

The effect of physical exercise on oxygen saturation in college students

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Abstract:

The research aimed to investigate the effect of oxygen saturation on students before and after physical basketball training. This research employed an experimental method with a one-group pretest-posttest research design. A total of 40 students, comprising 21 female students aged 18-20 years and 19 male students aged 18-20 years, participated in the research. Respondents were given treatment in the form of a 5 vs. 5 basketball game for 20 minutes. The saturation value was measured using a pulse oximetry device. Oxygen saturation was measured before exercise and after exercise. The statistical analysis technique used the t-dependent sample test with a significance level of 5%. The results of this study showed that the average oxygen saturation of male students at the pre-test was 96.47% and 95.47% at the post-test. For female students, the average pre-test oxygen saturation was 96.29% and 95.10%. Overall, the average oxygen saturation value before exercise was 96.38% and decreased after exercise to 95.28%. Based on the results of statistical calculations, there was no notable change in oxygen saturation values after basketball physical training ($t_{\text{observation}} 2.157 < t_{\text{table}} 2.44$). There was no notable change in oxygen saturation after physical exercise or a decrease in oxygen saturation, indicating that basketball training did not necessitate an increased oxygen uptake by the tissue. During the period, the peripheral appeared to function normally with no observed rise in oxygen uptake. Based on the research results, a physical exercise carried out for 20 minutes did not affect oxygen saturation.

Keywords: Oxygen, Physical, Saturation, Training, Uptake.

Introduction

As a student majoring in sports, physical exercise is a normal thing for sports students to do. Physical exercise has become mandatory for sports students to do every day. Exercise or physical activity will affect a person's physical fitness. Physical fitness supports daily activities (Agus et al., 2021). Routine activities carried out as a sports student include lectures, organizational activities, personal activities, and physical training. The intensity and form of training each student carries are undoubtedly different. For example, the intensity and shape of basketball and taekwondo training differ. Basketball is a physical skill confrontation and a comprehensive sport centered on hands (Zheng & Qu, 2021). For students who are active in physical activities such as sports, one of the indicators that is the goal is being able to excel in the branch they are involved in (Sepriadi, S., & Eldawaty, 2019).

Carrying out all activities cannot be separated from the physical movements carried out by the body's muscles and supporting systems. Physical activity is a form of body movement produced by skeletal muscles and requires energy expenditure (Kemeryte-Ivanauskienė et al., 2022). Thus, it can be interpreted that physical activity is body movement by the body's muscles and supporting systems that require energy expenditure. Meanwhile, physical exercise is an activity that is carried out regularly, structured, and has an exercise program.

The World Health Organization (WHO) defines physical activity (PA) as any bodily activity produced by skeletal muscle that requires energy expenditure (World Health Organization, 2021b). All physical activities use movement; therefore, humans and movement cannot be separated. A body that is unhealthy or has an injury certainly cannot carry out physical exercise effectively. Therefore, every physical exercise requires a body that is healthy and ready to carry out the physical exercise. The average intensity of basketball training is 3-5 hours per day, while taekwondo training is 2-4 hours per day. Physical activity and exercise are essential means of lifestyle management, and as they continue to increase in prevalence, their necessity is bound to grow (Kalra et al., 2023).

Basketball is a sport that is popular with Indonesian people. This modern sport, played in teams, is proliferating and attracting attention, especially from the younger generation. Basketball is one of the big ball sports that is popular among students. Basketball is a highly dynamic, poly-structural type game with many changes in speed, tempo, and alternating cyclic and acyclic movements (Stojmenović et al., 2023). Basketball is synonymous with tall, well-built, and proportional athletes, who are the main attraction of basketball. Basketball is a sport that involves a lot of leg and arm muscles as well as cardiovascular endurance. These three physical conditions are the dominant physical conditions in basketball.

