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EFFECT OF PHYSICAL ACTIVITY AND HAEMOGLOBIN LEVELS ON CARDIORESPIRATION

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This study **aims** to determine: 1) the effect of physical activity on cardiorespiration, 2) the effect of haemoglobin levels on cardiorespiration, 3) the effect of physical activity and haemoglobin levels on cardio respiration, and 4) the contribution of physical activity and haemoglobin levels to cardiorespiration. The research **method** used is a survey method. The respondents of this study were 194 students of the Department of Sport Education, Faculty of Sports Science, Yogyakarta State University (FIK UNY) who were taken randomly. The data used are respondents' cardiorespiratory rate, physical activity, and hemoglobin levels, which are measured using instruments such as multi-stage tests, Global Physical Activity Questionnaire (GPAQ), and hemoglobin haemometer. The data analysis technique used a regression test. The **results** showed that at a significance value of $0.001 < 0.05$, there was a significant effect between physical activity and cardiorespiration, haemoglobin levels with cardiorespiration, and physical activity with haemoglobin levels. Physical activity or haemoglobin levels affect cardiac respiration by 83%. This study **concluded** that cardiorespiration is strongly influenced by physical activity and haemoglobin levels.

Keywords: *cardiorespiration, health, haemoglobin, haemoglobin levels, physical activity.*

Introduction. Physical activities carried out in a planned and programmed manner will impact the health of the body. Physical activity is the body's movement within a certain time produced by the skeletal muscles so that energy is expended from the body [12, 26]. Everyone has different goals when doing physical activities. Physical activity, if done properly, can increase the degree of vibrant health to prevent disease. Physical activity is related to psychological satisfaction and self-determined motivation [24].

Cardiac muscles can develop due to the influence of physical activity. A fit person's heart and lungs will supply more blood and oxygen to their body tissues, so they do not need to work too hard compared to people whose heart and lung systems are not fit. Exercise significantly increased absolute and relative cardiorespiration [15]. This is also consistent with the research results of Balagué et al. [5] and Pollock et al. [21] that improving the interpretation of cardiorespiration exercise is highly recommended in health care.

Another critical component that supports health is haemoglobin. In the haemoglobin in the blood, iron is a crucial element [8]. Haemoglobin in the blood binds to Oxygen and acts as a "delivery" mechanism for Oxygen [10, 22]. Lack of blood haemoglobin, blood distribution, or the ability to pump the heart can be increased through exercise [18, 23]. Internal haemoglobin can be greatly affected by physical activity because it will produce much oxygen when there is muscle movement, increasing VO2 Max.

The observation shows that the Department of Sports Education's average student, FIK UNY, tends to be heavy. Apart from studying, students also continue to do physical activities, especially sports, according to their sport. This strenuous physical activity must be supported by good physical fitness so that physical activity does not quickly provoke fatigue and a decrease in haemoglobin occurs. Decreased haemoglobin will cause anaemia. Someone who has anaemia, of course, when doing activities, will quickly experience fatigue. This study aims to analyze the effect of physical activity on cardio respiration, the influence of haemoglobin levels on cardio respiration, the effect of physical activity and haemoglobin levels on cardio respiration, and whether there is a contribution of physical activity, and haemoglobin levels to cardiorespiration.

Materials and Methods. This research is a correlational study using a survey method. This research design can be described in Fig. 1.

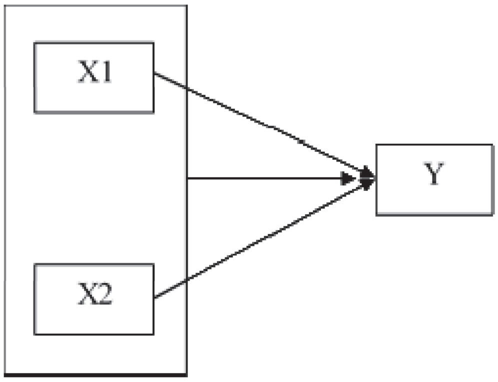

Fig. 1. Research Design: X1 – physical activity; X2 – haemoglobin level; Y – cardiorespiration

This study's research subjects were students of the Faculty of Sport Sciences, Yogyakarta State University. This study used a random sampling technique, namely, by taking a random sample. The samples taken were 194 students. This study has three variables consisting of 1 dependent variable and 2 independent variables. The dependent variable is cardiorespiration (Y), while the independent variable includes physical activity (X1) and haemoglobin level (X2). Operationally these variables can be defined as follows:

1. Cardiorespiration is the ability of the heart and lung capacity to perform activities measured using a multi-stage test.
2. Physical activity is the activity of sports education students starting from waking up to sleeping again in one day for seven days, as measured by using a questionnaire from the Physical Activity Questionnaire for Older Children (PAQ-C).
3. Haemoglobin level is a measure of the respiratory pigment in red blood cell granules, which function as oxygen carriers, measured using a haemoglobin diaspect haemoglobin T.

