The Effect of Badminton Training on Changes in Physical Fitness Levels (VO2 Max, Blood Pressure, and Hemoglobin Levels) of Badminton UKM Students at the Bina Guna Sports and Health

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Abstract.

Background Sports training such as badminton training is an aerobic activity, which is useful for improving and maintaining the health and endurance of the heart, lungs, blood circulation, muscles and joints and involves muscle strength, muscle endurance, flexibility and cardiorespiratory endurance so that it can affect physiological activities such as VO2 max, blood pressure and Hb levels.

Objectives The effect of badminton training on changes in physical fitness levels (VO2 max), blood pressure, and Hb (hemoglobin levels) UKM Students of Bina Guna Sports and Health College.

Methods The research design used a pre-experimental research type with a one-group pre-post test design. The population was taken from all members of the STOK Bina Guna Badminton UKM, while the sample was taken using a purposive sampling technique.

Results The research data were tested for normality using the Shapiro-Wilk normality test with a p value of >0.05 for all variables, then a significance test was carried out using a paired t test. The p value of VO2 max was 0.002 <0.05. The assessment of VO2 max levels used the YMCA step test. The p value of systolic blood pressure was 0.004 <0.05, while the p value of diastolic blood pressure was 0.002 <0.05, while the p value of Hemoglobin levels was 0.000 <0.05.

Conclusion Badminton training for 3 weeks with a total of 12 training sessions has an effect on the level of physical fitness, namely VO2 max, blood pressure and hemoglobin levels in members of the STOK Bina Guna Badminton UKM.

Keywords: Badminton Training, VO2 max, blood pressure, Hemoglobin levels.

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INTRODUCTION

Cardiorespiratory endurance is a component of physical fitness that describes the ability of the respiratory and circulatory systems to supply oxygen to working muscles during physical activity (Virra, 2023). Cardiorespiratory endurance in men peaks between the ages of 18 and 25, coinciding with peak muscle mass. Regular, measured exercise with light to moderate intensity can improve health, fitness, and immunity (Siti, 2021). Cardiorespiratory endurance is reflected in the predicted VO2max capacity, which is an indicator of physical fitness level. Many official organizations use oxygen consumption volume as a measure of fitness. This measure of cardiorespiratory vascular performance is often referred to as maximum oxygen volume, or VO2max, for short (Yohandika, 2023).

Total fitness encompasses four aspects: physical, emotional, social, and intellectual well-being (Howell & Sarwono, 2020). A crucial component of a complete, healthy quality of life is physical fitness, or physical fitness. Two terms used interchangeably are another term for physical fitness. A body is considered dynamically healthy when all organs are able to function normally when a person is actively moving and has no abnormalities.

According to McGowan (2021) in Enggel (2023), exercise is as effective as blood pressure medication and has no adverse side effects. Exercise helps the heart and blood pressure function properly because the heart is a vital organ that supplies blood throughout the body. As physical activity increases, the need for oxygenated blood increases. This need is met by the heart by increasing blood flow. Blood vessels respond by widening their diameter (vasodilation), which in turn affects the individual's blood pressure (Rai,

2022) in Enggel (2023). During activity, breathing becomes deeper, meaning ventilation increases. For anyone who exercises for a long time, the need for oxygen to maintain metabolism increases, as does the need for air. This increase in ventilation during exercise is very significant; for example, while at rest, people only inhale 5 to 10 liters of air per minute, while during exercise, they inhale 150 liters or even 200 liters of air per minute (Sudarno & Saiful, 2023).

During activity, the vital respiratory organ, the lungs, needs fresh oxygen to meet the body's metabolic needs. This function transports oxygen from the lungs to all blood cells in the body, and returns carbon dioxide from all cells to the lungs for excretion. Equally important in this process is the oxygen-carrying compound, hemoglobin, found in red blood cells. Therefore, if hemoglobin levels are low, red blood cells will also carry less oxygen (Saiful, 2023).

According to Bart Crum (2021) in Ma'ruful Kahri (2022), the main problem facing physical education today is a change in cultural values, a change in movement culture. This means a cultural shift has occurred, from a culture of movement to a culture of silence. This cultural shift is triggered by the impact of economic globalization, automated communication and transportation technology, so that children tend to eliminate physical activity in various activities. For example, in daily life, a lot of time is spent sitting in front of the television, videos, PlayStation, the internet, Facebook, and so on. Going to school/campus using vehicles as transportation, going to the mall using elevators and escalators instead of taking the stairs.

