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The Effect of High Intensity Interval Training (HIIT) Training Method Using Elevation Training Mask (ETM) on Anaerobic Capacity

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ABSTRACT
This study aims to determine the effect of the high-intensity interval training method using an elevation training mask on anaerobic capacity. This research uses an experimental method of One-Group Pretest-Posttest Design. The sample consisted of 10 student-level athletes in one of the women's futsal clubs. The test instrument used was the running-based anaerobic sprint test—data analysis using non-parametric statistics. The results showed that the paired-sample t-test had a sig value. Of 0.016 so it can be concluded that there is an effect of high-intensity interval training using an elevation training mask on the increase in anaerobic capacity.

Keywords: *Anaerobic Capacity; High Intensity Interval Training; Elevation Training Mask.*

INTRODUCTION

An athlete is required to improve performance to achieve achievement; therefore, physical exercise and adequate nutritional intake are needed. The coach will apply several training methods and the use of certain tools that support maximizing the exercise performed. Four internal factors support an athlete's peak performance, namely technique, tactics, mental and physical condition. Physical condition is a very important aspect in improving performance (Sidik et al., 2019). Physical conditioning training is a systematic and progressive repetition process for improvement and maintenance, emphasizing the efficiency of body physiology. A quality futsal player must have excellent physical condition and is required to be able to recover quickly. Therefore, futsal players will not quickly experience excessive fatigue by having excellent physical condition, and there will be no decline in skill abilities.

Increased achievement in futsal can be achieved if the supporting aspects are met. One of the supporting aspects of the achievement of an athlete is a prime physical condition. The ability to master technique, tactics and perfect mentality will be achieved if an athlete is in excellent physical condition. A futsal athlete's dominant physical condition components include endurance, speed, agility, explosive power, and strength.

Endurance is the body's muscles carry out physical activity for a long time. The longer the time of the match, the higher the endurance the athlete must have. High endurance capacity has an important role for futsal players because the many repetitions of the technique can run smoothly with high intensity. Futsal games will always be of high intensity because of the narrow field area so that futsal players must have high anaerobic resistance by increasing anaerobic capacity (Suharjana, 2013).

Anaerobic capacity is the energy obtained through anaerobic metabolism with the phosphagen system (ATP-PC) and the anaerobic glycolysis system (Medbø, J. I., & Burgers, 1990). The body provides ATP through anaerobic metabolic processes, interpreted as metabolism that occurs without oxygen. The energy obtained through anaerobic metabolism is the result of high-intensity body activities that require energy supplies as quickly as possible. Aerobic metabolic processes can carry out the availability of oxygen in the blood for too long. Therefore, the body uses anaerobic metabolic pathways to synthesize ATP. Anaerobic metabolism process will produce ATP faster than aerobic.

In simple terms, anaerobic can be interpreted as doing activities without oxygen (Sumpena, A., & Sidik, D. 2020). This activity without oxygen will trigger the speed of moving to increase the ability to run. The level of oxygen consumption during exercise where the production of lactate in the muscles exceeds the rate of lactate oxidation so that lactate will appear in the blood circulation system. Levels of lactate in the blood can be balanced or not, depending on the intensity of exercise. This means that the muscles begin to produce more lactic acid than the body can eliminate.

The increase in anaerobic capacity varies depending on the modification used (Zamzami et al., 2020). 3x3 games are useful for increasing anaerobic capacity. The anaerobic capacity of each individual is almost the same if they have the same ability and speed in an exercise (Saifullah et al., 2020). An anaerobic capacity is a form of the ability to store as much energy as possible at one time to be used in an activity.

Anaerobic activities are generally carried out by people who live in mountainous areas or highlands (Hakmi, 2008). This happens naturally due to unstable ground

conditions. The availability of oxygen in the highlands is less than in the lowlands, making people in the area accustomed to activities with limited oxygen; oxygen limitations trigger an increase in anaerobic capacity to research. That has been done by (Judge 2008).

There is a difference between the anaerobic capacity of men and women who live in the highlands compared to those who live in the lowlands. The significant difference between anaerobic capacity in the highlands and lowlands was carried out by statistical tests, which resulted in better anaerobic capacity. The greater anaerobic capacity of the high region group than the low region group may be caused by daily habits and the influence of the morphology of the living environment (Hakim, 2008) where the condition of the surface of the area in the form of hills, the roads around the residential area of the population look up and down. When compared with areas with flat and sloping surfaces, the habits of groups in high areas may be walking on hilly surfaces and up and down. The habit can cause muscle adaptation in response to more strenuous work, especially when walking through hills. The possibility of adaptation is greater strength and muscle power than the low area group.

