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# The Effect of Body Mass Index and Haemoglobin on Cardiorespiratory Endurance

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This study aims to determine the effect of body mass index and haemoglobin towards the cardiorespiratory endurance. The research method is a survey, and the analysis technique is path analysis. This research was held in the Islamic University of 45 Bekasi with a sample of 20 from the athlete student club (UKM) Pencak Silat. The instruments used are a cardiorespiratory endurance with bleep test. Body mass index calculated as weight in kilograms divided by the square of height in meters (kg/m2) and haemoglobin level measurement using Harenz Scale. Based the results of data processing and analysis, the conclusions are: (1) body mass index directly affects cardiorespiratory endurance with ρy1 = 0.705, (2) haemoglobin directly affects cardiorespiratory endurance with ρy2 = 0.946, (3) body mass index directly affects haemoglobin with ρ21 = 0.923. Thus, body mass index and haemoglobin are two factors where there is a direct effect on cardiorespiratory endurance.

**Key words:** *Body Mass Index, Haemoglobin, Cardiorespiratory Endurance, Pencak Silat.*

## Introduction

The development in sports has had an impact on the achievements of sports athletes from various sports at the regional, national and international levels. In this case, the organisers of the organisation both at the lowest level to the central level is very important, because in the organisation is very possible to do coaching and preparation of training programs.

Cultural diversity in Indonesia has provided a positive benefit for the State of Indonesia in the International. One of the cultures to be proud of is Pencak Silat, which is the result of the movement and taste of Indonesian society with all the advantages to create a unique martial art.

Pencak Silat is one of the growing martial arts that needs to get coaching and then develop into a sport of more popular achievement (Haqiyah, 2019). Pencak Silat has long been known in Indonesia as a martial art that many devotees in the community, both men and women without age limit and has spread throughout the world. Many championships are held following the rules of the game to prevent the risk of injury of the fighters, and match numbers that were separated between the athlete's son and daughter based on weight.

In an effort to prepare martial arts athletes and to face a match, the direction of coaching is emphasised on the factors of physical condition, technique, and tactics and mental condition. In other words, an athlete should be equipped with motor skills, physiological conditions and the readiness of psychological aspects. Especially in the match category, the athlete will be dealing directly with the opponent so that the athlete must be ready when hit or kicked although there is equipment match that will protect the athletes at the time of the game in the form of body protector (protective body), gentle cup (male protector) in men. In this category, the risk of injury is greater than the single category, double and a team that only displays a series of stances. Therefore, physiological factors (physical condition) becomes very important, because the sport of martial arts category must complete 3 rounds or 6 minutes on each competition (Lubis, 2014).

The one determinant of the degree of physical fitness and aspects that must be considered athletes before the match is the nutritional status and cardiorespiratory endurance. In this case, the emphasised nutritional status is body composition/body mass index and haemoglobin (Haqiyah, 2015).

The effect of aerobic exercise for 8 weeks will increase as much as 62% of resting conditions or about 18% when not taking a break. Based on the above description it is necessary to conduct an in-depth study of the effect of body mass index and haemoglobin on cardiorespiratory endurance of Pencak Silat athletes.

Body mass index (BMI) is the cornerstone of the current classification system for obesity and its advantages are widely exploited across disciplines ranging from international surveillance to individual patient assessment. However, like all anthropometric measurements, it is only a surrogate measure of body fatness (Prentice & Jebb, 2001). BMI is the weight in kilograms divided by the square of the height in meters (De Gonzalez et al., 2010).

This method can estimate body fat, but it cannot be interpreted as a definite percentage of body fat. This method is very useful to estimate an ideal person's weight from the results of the comparison of body weight and height.