According to G. Petersen (2019) in Ma'ruful Kahrī (2022), a WHO representative from Indonesia, "Today, many people worldwide are inactive, resulting in very low physical fitness." The impact of low physical fitness leads to hypokinetic diseases such as cardiovascular disease, diabetes, obesity, and heart disease. Heart disease no longer affects adults, but also children and adolescents. If this can be prevented early, it will reduce the death rate by 2 million people, or 5,479 people die from hypokinetic diseases each year. This case is one of the ten causes of death worldwide.

Furthermore, based on research by Fu and Fung (2020); Chin Ming-kai (2020) in Ma'ruful Kahrī (2022), it states, "A study conducted reported that 80% of Chinese living in Beijing, Shanghai, and Hong Kong were sedentary." Fu and Fung stated that 80% of Chinese people living in Beijing, Shanghai, and Hong Kong behave in a sedentary manner". This kind of behavior does not only occur in China and Hong Kong, but also in Europe. Regarding this, Janz et al., (2021), Tybor, (2021); Janssen et al (2021; Chin Ming-kai (2021:9) in Ma'ruful Kahri, 2022 stated that as many as 130,000 school children from 34 European countries experienced decreased physical activity due to the time spent watching television.

Nowadays, badminton matches require thorough preparation. A player must be mature in their strokes, understand tactics and strategies, and be able to read their opponent's strengths. Not only must they be mature in their strokes and identify their weaknesses, but they must also be aware of their opponent's physical condition. In badminton, when two players are nearly equal, victory or defeat is determined by their mental and physical condition. It is crucial for a badminton athlete to maintain a high level of physical condition, as improving physical condition supports athletic activity and the pursuit of peak performance (Suharno, 2019: 38 in Sigit, 2020). Badminton is a popular sport and is enjoyed by many people in Indonesia, and even around the world. It is an individual game, played one-on-one or two-on-two. It can be played by men, women, or mixed pairs. Badminton is a game that relies heavily on physical ability, with fast movements and powerful shots delivered within seconds between long rallies (Boby, 2021).

Physical ability is one of the most dominant components in achieving success in badminton. Badminton success is inseparable from the elements of tactics, technique, and quality of physical condition. Badminton players greatly require good quality strength, endurance, flexibility, speed, agility, and coordination of movement (Sigit, 2020). With the increasing number of sports offered, it is becoming easier for people to choose and participate in sports they enjoy. However, it is unfortunate that only 26.2% of Indonesians aged 10-30 years old participate in sports (Alim Abdul & Cerika Rismayanthi, 2021). Based on researchers' observations, badminton itself is a type of sport that is popular among students because this type of game is not as strenuous as other types of sports. Therefore, the authors feel the need for a scientific approach to prove the effect of badminton on health. especially the level of physical fitness by conducting research on students, considering that students are required to always be active with high activity towards the learning process and extracurricular activities that require students to always be fit, apart from that the researcher also hopes that this research can also be useful and can be applied by the nursing profession that requires fitness in carrying out their profession because the nursing profession accompanies patients for 24 hours which requires the nurse to be in a healthy condition, so that by exercising can improve their fitness one of which is through badminton. Syaifuddin's research (2023) conducted at the LKK Ngesti Rahayu Sidoarja foundation stated that badminton is a solution to reduce work frustration for workers. Based on this research, it states that sport is an activity to encourage, foster, and develop physical, spiritual and social

potential. Meanwhile, according to Widodo (2024) that in addition to being beneficial for physical health, badminton can also be used as a filler for free time in between their busy work routines for workers.

Physical fitness is crucial for nurses to perform their work. As the workload increases, good fitness is also required. This is supported by Kurniawati (2022) who stated that nurses in the inpatient ward of Fatimah Islamic Hospital in Cilacap are classified as having a high level of fatigue with a fatigue percentage of 63.8%. This is caused by several factors that cause work fatigue and a lack of ways to overcome it. In this study, work fatigue arises from not knowing how to prevent fatigue. One way to prevent fatigue and increase productivity is by improving physical fitness. One way to improve fitness is through exercise. Based on the background description above, therefore, we want to conduct a study on the effect of badminton training on changes in physical fitness levels (VO2 max), blood pressure, and hemoglobin levels) of UKM students at the Bina Guna Sports and Health College..