Instruments of this study are:

1. Cardiorespiration measurements were performed using a multi-stage test.
2. Physical activity measurements were carried out using the Global Physical Activity Questionnaire (GPAQ).
3. Measurement of haemoglobin levels, measured using a hemometer diaspect Haemoglobin T.

Data processing was performed using the SPSS Statistics 24 program with the following steps:

1. Normality Test with Kolmogorov Smirnov.
2. Linearity test.
3. The hypothesis test is analyzed using a simple linear regression equation. A single correlation test or a simple linear regression equation using the Pearson product-moment correlation. The simple linear regression equation is used to test the first and second hypotheses, while the third hypothesis uses multiple regression.

Results. The included research data is a summary of the reduction data (difference), post-test (after) and pre-test (before). The explanation of the data can be seen in each of the following discussions:

Physical Activity of FIK UNY students. Physical activity data of FIK UNY students with a sample of 194 students had an average of 7.19; a standard deviation of 2.79; a maximum score of 9; a minimum score of 1.

Haemoglobin Levels of FIK UNY Students. Analysis results found that the Haemoglobin Level data of FIK UNY students with a sample of 194 students had an average of 13.33; the standard deviation of 1.34; a maximum score of 16; a minimum score of 1.

Cardiorespiration of FIK UNY Students. Based on the research analysis, it was found that the Cardiorespiration data of FIK UNY students with a sample of 194 students had an average of 35.80; a standard deviation of 6.84; a maximum score of 55.28; a minimum score of 22.06.

Hypothesis Test. The normality test uses the Kolmogorov-Smirnov Test. The calculation results can be seen in Table 1.

The Kolmogorov – Smirnov normality test using SPSS in table 1 is a significant value of Asiymp. Sig (2-tailed) of 0.902, which means that the value is greater than 0.05. It can be concluded that the data are usually distributed; thus, the assumptions or requirements for normality in the regression model have been met.

The linearity test uses deviation from linearity at the level of significance (α) = 0.05. If Sig < α means it is not linear, the rule applies if Sig > α means linear. The calculation of the haemoglobin levels linearity test with cardiorespiration obtained Sig > α (0.935 > 0.05), which means that the haemoglobin level data is linear to the cardiorespiration (Table 2).

The calculation of the linearity test of the haemoglobin level with cardiorespiration obtained Sig > α (0.02 > 0.05) means that the physical activity data is linear to the cardiorespiration (Table 3).

The results of the linearity test of physical activity data with haemoglobin levels Sig > α (0.01 > 0.05) means that the physical activity data is linear to the haemoglobin levels (Table 4).

Based on the output of the Regression Test, it is known that the significance value (Sig.) of 0.001 <0.05 probability, so it can be concluded that H0 is rejected and Ha is accepted, which means that there is an effect of physical activity (X2) on cardiorespiration (Y).

Based on Table 5, it is known that the significance value (Sig.) of 0.01 < 0.05 probability, so it can be concluded that H0 is rejected and Ha is accepted, which means that there is an effect of haemoglobin (X1) on cardiorespiration (Y). Physical activity can be walking, running, jumping, or others [16]. Walking in place or jumping jacks is a physical activity that, when done regularly, can increase heart rate and cardiorespiration endurance (after warming up but

Table 1

Normality test results

		Unstandardized residual
N		194
Normal parameters[a]	Mean	0
	Std. Deviation	3.716994
Most extreme differences	Absolute	0.041
	Positive	0.039
	Negative	–0.041
Kolmogorov – Smirnov Z		0.569
Asymp. Sig. (2-tailed)		0.902
a. Test distribution is normal		

Table 2

Linearity test of haemoglobin levels by cardiorespiration

			Sum of squares	df	Mean square	F	Sig.
HB * Cardio-respiration	Between groups	(Combined)	155.444	74	2.101	1.32	0.089
		Linearity	71.768	1	71.768	45.081	0.005
	Within groups	Deviation from linearity	83.677	73	1.146	0.72	0.935
			189.442	119	1.592		
	Total		344.887	193			

