0.004 <0.05. The results of the interaction of exercise methods and lung vital capacity showed no significant value between lung vital capacity, and vo2max was 0.500. This value is more significant than 0.05, so it can be concluded that there is no interaction between lung vital capacity and exercise method 0.500> 0.05.

DISCUSSION

Interval training is a form of training method used to increase endurance for athletes. The interval training method is carried out on a running track with a track length that can be adjusted to your needs. This study uses a track length of 20 meters for extensive intervals, while it uses a track length of 100 meters for intensive intervals. In this interval training process, athletes are required to meet predetermined distance targets. Interval training forces athletes to comply with time requirements, namely predetermined rest periods. This will allow athletes to maximize their performance during training, and the expected results are vo2max cardio-pulmonary endurance aerobic and aerobic abilities will increase for athletes (Kumari et al., 2023).

Based on research experiments that have been carried out for 16 meetings, there has been a significant increase in vo2max, meaning that the training process carried out by athletes is effective and can be used to increase vo2max. The increase occurred in several factors that were fulfilled in implementing the interval training process, such as training intensity, relatively short rest periods, and the training volume imposed on athletes (Wen et al., 2019).

The training given to athletes is adjusted to a predetermined intensity with the athlete's maximum pulse rate and predetermined volume so that athletes can adjust to the training program provided when exercising. The number of sets and repetitions is given an increase, where every 4 subsequent meetings the number of sets and repetitions is

increased so that the athlete's physical condition experiences a measurable improvement while doing the exercises. The rest time is a decrease in the amount of time namely, from the beginning, the rest time is long, then it is trimmed to less, this will cause athletes to be more displaced in receiving interval training (Kaur, 2018).

The results showed that the extensive training model increased more effectively than the intensive training model. This happens from intensity, reps, sets, and rest periods. The extensive interval training model with moderate intensity, more repetitions, and sets, as well as short rest periods, causes the athlete's physiology in the body to process energy more quickly and oxygen to be converted into energy to carry out the given physical training activity. So, the group with the extensive interval training model gave better results than the group with the intensive interval training model (Ramadhan et al., 2022).

Interval training is more effective for increasing the athlete's vo2max endurance. The research used two types of extension and intensive interval training. In this study, the extensive interval training model had a better improvement value than the intensive interval training model (Grossman et al., 2023).

The vital capacity of a person's lungs is related to oxygen availability in the body. The vital capacity of the lungs has a role and a strong relationship with aerobic exercise activities. The greater the amount of oxygen volume that is accommodated by the lungs, the better it is at carrying out physical activity in the long term (García et al., 2021).

Based on the results of this study, there are differences in the effect of athletes who have high and low lung vital capacity on vo2max. Athletes with high lung vital capacity values, get better results compared to athletes with low lung vital capacity values. The amount of oxygen in the lungs is the ability or ability of the lungs to accommodate oxygen in it. The ability and condition of the lungs must be good in inhaling oxygen to the maximum and accommodated in it, to then be supplied to all body parts. Oxygen supplied to parts of the body is used by the body to carry out

movement activities with volume, high intensity, and for a long time (Amiri-Farsani et al., 2011).

In general, from the study results, the exercise group with high and low lung capacity experienced an increase. Based on the research data, it was stated that the vital capacity of the low half experienced a higher increase than athletes who had a high lung vital capacity even though the difference in values was small (Warganegara, 2012). These results illustrate that the volume of humans' total lung vital capacity by obtaining physical exercise can be increased, and human physiological functions can be affected by activities carried out by athletes (Lynch et al., 2021).

Consuming the amount of oxygen during sports activities can certainly affect the performance of athletes in motion so that the condition of the athlete's lung function must be in good condition. Sports activities can affect lung function for athletes, which can improve lung vital capacity (Rezaimanesh & Amiri-Farsani, 2011).

Based on the results of the data from this research process that has been carried out and statistical tests that have been carried out, it states that there is no interaction between the interval training method and lung vital capacity on vo2max. The exercise group with a high lung vital capacity value can do the exercise better than the athletes with a low lung vital capacity value. The ability of the amount of oxygen capacity in the lungs to have a minimal effect on the ability of vo2max.

Several factors, including heredity, age, gender, body fat content, body structure anatomy, state of exercise, exercise intensity, activity, and nutritional intake, influence Vo2max. When the body is given endurance training activities, the size of the lung's vital capacity will affect the amount of oxygen consumed during the exercise process because a lot of oxygen is supplied to the muscles that are working (Khasan et al., 2013). If the volume of air that the lungs can accommodate is greater, the greater the amount of oxygen available to be supplied to all body parts, thus allowing aerobic metabolic processes to occur for a longer time (Arboleda-Serna et al., 2022).

The training group with a high vital lung capacity has a greater amount of oxygen volume so that the muscles get more oxygen supply and can carry out sports activities for a long time without feeling significant fatigue. Sports activities can also help increase lung vital capacity, and the muscular system in the lungs increases, which can help the lungs in the process of inspiration and expiration (Putra et al., 2020).

CONCLUSION

The research results and data analysis show differences in the effect of extensive and intensive interval training methods. Extensive interval training is better than intensive interval training on vo2max in futsal athletes. There are differences in the impact of high and low lung vital capacity on vo2max. Players with high lung vital capacity are better than those with low lung vital capacity on vo2max in futsal athletes. There was no interaction effect between lung vital capacity and training method on vo2max in futsal athletes.

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