Physical activity occurs when muscles contract to move the body (Singchainara et al., 2023). Physical exercise is an activity carried out by a person to improve and maintain body fitness and is recommended for each individual to avoid various diseases. Physical fitness is the ability of the body system to carry out suitable daily activities so that it can improve the quality of life and have good physical and spiritual condition (Ma'arif, Nurhasan, et al., 2023; Ma'arif, Setyawan et al., 2023; Sepriadi et al., 2023). Therefore, the way to improve physical fitness is to do regular exercise and daily physical activity (Sepriadi et al., 2022). In physical exercise, sufficient oxygen in the blood is necessary. If the blood does not carry enough oxygen to the body's tissues to meet its needs, it will cause hypoxemia. If the oxygen saturation is low, then you are at risk of experiencing hypoxemia. In other words, hypoxemia is a condition where oxygen levels in the blood are below normal limits.

Normal oxygen saturation in humans ranges from 90-99% (Tyler et al., 1985; Wei et al., 2016). Oxygen saturation measures how much hemoglobin is currently bound to oxygen compared to how much hemoglobin is still unbound (Hafen & Sharma, 2022). Based on the use of oxygen, physical exercise is divided into 2, namely aerobic and anaerobic exercise. Aerobic physical exercise requires oxygen for energy formation, while anaerobic physical exercise does not require oxygen for energy formation. Physical exercise can also be differentiated based on its duration, namely acute and chronic physical exercise. Acute physical exercise is exercise carried out for a maximum of 30 minutes, while chronic physical exercise is exercise carried out for a minimum of 30 minutes (Cantrelle et al., 2020).

Physical exercise will cause several changes in the body, such as oxygen levels in the blood. Typically, there is a reserve of oxygen in the blood when doing physical exercise. When carrying out physical activity, the body requires large amounts of oxygen to meet energy needs. Oxygen is taken up by the blood through the lungs and is linked to hemoglobin. If oxygen levels in the blood decrease beyond normal limits, it will be hazardous for the body because it can cause fainting and even death (Tarver et al., 2022). It was further explained that physical exercise also has an effect on the volume of oxygen in the blood and oxygen saturation (Kubo, 2016). So, we know that physical exercise influences oxygen saturation.

Previous research was conducted by (Eroglu et al., 2018) on male athletes with 90 minutes of training activity per day of the week. The treatment given was shuttle run training. As a result of statistical analysis, it was determined that there was a statistically significant difference between the participants' oxygen saturation and heart rate before and after exercise. So, it can be concluded that acute aerobic exercise can reduce oxygen saturation. Furthermore, research was conducted (Daglioglu et al., 2013), where the results of the study could be said to be that short-term exercise reduces oxygen saturation. However, regular exercise does not affect changes in oxygen saturation in short-term exercise. Also, research was conducted by (Choudhary et al., 2015) on medical students by providing aerobic exercise training. The research results obtained by aerobic exercise increased hemoglobin values and % hemoglobin saturation in medical students.

Research conducted by (Ataçocuğu & Yorulmazlar, 2017) provided aerobic and anaerobic exercise treatment to sedentary male subjects in the 20-25 year age group. The research results showed that warming up and aerobic exercise had no effect on oxygen saturation, but anaerobic exercise had a significant effect on oxygen saturation. In the study conducted on sports persons who perform ultra-endurance mountain races, it was reported that there was no significant difference between pre-race and post-race values, but post-race oxygen saturation decreased significantly (Belinchon-deMiguel & Clemente-Suárez, 2018).

Oxygen saturation is an essential element in the management and understanding of patient care. Oxygen is tightly regulated in the body because hypoxemia can cause many acute side effects on individual organ systems. This includes the brain, heart, and kidneys. Oxygen saturation measures how much hemoglobin is currently bound to oxygen compared to how much hemoglobin is not bound. At the molecular level, hemoglobin is composed of four globular protein subunits. Each subunit is associated with a heme group. Each hemoglobin molecule, in turn, has four heme-binding sites available to bind oxygen. Hence, during the transport of oxygen in the blood, hemoglobin is capable of carrying up to four oxygen molecules. Due to the critical nature of tissue oxygen consumption in the body, it is very important to be able to monitor current oxygen saturation.