The process of anaerobic activity can be trained with high-intensity physical exercise in a short time. High-intensity interval training, or abbreviated HIIT, is an exercise method that has been known to be effective for improving cardiac performance (Dalleck, 2015). The HIIT method consists of several physical exercises such as sprints, jogging, and jumping in a short period. This method is a combination of exercise and recovery at one time, so it is perfect for training anaerobic activities (Vidiari J et al., 2017).

Increasing this ability can be done by regular physical exercise with various methods, one of which is the High-Intensity Interval Training method, commonly called HIIT, an effective and efficient training method (Matos et al., 2018). High-Intensity Interval Training (HIIT) is one of the most popular forms of exercise and ranks first because it consists of several types of exercise quickly (Auguntari, I., Ray, H., 2018; Wibowo et al., 2019). HIIT exercise can increase VO2max to improve cardiorespiratory fitness (Nugraha & Berawi, 2017). HIIT is a physical exercise method that is often used by football and futsal coaches to improve the fitness of their players (Hutajulu, 2017). HIIT is a method that combines a variety of physical exercises ranging from sprints, jogging, walking to resting. The benefits of using the HIIT method are to increase not

only VO2max capacity but also recovery time, passing ability, and the capacity to repeat sprints in a shorter time (Laursen et al., 2002).

Interval training is a form of exercise that consists of alternating periods of activity and recovery that requires a lot of anaerobic activity. Research conducted on 30 handball players in India states that HIIT for eight weeks has an impact on increasing anaerobic capacity by 28.58% (Chittababu, 2014). An increase in anaerobic capacity is characterized by an increase in muscle performance or the size of muscle fibers to produce muscle strength. It is related to one of the anaerobic sports to increase muscle strength (Chittababu, 2014).

Increased anaerobic capacity is a cellular regulation that provides continuity of energy production. The maximum intensity of training is suggested to improve anaerobic performance due to increased cellular regulation. This regulation in cellular mechanisms buffers metabolic acidosis, which increases during exercise, causing fatigue to be delayed or fatigue resistance may be increased. In addition, it increases muscle support capacity and enzyme activity, both of which are affected by exercise stimulation.

HIIT uses proper work-to-recovery intervals to train the body to be more efficient at producing and using energy from the anaerobic energy system. It can also train the body to effectively remove metabolic waste from the muscles between work intervals. The HIIT method should only be done less than two days per week, as it is a full day of recovery between training sessions. In addition, HIIT can also burn a lot of calories in a short time. Some of the calories burned from high-intensity intervals come from a higher metabolism, which lasts for hours after a workout. Overall, HIIT delivers many of the same health benefits as other forms of exercise in less time. These benefits include lowering body fat, increasing heart rate and blood pressure. HIIT can also help lower blood sugar and improve insulin sensitivity (Moro et al., 2017).

Elevation Training Mask (ETM) is a new product in the world of sports that claims to improve athletic performance (Porcari et al., 2016). The Elevation Training Mask (ETM) is an adjustable inhalation resistance training device designed to simulate altitude training through oxygen restriction due to flux valves (Sumpena, A., & Sidik, D. 2020). A new product on the market that claims to simulate altitude training, this mask covers the nose and mouth with different size openings and flux valves. The ETM manufacturers claim that these masks can improve performance in high-volume, high-intensity resistance training assuming that oxygen restriction can lead to adaptations associated with increased buffer capacity (Jagim et al., 2018).

The mask must have a mechanism to lower the partial pressure of oxygen to cause a hypoxic state during exercise (Porcari et al., 2016). The shape of the ETM can cover the nose and mouth, which have openings of different sizes. The flux valve, opening, and flux valve can be adjusted to increase respiratory resistance, making breathing more difficult (Sumpena & Sidik, 2020; Rosdiana, F., Sidik, DZ, & Rusdiana, & A., 2019). The benefits of using ETM, among others, can strengthen the diaphragm so that the lungs work harder because of the use of oxygen little by little, which makes physical speed when moving will increase, endurance is better, and strength is higher.