**Table 1:** Practical Guidelines for Adult Nutrition Status Monitoring

| Category | Explanation | Female | Male |
|---|---|---|---|
| **Less Weight** | IMT = < 90% | <18.9 | <20.2 |
| **Ideal Wight** | IMT = 100% | 21 | 22.5 |
| **Normal Weight** | IMT = 90 – 110% | 18.9 – 23.1 | 20.2 – 24.7 |
| **Over Weight** | IMT = 110 – 120% | 23.1 – 25.2 | 24.7 – 27.0 |
| **Obesity** | IMT =m>120% | >25.2 | > 27 |

Another component is the nutritional status that is also closely related to resistance is haemoglobin. Deficiency of haemoglobin in the blood results in a lack of oxygen that is transferred to the body and brain cells, causing symptoms of fatigue, weakness and rapid fatigue. Haemoglobin is a protein compound with Fe and causes of the colour of red blood cells, whose function is to carry oxygen ($O_2$) into the network and take $CO_2$ from the tissues to the lungs (Aryadi & Sukeksi, 1989). The amount of normal blood haemoglobin is about 15 grams per 100 ml of blood and this amount is usually called "100 percent".

**Table 2:** Haemoglobin Level Limit

| Age | Hb (gr/100ml) |
|---|---|
| Baby New Born | 17-22 gram/dl |
| 1 week | 15-20 gram/dl |
| 1 month | 11-15 gram/dl |
| Child | 11-13 gram/dl |
| Adult Man | 14-18 gram/dl |
| Adult Women | 12-16 gram/dl |
| Old Man | 12.4-14.9 gram/dl |
| Old Women | 11.7-13.8 gram/dl |

The drive to avoid failure and high rewards contributes greatly to one's achievement. In this case, the achievement of maximum results is on the cardiorespiratory endurance test. Cardiorespiratory endurance is the ability of the heart, lungs and blood vessel systems to function optimally at rest and work conditions in taking oxygen and channelling it to the active tissue so that it can be used in metabolic processes of the body. Cardiorespiratory endurance is also called aerobic capacity or aerobic pre-dominant energy systems, so that the notion is often equated with aerobic endurance. It is now recognised that performance in long-distance events is determined by maximal oxygen uptake (V̇O2max), energy cost of

exercise and the maximal fractional utilisation of V̇O2max in any realised performance or as a corollary a set percentage of V̇O2max that could be endured as long as possible (Bosquet, Léger, & Legros, 2002). Endurance is the capacity of doing work continuously in an aerobic atmosphere and in a laboratory measuring physical fitness levels by measuring maximum oxygen per minute (VO2 max) (Badriah, 2009).

Endurance can be interpreted as something that is capable of working for a long time. Endurance athlete fatigue caused when physical activity (Tangkudung, 2012). The function of cardiovascular tests are: 1) Determining the physical classification of students, 2) Assessing students' physical fitness status, 3) Motivating students to be more active in practice. The norm table of physical fitness classification of cardiorespiratory function VO2 max is as follows:

**Table 3:** Classification of Physical Freshness Function Cardiorespiratory VO2 max (ml/kg/min) for Male

| No. | Classification | Age | | | | |
|---|---|---|---|---|---|---|
| | | 20 - 29 | 30 - 39 | 40 - 49 | 50 – 59 | 60 – 69 |
| 1. | High | 53 Up | 49 Up | 45 Up | 43 Up | 41 Up |
| 2. | Good | 43 -52 | 39 – 48 | 36 – 44 | 34 – 42 | 31 – 40 |
| 3. | Enough | 34 – 42 | 31 – 38 | 27 – 35 | 25 – 33 | 23 – 30 |
| 4. | Moderate | 25 – 33 | 23 – 30 | 20 – 26 | 28 – 24 | 16 – 22 |
| 5. | Low | s.d. 24 | s.d. 23 | s.d. 19 | s.d. 17 | s.d. 15 |