Table 3

Linearity test of haemoglobin levels by cardiorespiration

			Sum of squares	df	Mean square	F	Sig.
Physical activity * Cardio-respiration	Between groups	(Combined)	1390.052	74	18.784	20.718	0,01
		Linearity	939.25	1	939.25	1.036	0.073
		Deviation from linearity	450.802	73	6.175	6.811	0.02
	Within groups		107.892	119	0.907		
	Total		1497.943	193			

Table 4

Linearity test of physical activity data with haemoglobin levels

			Sum of squares	df	Mean square	F	Sig.
Physical activity * HB	Between groups	(Combined)	227.266	5	45.453	6.725	000
		Linearity	82.611	1	82.611	12.222	0.06
		Deviation from linearity	144.655	4	36.164	5.351	0.01
	Within groups		1270.677	188	6.759		
	Total		1497.943	193			

before cooling down) [6, 25]. Training-induced cardiovascular adaptation increases metabolic efficiency, whereas neuromuscular adaptation increases mechanical efficiency [3, 9, 17]. This is also supported by Ahmad & Rosli [1], Wang [27] and Zufrianingrum [29] that physical activities such as doing aerobics affect oxygen activity in the body so that oxygen flows throughout the body through the bloodstream. Regular physical activity can improve cardiovascular function. Improved cardiovascular function with physical activity has been associated with exercise-induced positive changes in metabolic disorders and risk factors associated with atherosclerosis [4]. Physical activity that a person does can affect the cardiorespiration system. The study results Haapala & Lintu (2018) show an association between cardiometabolic risk with physical activity and cardiorespiration fitness. It is in line with the statement above that movement skills (object control competence) and the ability to be positively involved in playing games (gaming competence) are equally important as a correlation between physical activity and cardiorespiration fitness [19]. Finally, physical activity that is carried out regularly can affect increasing cardiorespiration.

Based on Table 6, it is known that the significance value (Sig.) of 0.01 is smaller than < 0.05 probability, so it can be concluded that H0 is rejected and Ha is accepted, which means that there is an effect of haemoglobin (X1) and physical activity (X2) on cardiorespiration (Y). Haemoglobin contains iron. If it is deficient in iron, it will cause anaemia, causing weakness and fatigue. Lack of haemoglobin in the blood can result in a lack of oxygen circulated to the body and brain cells; this causes exhaustion and fatigue. Iron is required for the formation of haemoglobin and myoglobin and the enzymes involved in energy production. Lack of iron can be a problem for sports or activities, especially for menstruating women. Iron deficiency occurs in three stages: (1) iron depletion or low levels of iron stores; (2) iron deficiency erythrocytes, which is an impaired ability to produce red blood cells; and (3) iron deficiency anaemia or low haemoglobin levels (< 12 g • dL – 1 for women and < 13 g • dL – 1 for men) [20]. The decrease in haemoglobin will certainly reduce blood's ability to carry the closing volume. However, the increased flow compensates for this due to decreased viscosity [7]. The ability of haemoglobin to bind to hydrogen (H +) ions generated during the transport of carbon dioxide and the ability of pulmonary ventilation to and remove carbon dioxide are crucial for maintaining acid-base balance [20]. When doing physical activity, there is an increase in high metabolic activity. The production of acids (hydrogen ions, lactic acid) is increasing so that it can cause a decrease in pH, which results in a decrease in haemoglobin. Cardiorespiration is very dependent on oxygen transport; due to decreased oxygen transport, it will also reduce the cardiorespiration work capacity [2]. Lower haemoglobin levels mean lower oxygen transport. When doing physical activity will increase the oxygen demand of the human body. The relationship between haemoglobin concentration and cardiorespiration fitness shows that VO2max has the strongest relationship with the blood's oxygen-carrying capacity [14].