In theory, increased buffering capacity could increase muscle endurance and increase tolerance for high-intensity exercise. In addition, the use of ETM can increase oxygen saturation in the body which may have profound effects on long-term endurance, speed of recovery from exercise, and VO2max (Warren, 2017). The benefits of using ETM, among others, can strengthen the diaphragm so that the lungs work harder because of the use of oxygen little by little, which makes physical speed when moving will increase, endurance is better, and strength is higher.

Improved physiological characteristics and functional reserve of respiratory muscles when using ETM during the HIIT program. ETM also helps improve lung function and performance. Based on this explanation, the purpose of this study was to prove the effectiveness of the high-intensity interval training (HIIT) method using an elevation training mask (ETM) on increasing anaerobic capacity in female futsal athletes at the student level.

METHOD

This study uses experimental research methods. The experimental design used in this study is a quasi-experimental design used in this study is the One-Group Pretest-Posttest Design because there is only a group of 10 athletes who will do the pretest and posttest. This research focuses on providing exceptional treatment, namely the use of ETM to carry out specific tests to analyze the anaerobic capacity. The pretest and posttest still use the same test equipment, the only difference being the use of ETM with the HIIT training method to see the effect on anaerobic capacity. The population in this study was women's futsal athletes who were members of a futsal club at a state University with 20 members. Researchers chose futsal players as the population because futsal players have

an excellent physical condition. This makes the researcher assume that futsal athletes can carry out the test instrument that will be used.

The sampling technique used is the non-probability sampling purposive sampling method. In addition, the study set special requirements in this study, namely having participated in a pre-research training program carried out by researchers and having a minimum physical condition of 70%. Based on these requirements, the sample obtained in this study was ten people.

The test instrument used is the Running-Based Anaerobic Sprint Test (RAST) (Queiroga et al., 2013). RAST developed at the University of Wolverhampton England is a sprint exercise with a distance of 35 m with a time lag of 10 seconds used as a recovery. The selection of the Running-based Anaerobic Sprint Test (RAST) instrument was based on physiological rules and adapted to the characteristics of the futsal game field played with a field length of 25 m – 42 m and a field width of 15 m – 25 m so that it is considered valid and reliable to be used to measure anaerobic capacity. The purpose of RAST is to measure anaerobic power and capacity (Andrade et al., 2015).

The procedure for implementing the first RAST is to prepare the field to be used by marking the length of the field at each end of the track using cones. The length of the field used is 35 meters. The researcher explained the instructions for implementing RAST to the test participants and the frequency with which the test was carried out. The researcher acts as an officer who gives a signal with a whistle as a marker. The time is recorded when the test taker reaches the finish line. RAST was carried out six times so that there were six records.

The testee is declared to have stopped participating in a series of RASTs if he does not complete the distance and number that has been determined, falls, and does not perform by the provisions that have been set. Time recording is done six times according to the number of RAST implementations. The RAST score consists of max power, minimum power, average power, fatigue index (fatigue index), and anaerobic capacity (anaerobic capacity). Researchers only took anaerobic capacity data in this study, namely the combined score of all peak power output. Below is how to calculate and draw the RAST model. Anaerobic capacity is obtained from adding up the six Peak Power Output (PPO). The formula for PPO is

$$PPO = w \times \left(\frac{d^2}{t^3}\right)$$

Note :

PPO = *Peak Power Out*
w = *weight*
d = *distance*
t = *time for one track*

In this study, the sample used was only ten athletes, so the entire test used non-parametric SPSS assisted for data processing. The normality test aims to see whether the data distribution comes from data that is normally distributed. Normality test using SPSS with Shapiro Wilk test. To find out whether the difference in the average of two paired or related, the paired sample t-test is used

RESULTS AND DISCUSSION

Anaerobic capacity data collection using RAST was carried out twice. At the beginning of the test, participants did as usual and did it using the ETM. The results obtained are further categorized into three, namely high, medium and low. More detailed data collection results are presented in **Table** 1.

Tabel 1.
Anaerobic Capacity Categorization Before HIIT Exercise Using ETM

No	Category	Interval	Frequency	Percentage
1	high	$X \geq 1774$	1	10%
2	medium	$1774 < X \leq 1212$	5	50%
3	low	$X < 1212$	4	40%

In **Table** 1, the anaerobic capacity score interval is calculated for the highest and lowest results. The highest result was 2335.9, and the lowest was 462.3. Each score has an interval of 562, so the interval value is as above. It is the result of measuring anaerobic capacity before HIIT exercise using ETM. There was only 1 (10%) sample in the high category with a score of more than 1774. In the medium category, there were 5 (50%) samples in the category between 1774 to 1212, and in the low category, there was 4 (40%) sample with a score below 1212.