**Table 4:** Classification of Physical Freshness Function Cardiorespiratory VO2 max (ml/kg/min) for Female

| No. | Classification | Age | | | | |
|---|---|---|---|---|---|---|
| | | 20 - 29 | 30 - 39 | 40 - 49 | 50 – 59 | 60 - 69 |
| 1. | High | 49 Up | 45 Up | 42 Up | 38 Up | 35 Up |
| 2. | Good | 38 - 48 | 34 – 41 | 31 – 41 | 28 – 37 | 24 – 34 |
| 3. | Enough | 31 – 37 | 28 – 33 | 24 – 30 | 21 – 37 | 18 – 23 |
| 4. | Moderate | 24 – 30 | 20 – 27 | 17 – 23 | 15 – 20 | 13 – 17 |
| 5. | Low | s.d. 23 | s.d. 19 | s.d. 16 | s.d 14 | s.d. 12 |

Cardiorespiratory fitness and BMI with depression while controlling for age, ethnicity, sex, economic status (school lunch support), and other fitness factors (cardiorespiratory fitness or BMI) (Rieck, Jackson, Martin, Petrie, & Greenleaf, 2013). Cardiorespiratory endurance is influenced by several factors, namely: genetic, age, sex, and physical activity (Badriah, 2009). The explanation is as follows: Heredity (genetic) is based on the results of research, that the ability of maximal oxygen uptake per minute influenced by heredity (genetic). Especially the types of muscle fibres and Hb levels. The dominant muscle fibres for realising endurance work are the slow twitch fibre (the slow type of muscle fibres or red muscle fibres). It says red muscle fibres or slow muscle types because the filaments in this type of muscle are red because of the large number of capillaries that provide blood supply and nutrients for muscle work. The more capillary vessels that supply the muscle will make a longer contraction ability. With age, from children up to about age 20, cardiorespiratory endurance increases and reaches a maximum at the age of 20-30 years. In a trained person, decreased cardiorespiratory endurance after 30 years of age only decreases by about 20-30%. Gender, until puberty age there is no difference between men and women and after that, women are lower about 15-20% of men. This difference lies in the maximal muscular power associated with body surface area, body composition, strength, haemoglobin level, lung capacity, and testosterone hormone secretion. Physical activity, bed rest for 3 weeks will decrease cardiorespiratory endurance by 17-27%.

## Method

The research method used in this research is the survey method with a measurement and test technique. The analyst technique used is path analysis (Path Analysis) which is used to study the causal relationship between the independent variable and the dependent variable. Path analysis takes into account direct and indirect influences. Direct influence is the exogenous influence on endogenous variables without going through exogenous variables again. While the indirect effect is the influence where the exogenous variables that influence the endogenous variables through a variable called intervening variable. The total effect is a combination of direct and indirect influences (Kadir, 2015) (Muhamad, Memet; Aridhotul, 2015).

This research was conducted at Islamic University 45 Bekasi, Jl. Cut Meutia No. 83 Bekasi. The population in this study is the athletes of student activity units (UKM) Pencak Silat at the Islamic University 45 Bekasi who regularly follow the exercise and it amounted to 20 athletes. This research is called population research because all members of the population are sampled. In this case, the sample is obtained by the way set by the author because it is an athlete who regularly practices Pencak Silat.

To measure cardiorespiratory endurance, the authors used a multi-stage test (bleep test). A bleep test can be used as a measuring tool to measure maximum oxygen uptake capacity. The purpose of a multi-stage test is to measure the efficiency of heart and lung function, as measured by the measurement of maximum oxygen uptake, by the assessment of the greatest number of levels and perfect feedback successfully obtained and recorded as scores of test participants (Nurhasan, 2000). Body mass index calculated as weight in kilograms divided by the square of height in meters ($kg/m^2$) (WHO, 2016)(Bohlen, Boll, Schwarzer, & Groneberg, 2015; Centers of disease control, 2011; Inzucchi, 2012; National Obesity Observatory, 2009). The measurement of haemoglobin level was using Harenz Hb paper scale.