Table 5

Effect of physical activity on cardiorespiration

Model		Unstandardized coefficients		Standardized coefficients	t	Sig.
		B	Std. Error	Beta		
1	(Constant)	21.827	0.834		26.183	0.01
	Physicaly activity	1.943	0.108	0.792	17.966	0.001
a. Dependent variable: cardiorespiration						

Table 6

Effect of Haemoglobin Levels on Cardiorespiration

Model		Unstandardized coefficients		Standardized coefficients	t	Sig.
		B	Std. Error	Beta		
1	(Constant)	4.705	4.399		1.069	0.286
	HB	2.333	0.328	0.456	7.103	0.01
a. Dependent variable: cardiorespiration						

Table 7

Effect of Physical Activity and Haemoglobin Levels on Cardiorespiration

Model		Unstandardized coefficients		Standardized coefficients	t	Sig.
		B	Std. error	Beta		
1	(Constant)	3.519	2.696		1.305	0.193
	Physical activity	1.778	0.099	0.725	17.903	0.01
	HB	1.462	0.207	0.286	7.065	0.01
a. Dependent variable: cardiorespiration						

Table 8

Model Summary

Model	R	R Square	Adjusted R Square	Std. error of the estimate
1	.839[a]	0.704	.701	3.73640
a. Predictors: (constant), HB, physic activity				
b. Dependent variable: cardiorespiration				

To determine the magnitude of the effect of physical activity (X1) and cardiorespiration haemoglobin (X2) levels in a simple linear regression analysis (Table 7), we can refer to R Square or R2's value in the SPSS output in the Model Summary section (Table 8). Physically active individuals, especially women, have iron requirements that are greater than the average. Strenuous exercise requires a higher than the recommended intake of iron because small amounts of iron are lost through sweat, urine, and stool. A small impact can also cause mechanical trauma during jogging, damaging red blood cells [28]. Physical activity affects cardiovascular function, including 1) increasing blood flow to active skeletal muscle, 2) increasing blood flow to the myocardium, 3) increasing the dissociation of oxyhaemoglobin, 4) sweating, which plays a role in temperature regulation, and 5) reducing occurrence of abnormal rhythm in the conduction system of the heart (dysrhythmias), which can cause abnormal heart function [20]. Oxygen is used to change food substrates, converting carbohydrates and fats through aerobic metabolism into adenosine triphosphate (ATP). These compounds provide energy for physical activity, bodily functions, and the maintenance of constant internal balance. During physical activity, it takes more ATP to perform activities. As a result, the lungs and heart send more oxygen to all muscle cells to supply the body's energy. During physical activity, a person with high cardiorespiration resistance can deliver the required oxygen to the tissues with relative ease. The cardiorespiration system is the heart, lungs, and blood vessels' ability to be used during the body's metabolic processes both at rest and during activity. Good cardiorespiration fitness causes an increase in the ability to work at high intensity for a long time to achieve fatigue [11, 13].

These results indicate that the R Square value is 0.839, which means that 83.9% of the influence of haemoglobin (X1) and physical activity (X1) on cardiorespiration (Y).

Conclusions. From the findings, it can be concluded that cardiorespiration activity is influenced by physical activity and haemoglobin levels by 83%.

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ВЛИЯНИЕ ФИЗИЧЕСКОЙ АКТИВНОСТИ И УРОВНЯ ГЕМОГЛОБИНА НА ФУНКЦИОНИРОВАНИЕ КАРДИОРЕСПИРАТОРНОЙ СИСТЕМЫ

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Цель настоящего исследования: определить влияние физической активности на кардиореспираторную систему; определить влияние содержания гемоглобина в крови на кардиореспираторную систему; определить совместное влияние физической активности и содержания гемоглобина в крови на кардиореспираторную систему; определить вклад физической активности и содержания гемоглобина в крови в функционирование кардиореспираторной системы. **Материалы и методы.** Основным методом исследования стал метод опроса. В исследовании приняли участие 194 студента кафедры спортивного воспитания (факультет спортивных наук, Государственный университет Джокьякарты), выбранные случайным образом. В исследовании использовались показатели функционирования кардиореспираторной системы студентов (многоэтапное тестирование), данные физической активности (опросник уровня физической активности – GPAQ) и показатели содержания гемоглобина в крови (гемометр). Полученные данные были обработаны с использованием инструментов регрессионного анализа. **Результаты исследования.** Результаты исследования показали статистически значимую корреляцию между показателями функционирования кардиореспираторной системы и уровнем физической активности, между показателями содержания гемоглобина в крови и функционированием кардиореспираторной системы, а также между уровнем физической активности и содержанием гемоглобина в крови. Вклад физической активности и содержания гемоглобина в крови в функционирование кардиореспираторной системы установлен на уровне 83 %. **Заключение.** По итогам исследования сделан вывод о том, что физическая активность и содержание гемоглобина в крови оказывают существенное влияние на функционирование кардиореспираторной системы.

Ключевые слова: *кардиореспираторная система, здоровье, гемоглобин, уровень гемоглобина, физическая активность.*

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