Tabel 2.
Anaerobic Capacity Categorization After HIIT Exercise Using ETM

No	Kategori	Interval	Frekuensi	Persentase
1	high	$X \geq 1583$	4	40%
2	medium	$1583 < X \leq 797$	5	50%
3	low	$X < 797$	1	10%

In **Table** 2, the anaerobic capacity score interval changes by calculating the highest and lowest results. The highest result was 2370.9, and the lowest was 787.1. The results obtained have increased from the pretest. Each score has an interval of 787, so the interval value is as above. The increase in the sample who entered the high category was 3 (30%) samples that there were 4 (40%) students who increased. In the moderate category, there was a 5 (50%) sample, and in the less decreased category, 3 (30%) people so that only 1 (10%) test takers remained.

The sample in the study was very small so that the normality test used the Shapiro-Wilk non-parametric statistical test for the results of the pretest and posttest. The output value obtained is more than 0.05 (pretest; 0.559 and posttest; 0.891), so it can be concluded that the pretest and posttest results are normally distributed. The results of the Paired sample t-test were carried out with the help of SPSS, while the results of the Paired Sample t-Test were presented in **Table** 3.

Tabel 3.
Output Paired Sample t-Test

		Paired Differences					t	df	Sig. (2-tailed)
		Mean	Std. Deviation	Std. Error Mean	95% Confidence Interval of the Difference				
					Lower	Upper			
Pair 1	Pretest - Postest	-205,81000	219,66479	69,46410	-362,94872	-48,67128	-2,963	9	,016

The results in table 3 show 0.016 with a significance level set in this test of 5% or 0.05 and then Based on the results above with the value of sig. Thus, at an output of 0.016 < 0.05, it can be concluded that there is an effect of high-intensity interval training using an elevation training mask on the increase in anaerobic capacity.

Discussion

HIIT is a physical exercise method that football coaches often use to improve the fitness of their players (Hutajulu, 2017). HIIT is a method that combines a variety of physical exercises ranging from sprints, jogging, walking to rest (Laursen et al., 2002). ETM is one of the tools used during HIIT training in this research instrument because it is claimed to exercise efficiency because it simulates at a height.

This exercise aims to determine the anaerobic capacity of an athlete. First, in the pretest, RAST was performed. Then, anaerobic capacity calculation results are obtained

from adding up all peak power output. Calculations that have been done, the results obtained are 10 participants with the results that 10% of participants are in the high category, 50% of participants are in the medium category, and 40% are in a low category. The test participants ran without any obstacles so that the breathing process was still running as usual, where the anaerobic capacity was not maximized.

Anaerobic capacity (anaerobic capacity) is the amount of energy obtained through anaerobic metabolism with the phosphagen system (ATP-PC) and anaerobic glycolysis system (Doewes, 2008). Anaerobic capacity is the total energy needed to do work obtained from the alacacid and lactation energy systems. Thus, anaerobic capacity is a combination of the capacity of the alacacid energy system and the capacity of the lactacid energy system.

The body provides ATP through anaerobic metabolic processes, interpreted as metabolism that occurs without oxygen. The energy obtained through anaerobic metabolism is the result of high-intensity body activities that require energy supplies as quickly as possible. Aerobic metabolic processes can carry out the availability of oxygen in the blood for too long. The body uses anaerobic metabolic pathways to synthesize ATP. Anaerobic metabolism process will produce ATP faster than aerobic.

During the posttest, where the test takers were treated with the HIIT training method using ETM during the data collection process, it was found that 40% of the test takers were in the high category, 50% of the test takers were in the medium category, and 10% of the test takers were in the high category. Low category. This can be seen as an increase in the high category and a decrease in the low category after using ETM.

According to one of the tests, participants explained that at the beginning, the use of ETM was a little annoying because of difficulty breathing, so that they were not able to do HIIT well. As time goes by and the intensity of the exercise, the participants begin to adapt until they reach the maximum speed limit, which is better than before using the ETM. There is a difference between the anaerobic capacity of men and women who live in the highlands compared to those who live in the lowlands (Hakim, 2008). The significant difference between anaerobic capacity in the highlands and lowlands was carried out by statistical testing, which resulted in better anaerobic capacity in the highlands (Hakim, 2008).