Pulse oximeters can measure oxygen saturation. Pulse oximetry is a noninvasive device that is placed over a person's finger (Eroglu et al., 2018). It measures the wavelength of light to determine the ratio of current levels of oxygenated hemoglobin to deoxygenated hemoglobin. The use of pulse oximetry has become the standard of care in medicine. It is often considered the fifth vital sign. Thus, medical practitioners must understand the functions and limitations of pulse oximetry. They must also have basic knowledge of oxygen saturation (Hafen & Sharma, 2022). This study aimed to look at changes in oxygen saturation with the effect of short-term exercise in basketball students.

Material & Methods

This experimental research used a one-group pretest-posttest research design, which was carried out in May 2023 at the FIK Lubuk Buaya Campus, Universitas Negeri Padang 40 students participated in this research consisting of 19 male students and 21 female students, with the age category criteria being 18-21 years old and healthy. A purposive sampling technique was used in the sampling technique, using instruments in the form of observation sheets for oxygen saturation values and basketball training for 20 minutes. Oxygen saturation is measured using a pulse oximeter with the brand "Fingertip Pulse Oximeter." maintain arterial oxygen saturation

can be assessed by pulse oximetry (SpO_2) blood gas analysis (Sao_2) or arterial oxygen pressure (Semler et al., 2022). The purpose of Pulse oximetry is to estimate arterial hemoglobin oxygen saturation measurements. Pulse oximetry is indicated in patients at risk of hypoxemia, such as during conscious sedation procedures, transport, and adjustment of inspired oxygen fraction (FiO_2) (Lee, 2017). Oximetry has two types, namely, those placed on the fingers and those placed on the ear. The oximeter that the researchers used was placed on the finger of the hand. How to use an oximeter is to 1) Make sure the finger is positioned between the oximeter claws. 2) the finger needs to be positioned correctly so that the oximeter beam or light can work correctly and the oximeter can measure oxygen levels optimally.

The research procedure begins with filling in the participant data foam. Next, participants took initial measurements of oxygen saturation values (SpO_2) using an oximeter (Pre-test). After that, participants were given intervention in the form of physical training with a 5 vs 5 basketball game for 2 x 10 minutes, and groups were randomly selected. After 20 minutes of playing, participants measured their oxygen saturation again to see oxygen levels (Post-test). After the data is obtained, a mean difference test (T-Test) is carried out to see the comparison of the means between the two variables.

Results

This research was conducted on students majoring in Sports Education with a total sample of 40 respondents. The age categories in this study are based on the Indonesian Ministry of Health, and it is known that the majority of respondents' ages are late teens, namely 17-25 years old, and the category of students who participated in this research is in the age range of 18-21 years. Adolescence is a period of significant development that begins with the onset of puberty and ends in the mid-20s (Bonnie & Emily P. Backes, 2019).

Oxygen is the most critical need in human life. Oxygen inhaled by living creatures enters the lungs, circulates throughout the body, and is bound by red blood cells. The presentation of red blood cells bound to oxygen in the arteries is called oxygen saturation. Oxygen saturation (oxygen level) measures how much hemoglobin is bound to oxygen compared to how much hemoglobin remains unbound (World Health Organization, 2021a).

Respondents of the male gender were 19 students (47.5%) with an average oxygen saturation value before exercise of 96.47%, which decreased after exercise to 95.47%. Respondents female gender were more, namely 21 students (52.5%) with an average score before practice of 96.29% and decreased after practice of 95.10%. Overall, the mean value of oxygen saturation before exercise was 96.38% and decreased to 95.28% after exercise.

Table 1. Saturation distribution score based on gender

Gender	F	P (%)	Average score (%)	
			Pre	Post
Male	19	47.5	96.47	95.47
Female	21	52.5	96.29	95.10
Total	40	100.00	96.38	95.28

Statistical Test Results Dependent Sample T-Test

Based on the dependent sample T-test statistical test, it was found that the t_{count} was $2.157 < t_{\text{table}} 2.44$, so the hypothesis was rejected, namely that there was no increase in oxygen saturation values after being given treatment in the form of basketball training.

