

The Effect of Aerobic Exercise on Changes in Vo2 Max in Pertina Boxing Athletes, Pekalongan City Hafnita^{1*}

¹ Universitas Negeri Semarang

* Corresponding author: hafnitasiagian4@students.unnes.ac.id

Abstract: The aim of this study was to find out the effect of regular aerobic exercise on changes in VO2 max within 20 meetings. This research is motivated by the fact that sport or physical exercise is very important to maintain and improve physical fitness. Exercise is divided into aerobic and anaerobic exercise. Almost all the energy needed for muscle activity is produced by aerobic and anaerobic processes. The effect of aerobic exercise is cardiorespiratory fitness, because exercise can increase oxygen uptake. One way to assess a person's fitness in carrying out activities is to measure VO2 max. VO2 max is the maximum amount of oxygen in milliliters, which can be used in one minute per kilogram of body weight. People who are in good shape have higher VO2 max values and can perform activities more vigorously than those who are not in good condition. **Materials and Methods.** This research uses a quasi-experimental method, a quantitative method while the design uses One Group Pretest-Posttest Design. In the research, the sample used was the PERTINA Boxing Team of Pekalongan City, totaling 10 people, with male gender, age 16.40 ± 1.17 years, weight 63.70 ± 5.21 kg and height 167.70 ± 1.57 meters and a Body Mass Index of 18.99 ± 1.47 . VO2 max was measured before doing aerobic exercise, and after doing regular aerobic exercise at the 6th and 6th meetings. Differences in results before and after regular aerobic exercise for 6 meetings were analyzed using the Excel Statistical Analysis Tool. **Results.** There was a very significant increase in VO2 max after doing programmed aerobic training for 20 meetings. **Conclusion.** Aerobic exercise for 6 meetings can increase the VO2 max value.

Keywords: aerobic exercise, VO2 max, boxing.

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INTRODUCTION

In today's modern era, humans work to save more time and energy, and this is accompanied by an increase in living standards. However, the development of technology has had a negative impact, causing humans to have less physical activity, changing lifestyles and excess nutritional intake. Currently, modern lifestyle patterns and lifestyles are increasingly widespread in society. This phenomenon is welcomed as a form of development progress and technological development. However, on the other hand, this tendency can be detrimental, because it can increase the risk of blood vessel and heart disease. In Indonesia, this disease has risen in rank to become the number 3 killer after diarrhea and respiratory infections. In carrying out daily life, every person cannot be separated from physical fitness, because physical fitness is a very important factor in carrying

out daily life. Physical fitness is closely related to a person's state of health. Health is defined as a state of physical, mental, and social well-being and not simply the absence of disease or infirmity. Based on the definition above, one indicator that someone is said to be healthy is having good physical fitness. (Raden Ayu Tanzila et al., 2018)

Sport or physical exercise is very important to maintain and improve physical fitness. Physical fitness is a need that must be met so that we can carry out daily life activities well. Physical fitness is the body's ability to carry out activities without experiencing excessive fatigue. The higher a person's level of physical fitness, the better their physical work ability. Physical fitness is the key to true health and endurance. (Alfin Yuda, 2021)

Physical condition development is initial development and is the main basis for participating in sports training to achieve an achievement. By having excellent physical condition, each athlete will be able to achieve optimal performance. The elements of physical condition are cardiac-respiratory-circulatory endurance (respiratory-cardio-vascular endurance), muscle endurance, strength, accuracy, speed, agility, reaction, balance, coordination, joint flexibility and explosive power (I Wyn Dedy Hariyanta et al., 2014).

Training is a process in sports activities for develop the potential that exists in athletes, especially in abilities and skills possessed systematically and carried out according to a time period which has been determined (Parthiban, et al., 2021). Practice itself is athlete development program to compete, in the form of improving skills and energy capacity, exercise is a systematic process to improve athlete's fitness according to the chosen sport, training is a systematic process that is carried out repeatedly and the amount of burden increases day by day. Training is a process for athletes to achieve something desired achievement, therefore an athlete must be serious about training himself in stages (Dharma & Duhe, 2020). Special training aimed at improving the physical quality of athletes Overall it can be done by means of training and loading, which formulated. The main goal of physical training is to improve quality of energy fitness and muscle fitness. Energy fitness includes improving low-intensity aerobic ability, medium intensity, as well as high intensity and anaerobic both alactic and yang causes lactation (Emral, 2017).