ETM can increase endurance and VO2max, as well as improve lung function. The multi-level resistance system allows users to simulate heights from 914 m to 5,486 m. The mask must have a mechanism to lower the partial pressure of oxygen to cause a hypoxic

state during exercise (Porcari et al., 2016). Physically, this mask is like a mask covering the mouth equipped with a channel or valve. ETM design on the front limits the amount of oxygen that will be received and a valve where the air is exhaled to let the air out. The condition that occurs when using ETM is that a person will feel the oxygen intake is reduced so that the heart and lungs work faster. When the ETM is opened, the body will use oxygen more efficiently. If, during physical exercise, using ETM regularly, the physician will feel more substantial.

The ETM covers the nose and mouth and has different opening sizes and flux valves. The flux opening and valve can be adjusted to increase respiratory resistance, making breathing more difficult when wearing a mask (Porcari et al., 2016). As a result, ETM can increase endurance and VO2max, as well as improve lung function. ETM design on the front limits the amount of oxygen that will be received and a valve where the air is exhaled to let the air out. The condition that occurs when using ETM is that a person will feel the oxygen intake is reduced so that the heart and lungs work faster.

In the paired sample test for anaerobic capacity, the results showed an effect before the use of ETM and after the use of ETM. Increasing anaerobic capacity can be done by doing HIIT exercises, one of which is using ETM. The body provides ATP through anaerobic metabolic processes, interpreted as metabolism that occurs without oxygen. The energy obtained through anaerobic metabolism is the result of high-intensity body activities that require energy supplies as quickly as possible. Aerobic metabolic processes can carry out the availability of oxygen in the blood for too long. Therefore, the body uses anaerobic metabolic pathways to synthesize ATP. Anaerobic metabolism process will produce ATP faster than aerobic.

This resulted in the test takers being able to maximize their running strength and anaerobic capacity. After completing HIIT, the test taker will open the ETM and what happens is that the body will use oxygen more efficiently. Thus, HIIT exercise can increase VO2max to improve cardiorespiratory fitness (Nugraha & Berawi, 2017). HIIT is a physical exercise method that is often used by football and futsal coaches to improve the fitness of their players (Hutajulu, 2017). HIIT is a method that combines a variety of physical exercises ranging from sprints, jogging, walking to rest (Laursen et al., 2002). The benefits of using the HIIT method are to increase VO2max capacity and recovery time, passing ability, and the capacity to repeat sprints in a shorter time.

Anaerobic performance is determined by the proportion of fiber type and glycolytic enzyme capacity of skeletal muscle, which are strongly influenced by genetic factors. The

increase in anaerobic performance can vary according to the intensity of the exercise, the training period, and the athlete's ability. Some studies state that the intensity training method's height or maximization affects anaerobic performance in some sports players. For example, anaerobic capacity in the HIIT group increased by 28.58%, and the fatigue index decreased by 38.74% (Chittababu, 2014).

The increase in strength after a training program can be partially related to an increase in muscle performance or muscle fiber size for muscle strength production has been associated with an increase in muscle fiber size. The development of muscle performance with an exercise program is related to improving motor unit function or neuromuscular adaptation. Neuromuscular adaptations such as increased inhibitory muscle antagonists and synergistic muscle contraction may explain the increased strength. Anaerobic performance, about increased muscle enzyme activity, can be improved by high-intensity exercise or HIIT.

If, during physical exercise using ETM regularly, the physician will feel more substantial. In his research, Porcari (2016) found that the test group using ETM experienced a significant increase in VO2max and Peak Power Out (PPO), VT, PO in VT, RCT, and PO in high-intensity RCTs for six weeks. The relatively significant increases in VT, PO in VT, RCT, and RCT when wearing an ETM improved performance significantly. Improved physiological characteristics and functional reserve of respiratory muscles when using ETM during the HIIT program. ETM also helps improve lung function and performance.

CONCLUSIONS AND SUGGESTIONS

Based on the analysis of the data obtained, it can be concluded that there is a significant effect of the high-intensity interval training method using an elevation training mask on the increase in the anaerobic capacity of female futsal athletes at the college student level

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