Table 2. Dependent sample t-test results in oxygen saturation values before and after physical exercise

T-test Dependent Sample	T_{test}	T_{table}
	2,157	2,44

Discussion

Based on the data in Table 1 above for the male and female sexes, oxygen saturation values are obtained in the normal range. The normal value of normal oxygen saturation is between 95% - 100%. This shows that in the age range of 17-21 years, the ability of hemoglobin to bind oxygen is still normal. The overall average oxygen saturation value based on Table 1 before being given physical exercise was 96.38% and decreased after being given physical exercise to 95.28%. Most of the oxygen delivered to the blood in the lungs is transported in the form bound to hemoglobin. When blood in the arteries arrives at the capillaries at the tissue level, a certain amount of oxygen is released for use by the cells. So, the amount of oxygen bound to hemoglobin in 100 ml of blood is reduced to 15.1 ml, and the amount of dissolved oxygen is reduced to 0.1 ml (Eroğlu et al., 2018). In this study, there was a slight and significant decrease of 1.1%, but the average oxygen saturation was still within normal limits, namely 95.2.

The oxygen saturation level in this study was in the excellent or average category but showed different values before and after physical basketball training. This is based on Berman's theory, explaining that there are factors that influence the results of oxygen saturation measurements, namely hemoglobin, circulation, and activities carried out (Hafen & Sharma, 2022). The differences in measurement results of this study were

influenced by activity factors and the healthy condition of the respondents, showing that most of them had no history of illness and were in the productive age category, namely late teens.

This study followed research (Kalkan & Daglioglu, 2018), which assessed the effect of short-term exercise on oxygen saturation with cycling physical exercise in soccer players. In this study, there was a decrease in oxygen saturation after physical activity, and in the control group, saturation values were obtained before and after sedentary physical activity. The same thing from the results of a similar study by (Eroğlu et al., 2018) showed a decrease in oxygen saturation values after acute aerobic exercise as well as research conducted by (Rahayu et al., 2019), with the results of the study showing that there were significant differences between the control group and the treatment group regarding BG 60', and HR 60', 90', and 120' with a higher increase in upper extremities exerting slowly. However, the percentage of oxygen saturation (SpO₂) did not differ between groups.

The results of the dependent sample T test obtained T-observation 2.157 < T-table 2.44, which means there is no significant difference or no significant effect between the oxygen saturation value before and the oxygen saturation value after physical exercise. The normal condition is the oxygen saturation value before and after physical exercise, as a result of the respondent being in good health without any comorbidities, which will affect the oxygen saturation value. Meanwhile, an increase in oxygen saturation values after physical activity indicates that there is an increase in oxygen uptake by the lungs, thereby increasing the capacity of the blood to transport oxygen (NHLBI, 2018).

Physical exercise can benefit the body, regardless of its effect on other risk factors. Someone who diligently exercises physically can do muscle work more efficiently than someone who rarely does physical exercise. Regular physical exercise can improve cardiovascular abilities. Regular physical exercise can also increase the lungs' vital capacity and oxygen uptake by the lungs, and the oxygen used by the body will be quickly replaced. With regular physical exercise, the oxygen saturation value will increase or remain the same after completing physical exercise. This can help the body for longer and optimal physical exercise because if the oxygen supply to the muscles is sufficient, the need for energy will be more easily met (Hall et al., 2016).

Conclusion

The conclusion from this study is that there is no significant effect between physical exercise in the form of basketball training on oxygen saturation in students, with $t_{\text{observation}}$ results of $2.157 < t_{\text{table}} 2.44$. There is no increase in oxygen saturation after physical exercise or a decrease in oxygen saturation, indicating that basketball training does not require oxygen uptake by the tissue. At this time, peripheral diffusion is running normally, so there is no increase in oxygen uptake. Although no significant differences were observed in the oxygen saturation between before physical activity and after physical activity, this research demonstrated the effect of exercise activity on oxygen saturation. Even though they are not significant, we only looked at the differences and did not look in depth at the effectiveness of physical exercise on oxygen saturation. In summary, this research contributes valuable insight into the influence of physical activity on oxygen levels to pave the way for future research to optimize physical activity interventions to increase oxygen saturation and physical fitness.

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