Physical exercise is a body movement carried out by muscles in a planned, structured and repetitive manner that involves the use of energy to improve fitness. Regular exercise has beneficial effects on health, especially helping to reduce and prevent various cardiovascular diseases, metabolic syndrome disorders and osteoporosis (Elsa Yuniarti & Afriwardi, 2015)

Cardiovascular endurance is the maximum amount of work a person can do continuously using a number of large muscles (such as the legs and arms) and depends on the body's ability to use oxygen efficiently. The more a person's body

can use oxygen, the more work it can do. (I Ketut Sudiana, 2014). The cardiorespiratory system is related to the cardiovascular circulation so that the structure of lung function selectively contributes to the heart. Cardiorespiratory endurance is the readiness of the heart to pump blood and distribute oxygen throughout the body properly, efficiently and efficiently (Kartika et al., 2020).

Endurance training is the body's ability to fight fatigue so that the body is able to carry out activities or work relatively quickly to get back in shape. Endurance is a very important physical factor, which determines an athlete's performance, because with good endurance an athlete will be able to apply techniques and tactics to the maximum, so that with excellent endurance the opportunity to achieve achievement will be easier. The main factor for success in sports training and competitions is influenced by the athlete's level of endurance ability, so a person's good endurance ability will be able to do their job optimally.

According to Bompa in (Ziko Fajar Ramadhan et al., 2019) Any exercise, whatever the form, if done correctly will provide a change in the body's systems, be it the aerobic system, hormonal system or muscle system. Training is a systematic sports activity over a long period of time, increased progressively and individually which leads to the characteristics of human psychological and physiological tasks to achieve specified targets. There are aerobic and anaerobic sports exercises, so it is necessary to choose effective exercises to increase the body's immunity. Body immunity can be seen from a good level of physical fitness, so a test is needed to determine the level of body immunity through a Physical Fitness Test. The Physical Fitness Test is influenced by the condition of the Body Mass Index in determining the type of exercise that is effective in increasing the body's immunity. (Tri Sapton, et al., 2021). A good immune system or immune system can protect the body from the first time germs that cause disease enter the body, having a strong immune system is very important to prevent getting sick, especially during a pandemic. One type of activity to maintain the body's immunity is to do regular exercise. There are aerobic and anaerobic sports exercises, so it is necessary to choose effective exercises to increase the body's immunity. Body immunity can be seen from a good level of physical fitness, so a test is needed to determine the level of body immunity through a Physical Fitness Test. The Physical Fitness Test is influenced by the condition of the Body Mass Index in determining the type of exercise that is effective in increasing the body's immunity.

Aerobic exercise is a type of exercise that stimulates the heart rate and respiratory rate to increase rapidly during aerobic exercise sessions known as cardio, namely exercise that requires oxygen to be delivered to the working muscles. This exercise is carried out for a short duration but with high intensity. This type of exercise can stimulate muscle activity at high intensity which can increase muscle strength and endurance. Examples of anaerobic exercise are weight lifting and sprinting. (Tri Saptono et al., 2021). Aerobic exercise aims to

prepare the circulatory and respiratory systems, strengthen tendons and ligaments, reduce the risk of injury and provide energy sources for long-term, low-intensity activities. Aerobic exercise has been known to lower your resting heart rate. The function of a low pulse state, meaning that the lower the pulse rate in a resting state, the better the physical fitness. Another factor that influences aerobic fitness is activity. That the activities we do regularly will shape our health, vitality and quality of life. The effects of years of training can be lost in just 12 weeks by stopping the activity. Bed rest can reduce fitness by 29% or 10% per week Aerobic exercise energy system: 1) moderate work intensity, 2) work duration of more than 3 minutes, 3) movement (work) rhythm is smooth and continuous (continuous), 4) during activities produces carbon dioxide + water (CO₂ + H₂O). Activities whose energy source comes from the aerobic system tend to use low power and are closely related to cardiorespiratory endurance (Tri Saptono et al., 2021).