METHOD

Research Design

This study was conducted using a pre-experimental research design with a one-group pre-post test design. The researchers used this design because the study aimed to reveal cause and effect by involving a single group of subjects. The subject group was observed before the intervention (pre-test), then again after the intervention (post-test).

Participant

This research was conducted at the Badminton Student Activity Unit (UKM) of the Bina Guna Sports and Health College. This research will be conducted for 2 months, in March-April 2025. The sample was taken using a purposive sampling technique with a sample size of 15 and badminton training for 3 weeks with a total of 12 training sessions. The population is defined as a group of subjects to be subjected to generalization of research results (Azwar, 2010). The population in this study were members who entered the UKM of the Bina Guna Sports and Health College. A sample is a part of the population that is selected in a certain way so that it is considered representative of the population (Nursalam, 2022). The sample in this study was 15 members of the UKM of the Bina Guna Sports and Health College.

Data Analysis

The data analysis used was descriptive data analysis, a type of quantitative analysis. This analysis allows us to obtain the relationship between a system and the development of the variables being studied. The description of each variable studied includes blood pressure during badminton training.

RESULTS AND DISCUSSION

Results

The results of this study were conducted on STOK Bina Guna Badminton UKM students with a sample of 15 male students who are members of STOK Bina Guna Badminton UKM. The study was conducted in the STOK Bina Guna campus hall. The effect of badminton training on dependent fitness levels (Vo2 Max, Blood pressure and Hb levels).

Table. 1

TTV	Exercise	Average TTV	Average Change	P Value
Vo2 max	*Pre test*	90,4	10,4	0.002
	Post test	80		
TD Sistole(mmHg)	*Pre test*	129,3	5,4	0.004
	Post test	124,53		
TD Diastole(mmHg)	*Pre test*	76,47	3,87	0.002
	Post test	72,66		
Hb (mg/dl)	*Pre test*	11,67		0.000
	Post test	13,27		

After analysis with paired t test after badminton training for 3 weeks with a training frequency of 12 times, the results obtained were: changes in Vo2 max, namely an average change of 10.4 with a p value analysis result of 0.002, changes in systolic blood pressure of 5.4 with a p value of 0.004, changes in diastolic blood pressure of 3.8 with a p value of 0.002 while changes in hemoglobin levels were 1.6 with a p value of 0.000. The largest quantitative changes occurred in Vo2 max while statistically significant changes occurred in hemoglobin levels, as evidenced by the smallest p value (0.000).

Discussion

Fitness can prolong a person's life. Fitness can be measured with the YMCA step test (Young Men's Christian Association) (Nathalia, 2009). To assess fitness levels with the YMCA step test (Young Men's Christian Association), a person must engage in physical activity. Physical activity is beneficial for everyone because it can improve fitness, prevent excess weight, and improve heart, lung, and muscle function (Abd Halim, et al. 2011). Various sports activities undertaken by humans aim to improve the physical quality of human resources, especially when done correctly and regularly. Regular and measured exercise with light to moderate exercise intensity can improve health, physical fitness, and immunity (Siti, 2013). Based on the statement above, it is clear that physical activity such as exercise is very beneficial for body health, so researchers are challenged to examine the effect of badminton on fitness levels, including VO2 max, blood pressure, and hemoglobin levels.

In theory, VO2 Max is limited by cardiac output, the respiratory system's ability to deliver oxygen to the blood, or the muscle's ability to utilize oxygen. Therefore, VO2 max also limits aerobic capacity and is therefore considered the best parameter for measuring a person's aerobic (or cardiorespiratory) capacity. VO2 max is the highest value at which a person can consume oxygen during exercise, and is a reflection of the cardiorespiratory and hematologic elements of oxygen delivery and muscle oxidative mechanisms (Adhikarmika, 2009). According to (Rowland M.D. 1996 in Muizzah, 2013), VO2 max can be measured in two ways: maximal and submaximal tests. In the maximum test, VO2 max is measured in a state of maximum fatigue during physical activity so that the cardiorespiratory system is truly experiencing VO2 max (using oxygen maximally) meanwhile, the submaximal VO2 max test is carried out by measuring before reaching a state of maximum fatigue because individuals such as children or the elderly will stop the physical exercise load when they feel tired even though they are not yet at maximum fatigue, so this study was conducted on men aged 18-25 years because according to (Siti, 2013), Cardiorespiratory endurance in men reaches its peak at the age of 18-25 years along with the peak of muscle mass.