However, aerobic exercise is actually defined as exercise that requires a lot of oxygen and involves a lot of large muscles. This type of exercise is done at low intensity and over a long period of time. Every time you do physical activity, the body will form energy to be used as energy. When we do aerobic exercise, most of the body uses glycogen or muscle sugar and fat reserves as the basic ingredients for energy formation. This type of exercise is good for losing weight and maintaining heart health. Therefore, aerobic exercise is highly recommended for people who are overweight. By doing aerobic exercise, you can also reduce fat levels in the body, prevent you from experiencing stress, and reduce the risk of various degenerative diseases. Types of aerobic exercise are sports that are comfortable to do, without making it difficult for you to breathe, such as leisurely walking, swimming, dancing and cycling. Each type of aerobic exercise has a different duration. However, the Cleveland Clinic recommends doing moderate intensity aerobic exercise, which is done for 30 minutes every day of the week (Annas Said et al., 2022).

Cardiovascular endurance is an important component in physical fitness where the heart, blood vessels and lung system function optimally in rest and work conditions in taking in oxygen and distributing oxygen to active tissues so that it can be used in the body's metabolic processes. Cardiovascular endurance is also called heart-lung endurance. This heart-lung endurance shows how a person's heart and lungs are able to deal with physical workload. Cardio-lung endurance can be used as a direct guide in assessing a person's fitness level. The ability to uptake oxygen during physical exercise reflects the person's metabolic ability [1]. Decreased work of the cardiovascular system causes the heart-lung system to not work optimally, this will cause the emergence of degenerative diseases, namely low physical activity which usually has an impact on heart disease, chest pain and stroke. The World Health Organization (WHO) reports that CVD (Cardiovascular

Disease) is the number one cause of death in the world. It is estimated that by 2030, nearly 25 million people will die from CVDs, mainly from heart disease and stroke. Cardiovascular disease is the leading cause of death in America, accounting for 34.3% of all deaths in the United States in 2006 [2]. Many factors influence a person's level 2 of physical fitness, including age, gender, heredity, food, smoking habits, exercise, physical activity and body fat (Annas Said et al., 2022).

The effect of aerobic exercise is cardiorespiratory fitness because aerobic fitness or cardiorespiratory fitness is a collection of the heart's ability to pump oxygen-rich blood to other parts of the body and the ability to adapt and recover from sports activities. (Indrayana et al., 2019) People who regularly do physical exercise increase their VO₂Max. (I Gede Dharma Utamayasa, 2021) What athletes need to pay attention to is the physical condition and techniques mastered by the athlete. For this reason, it is necessary to pay attention to the mechanisms underlying a given exercise.

Regarding the principle that training must be progressive, with the weight training method with linear increases, the training load is increased gradually and increases continuously. Increased exercise regularly and increasing the load as one way to maintain and improve physical fitness. (Sabran A. Burahim et al., 2022) In order for the body's adaptation process to occur, the overload principle is needed followed by the progressive principle. Training is progressive, meaning that the exercise is carried out from easy to difficult, simple to complex, general to specific, part to whole, light to heavy, and from quantity to quality, and carried out in a steady, progressive and continuous manner. Applying the overload principle must be done gradually, carefully, continuously and precisely. This means that each training goal has a certain time period for the athlete's organs to adapt. After the adaptation period is reached, the training load must be increased. This means that each individual is not equally able to adapt to the given load. If the training load is increased suddenly, the body will not be able to adapt and it will even be damaged and result in injury and pain (Emral, 2017). (Bompa & Haff, 2019) states that "from gymnastics to elite, training loads must be increased gradually and varied periodically based on the physical capacity, psychological abilities and workload tolerance of each athlete." In conclusion, loading must be done gradually to improve performance, but also controlled by the needs and status of the athlete, as well as whether or not they are able to obtain the load given during training. Progressive is an increase in training load compared to the previous training exercise.

The overload principle is the basis of a weighted training program. This principle of overload is an important factor in increasing an athlete's ability. The overload principle is a training principle that emphasizes training loads that are heavier than what the athlete is capable of doing (Aprilia, 2018). From the beginning of growth to the growth of becoming an outstanding athlete, the