In this study, to maintain sample homogeneity, the researcher selected potential respondents by only recruiting new players to the badminton team. Furthermore, the study found that all respondents had stage II hypertension. Therefore, the researcher controlled for lifestyle factors that could affect blood pressure, such as nutritional status, sleep quality, caffeinated beverages, smoking, and medication use during the study.

The results of the pre-test on the respondents' fitness levels were as follows: 2 respondents had excellent VO2 max, 4 respondents had good, 5 respondents had above average, 3 respondents had below average, and 1 respondent had poor blood pressure. Blood pressure levels were classified as normal (systolic blood pressure) in 3 respondents and diastolic blood pressure in 10 respondents; 9 respondents had pre-hypertension (systolic blood pressure), 3 respondents had diastolic blood pressure; 3 respondents had stage I systolic hypertension, and no respondents had diastolic blood pressure. Hemoglobin levels were low for all respondents.

After 12 training sessions, the results showed that VO2 max levels were excellent for 4 participants, good for 7 participants, above average for 2 participants, and average for 12 participants. Blood pressure levels were classified as normal (systolic blood pressure) for 4 participants and diastolic blood pressure for 12 participants. Pre-hypertension was present in 11 participants, while diastolic blood pressure was present in 3 participants. No respondents had stage I or II hypertension. Hemoglobin levels were low in 10 participants, while 5 participants had normal levels.

Fitness is a set of physical characteristics possessed or achieved by a person related to their ability to perform physical activity. A fit person is able to carry out daily life without limits to their body's stress tolerance and is healthy and is not at risk of developing diseases caused by low fitness or lack of activity (Siti, 2013). Commitment to training was one of the factors contributing to the success of this study, as was the case for the respondents.

Furthermore, to determine the effect of badminton training on fitness levels assessed by the YMCA step test, a paired t-test was conducted which had previously been tested for normality using the Shapiro Wilk test and compared the pre-test results and post-test results.

After conducting the Paired t test, the following results were obtained: Changes in VO2 max: after 3 weeks of training, a p value of 0.002 p <0.05 was obtained, meaning there was a significant influence of badminton training. The average VO2 max pre-test level was 90.4 and the post-test was 80 with an average change of 10.4. Changes in Blood Pressure, namely Systole: a p value of 0.004 p <0.05 was obtained, meaning there was a significant influence of badminton training. The average pre-test systole was 129.3 and the post-test was 124.53 with an average change of 5.4, while Diastole had a p value of 0.002 p <0.05, meaning there was a significant influence of badminton training. The average pre-test diastole was 76.47 and the post-test was 72.66 with an average change of 3.87. Regarding changes in hemoglobin levels, a p-value of 0.000 was obtained, indicating a significant effect of badminton training. The average pre-test Hb level was 11.67 mg.dl and the post-test was 13.27 mg.dl, with an average change of 1.6 mg.dl.

Based on these results, significant changes were observed in VO2 max, blood pressure, and hemoglobin levels. Because this study was empirical, the researchers assumed these changes were due to the homogeneity of the respondents, who were only male and aged 18-25, and other inclusion criteria. This resulted in significant results with a strong influence, as well as a fairly representative training period of 3 weeks with 12 sessions, which can lead to physiological changes, particularly in fitness.

Exercise or physical activity tends to place a greater workload on the body. When this load is continuously applied to the body, various systems in the body will undergo changes to work more efficiently under the added load. Some of the organ systems involved are the respiratory system, cardiovascular system, endocrine system, and neuromuscular system (Katch, 2011). During exercise, various cardiovascular and respiratory mechanisms must work in an integrated manner to meet the oxygen needs of active tissues and remove CO2 and heat during the activity. O2 uptake from the blood to the working muscles will increase, and ventilation will also increase, so that additional O2 will be available, and some heat and excess CO2 will be released (Ganong, 2008).

The most important fitness capability, directly and primarily related to health, is cardiorespiratory endurance (Fatma, 2011). High cardiorespiratory endurance indicates high work capacity, meaning the ability to expend a significant amount of energy over a long period of time. Several fitness measurement procedures can be used. The most accurate and suitable fitness measurement for use with a large sample size is the step test. This measurement is based on the pulse rate during or immediately after performing a step-up-and-down activity, the procedure for which has been standardized.