workload in training can be increased slowly, according to the athlete's physiological and psychological abilities. Physiological is the basis of adding load to exercise which will allow increased oxygen consumption per minute, until a maximum figure is reached. This occurs by changes in cardiorespiratory function, such as pulse rate, heart stroke volume, blood pressure, arteriovenous oxygen difference and pulmonary ventilation, so that this principle, as a result of training, the body's functional efficiency and capacity to do work, slowly increases. over a long period of time. Increasing abilities drastically requires a long period of training and adaptation. Athletes experience anatomical, physiological and psychological changes that require increased training loads. Improved development of nervous system function and reactions, neuro-muscular coordination and psychological capacity to cope with stress as a result of heavy training loads, changes slowly, requires time and leadership. According to Bompa in (Shobarna Rohmatul Insan, 2024) it is explained that the training load must exceed the habit of regular daily activities. This aims to ensure that the physiological system can adapt to the functional demands required for a high level of ability. The value of improvement in ability depends directly on the value and habit of increasing the load in training. Low training load standards will have the effect of reducing the impact of training, and in long distance running it will be shown through worse physical and psychological conditions, reduced capacity.

The element of oxygen use in training is one of the determining factors because an athlete's superiority lies in the ability to provide oxygen according to his needs. Maximum oxygen consumption in athletes, hereinafter referred to as Maximum Oxygen Volume, is intended to indicate the body's capacity to use oxygen optimally and is often abbreviated to VO₂ max. One way to assess a person's fitness in carrying out activities is to measure VO₂ max. VO₂ max is the maximum amount of oxygen in milliliters, which can be used in one minute per kilogram of body weight. Good physical endurance is the maximum ability to meet oxygen consumption which is characterized by the maximum oxygen volume level (VO₂ Max). VO₂ Max is the maximum amount of oxygen in milliliters, which can be used in one minute per kilogram of body weight. People who are in good fitness have a higher VO₂ Max value and can perform activities more vigorously than those who are not in good condition. (Mohammad Faiz Setio Budi, 2015).

Boxing is a martial sport which in appearance requires good physical condition. Good physical condition for boxers includes explosive power, agility, speed, strength, endurance and hand eye coordination (Marisa & Umar, 2020). According to (Abdurrojak & Imanudin, 2016) that boxing is a sport and fight where two participants of the same weight compete against each other by punching or boxing, the length of this sporting match is determined by rounds, each round has an interval of one or three minutes.

Aerobic training has been applied to PERTINA Pekalongan City Boxers. The training portion and duration are determined by the trainer based on experience and certain standard procedures. For this reason, the author wants to conduct this research on PERTINA Boxers in Pekalongan City. Research will be carried out by observing the effect of aerobic exercise on changes in VO₂ max.

METHOD

The method used is quasi-experimental using quantitative methods. One group pretest-posttest design and pretest measurement of HR before and after treatment. The sample taken is the Total Population Sampling Sample, namely all athletes. The target is 10 PERTINA Pekalongan City Boxing Athletes, with male gender, age 16.40 ± 1.17 years, weight 63.70 ± 5.21 kg and height 167.70 ± 1.57 meters and Body Mass Index 18.99 ± 1.47 with exclusion criteria: there are no circumstances that interfere with the measurement, such as the participant being sick, smoking, the subject refusing to participate either in the measurement or in participating in programmed physical exercise, participating in other physical exercise outside the training program PERTINA Pekalongan City. Data collection was carried out on November 18 2023. This research was conducted at the PERTINA gym, Pekalongan City. Research subjects carry out physical exercise regularly, systematically and continuously in accordance with a predetermined exercise program, which consists of aerobic exercise, namely exercise that uses energy derived from combustion with oxygen.

Aerobic training is carried out by running 400 meters \leq 130 seconds, training duration 8 repetitions, rest for each repetition 1:4, training 20 times. Hanjabam & Kailashiya in (Nandita Nury Latifah et al., 2019) stated that aerobic endurance can be measured by looking at the maximum volume of oxygen consumption entering the body (VO₂max). VO₂ max measurements were carried out by providing a bench that had been modified to be 28 cm high. People try going up and down a bench with a frequency of 24 times per minute following the rhythm of a metronome (96 times per minute) for 3 minutes without taking a break. 1 minute after the implementation, the pulse rate was measured on the radial artery by palpation for 1 minute. After that, a formula is used to estimate the amount of VO₂ max, namely: $VO_2 \text{ max} = 15 \times \text{Max heart rate}$, then the result is divided by the resting heart rate after exercise. Try measuring people's VO₂ max before starting the aerobic exercise program at the 0th meeting and after carrying out the exercise program at the 20th meeting. Then an analysis of the differences in results before and after the program was carried out.