The YMCA 3-minute step test has the shortest time and the simplest calculation and has a height of 30 cm so it is suitable for mass tests (Nieman, 2007 in Muizzah, 2013), because of this, the YMCA 3-minute step test is very proportional to be applied to Indonesian people with smaller body shapes compared to people abroad who usually use Harvard benches with a bench height of 50 cm.

From the results of the research that has been done, it can be seen that the fitness level has changed both VO2 max, systolic and diastolic blood pressure and hemoglobin levels at a training frequency of 12 times the exercise. The human body is a mechanism that is interconnected with each other. According to (Herman, 2010), Exercise reduces heart rate, with a decrease in heart rate, the heart has a higher heart rate reserve (Heart Rate Reserve). The decrease in heart rate is caused by an increase in parasympathetic nerve tone, a decrease in sympathetic nerves or a combination of both. There is also a decrease in the frequency of impulse release from the heart lungs.

The same is true for blood pressure changes. Blood pressure is controlled by various physiological processes working together; these mechanisms ensure blood flows through the circulation and allows tissues to receive the nutrients they need to function properly. If any of these mechanisms is disrupted, high blood pressure can occur (Palmer & Williams, 2005). Blood pressure is regulated by a series of autonomic nerves and hormones that monitor circulating blood volume, blood vessel diameter, and heart contractions. Each of these factors is intrinsically linked to the regulation of blood pressure within the blood vessels (Palmer & Williams, 2005). Blood vessel values depend on the strength of heart contractions, blood vessel diameter, and blood volume in the circulation. This mechanism works similarly to the pressure of water coming out of a hose. You can increase the force of the water by turning the dial higher (e.g., making the heart contract more strongly and faster) or by pressing on the end of the hose and increasing the pressure in the hose (e.g., constricting and contracting the blood vessels) (Palmer & Williams, 2005).

Regular exercise is beneficial for burning calories, improving balance and muscle coordination, increasing immunity, making the heart rate a more efficient pump so that the heart does not have to work hard, increasing blood volume so that the body can more optimally distribute oxygen so that a person will

have stronger endurance when faced with heavy physical activities, increasing lung capacity so that the breathing frequency does not need to be too fast and the heart muscle will be stronger and can better channel blood. Exercise can cause a decrease in blood pressure, by exercising regularly will cause the smooth muscles in the blood vessels to be more relaxed and dilated so that the TPR (Total Peripheral Resistance) decreases. Therefore, it is often found that blood pressure in people who regularly exercise is lower than in people who rarely/do not exercise (Herman, 2010).

CONCLUSION

The results of the study showed that the fitness level before training was VO2 max of respondents in the Very good category 13%, good 26.6%, above average 33.3%, below average 20% and 6.6% less. Then at the blood pressure level, namely: Normal classification in systole 20%, diastole 66.4%, pre-hypertension category systole 60%, diastole 20%, HT stage I classification systole 20%, diastole 13%. While at the Hemoglobin level only low HB level is 100%. The results of the study after badminton training for 3 weeks obtained the results of VO2 max respondents in the Very good category 26.6%, good 46.6%, above average and average 13% each. Then at the blood pressure level, namely Normal classification systole 26.6%, diastole 80%. Classification of pre-hypertension systole 73.4%, diastole 20%, while the Hemoglobin level is low HB level 66.6%, normal HB level 33.4%. There is a significant influence on badminton training with YMCA step test assessment on fitness levels namely VO2 max with p value 0.002 <0.05, systolic blood pressure p value 0.004 <0.05 while diastolic blood pressure p value 0.002 <0.05 as for Hemoglobin levels with p value 0.000 <0.05.

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AUTHOR CONTRIBUTION STATEMENT

This research was conceptualized and designed by Aprilia Eka Putri Lumban Tungkup, who developed the research objectives and methodology, managed data collection, coordinated with participants, and supervised fieldwork at STOK Bina Guna Medan. Eka Abdurrahman performed data analysis, interpreted the findings, and contributed significantly to the preparation of the manuscript. All authors participated in manuscript revisions, approved the final version for submission, and take full responsibility for the integrity and accuracy of the work.

CONFLICT OF INTEREST AND FUNDING

The authors declare no conflict of interest related to the conduct, authorship, or publication of this study.

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