The collected data was analyzed using the Excel Statistical Analysis Tool. The presentation of the results of descriptive statistical analysis is described in Mean, Standard Deviation, minimum value, maximum value and mode. The normality of the test was tested using the Liliefors test, while the homogeneity of the test was

tested using the Excel Statistical Analysis Tool and VO2 max analysis using the t test. This test is to find out whether there is a significant difference in a variable/attribute that is measured repeatedly. A T-Test was carried out to determine the increase in VO2 max. An increase is declared significant if $p < 0.05$ is obtained. All analyzes were carried out with computer assistance using the Excel Statistical Analysis Tool.

RESULTS

Based on the results of data collection, secondary data was obtained on the profile of the participant with male gender, age 16.4 ± 1.17 years, weight 63.70 ± 5.21 kg and height 167.7 ± 1.57 meters and Body Mass Index 18.99 ± 1.47

Table 1. Characteristics of Research Subjects

Characteristics	Standard			Minimal	Maximum
	N	Mean	Deviation		
Subject					
Subject Age	10	12,6143	1,17	14	18
Weight	10	63,70	5,21	50	69

At the 0th meeting measurement, the average VO2 max value was 43,660 ml/kgbb/min. Then there is an increase in the VO2 max value. At the 6th meeting, the average value was 53.654 ml/kgbb/min. It can be seen that the change in VO2 max at the 0th meeting is very significant compared to the 20th meeting.

Table 2. General Linear Model Repeated Measure Test

VO2 max value	Mark	VO ₂	maxF	p
0th meeting	20th meeting			
Results	$43,660 \pm 5,3089$	$53,654 \pm 4,8638$	51,803	0,000

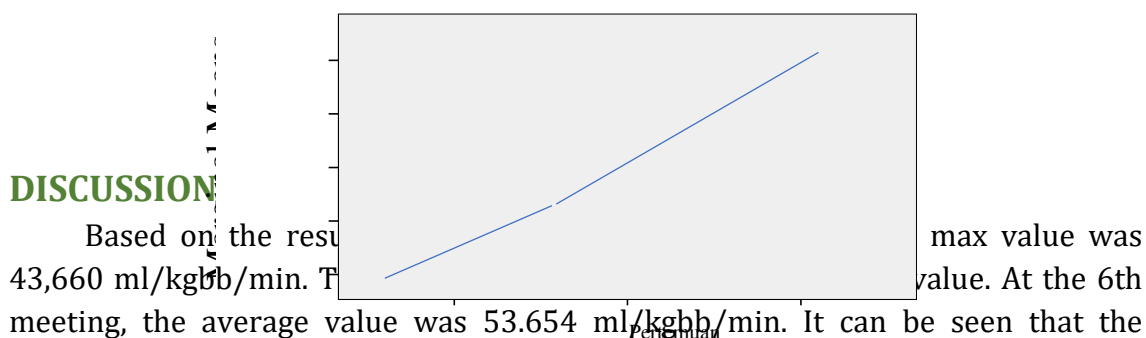
Measurements using the T-Test, the results are as follows:

	Average treatment	p
0th	$43,660 \pm 5,3089$	0,001
20th	$53,654 \pm 4,8638$	0,000

Table 3. T-Test of research subjects

A p value <0.05 was obtained at the 20th meeting, meaning that there was a significant increase in the average VO2 max value between before and after training

Estimated Marginal Means of MEASURE_1



DISCUSSION

Based on the results, the average VO2 max value was 43,660 ml/kgbb/min. The average value at the 6th meeting was 53.654 ml/kgbb/min. It can be seen that the change in VO2 max at the 0th meeting is very significant compared to the 6th meeting.

In this study, it was found that the VO2 max value increased very significantly. This is because the lung diffusion capacity of trained people is better than that of untrained people. The better the lung diffusion capacity, the greater the volume of gas that diffuses, the better a person's ability to carry out cardiorespiratory loads without experiencing significant fatigue. So that trained people will breathe more slowly and deeply, and the oxygen needed for muscle work in the ventilation process is reduced. As a result, with the same amount of oxygen, trained people will work more effectively than untrained people.

CONCLUSION

Aerobic exercise carried out regularly for 20 meetings can increase the VO2 max value in PERTINA Pekalongan City boxers.

Conflict of Interest

The authors declare that they have no conflicts of interest.

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