## Results and Discussion

### *Results*

In this study, samples were used on as many as 20 athletes with athletic qualifications who routinely practiced. For the results of calculation and measurement of average values, and standard deviations (Muhamad, Memet; Aridhotul, 2015) from the research variables, namely: body mass index, haemoglobin levels, and cardiorespiratory endurance can be seen in the table below:

**Table 5:** Descriptive Statistics Calculation Result

| Descriptive Statistics | | | | | |
|---|---|---|---|---|---|
| Variable | N | Minimum | Maximum | Mean | Std. Deviation |
| Body Mass Index | 20 | 19 | 25 | 22.10 | 1.774 |
| Haemoglobin | 20 | 12 | 18 | 14.40 | 2.010 |
| Cardiorespiratory Endurance | 20 | 32 | 43 | 37.30 | 3.164 |

From the test results to the research sample is used to draw the conclusion that whether the observed population is normally distributed or not. For normality testing using SPSS, the following data are obtained:

**Table 6:** The Result of Normality Test

| Variable | Kolmogorov-Smirnov[a] | | |
|---|---|---|---|
| | Statistic | df | Sig. |
| Body Mass Index | .182 | 20 | .082 |
| Haemoglobin | .187 | 20 | .065 |
| Cardiorespiratory Endurance | .188 | 20 | .063 |

Based on Table 6 above, it can be seen in column Kolmogorov-Smirnov and it can be seen that the significance value of body mass index of 0.082, haemoglobin of 0.065 and cardiorespiratory endurance of 0.063. Because the significance for all variables is greater than

0.05 it can be concluded that the data on the four variables of the study are normally distributed.

***Hypothesis Testing***

Based on the causal model in the theoretical form, data will be obtained using the path analysis diagram and then the coefficient value of each path will be calculated. Prior to the calculation to test the model of causality by using the path analyst method, the first data tested the results of research and has met all the necessary requirements. One of the most important requirements that must be met is a significant correlation between related variables and related to one another. The relationship that has been proved above has not concluded the occurrence of a causal relationship between these variables. From field data that have been processed and through various required tests, the next stage in testing the causality model is to conduct path analysis.

After conducting, the required tests for analysis of the normality test is that then the researcher did the hypothesis testing by using path analysis. For the data processing of path analysis, the researcher used SPSS version 23 (Kadir, 2015), which is the summary of test results presented as follows:

**Table 7:** Result Summary of Structural Test 1

| **Direct Effect inter Variables** | **Path Coefficient** | **t-cal** | **p-value** | **Conclusion** | **Remarks** |
|---|---|---|---|---|---|
| **$X_1$ on $X_2$ ($\rho_{21}$)** | 0.815 | 5.957 | 0.000 | Significant | $\varepsilon = 0.337$ |

By using the backward method, obtained two-model result of data processing. Path coefficient will be shown column of standardized coefficient (Beta), Known value of ρ21 = 0.815; t-cal = 5.957, p-value = 0.000 < 0.05, or $H_0$ is rejected, which means there is an direct effect between body mass index on haemoglobin. Body fatness as predicted by body mass index is an additional factor for developing cardiovascular diseases. While the results of the calculation of structural 2 can be seen in the table below:

**Table 8:** Result Summary of Structural Test 2

| **Direct Effect inter Variables** | **Path Coefficient** | **t-cal** | **p-value** | **Conclusion** | **Remarks** |
|---|---|---|---|---|---|
| **$X_1$ on Y ($\rho_{y1}$)** | 0.395 | 3.071 | 0.007 | Significant | |
| **$X_2$ on Y ($\rho_{y2}$)** | 0.601 | 4.672 | 0.000 | Significant | $\varepsilon = 0.106$ |

From table coefficient, obtained value ρy1 = 0.395; t-cal = 3.071, p-value = 0.007 < 0.05, or H0 is rejected, which means the body mass index a positive direct effect on cardiorespiratory

endurance. Value of ρy2 = 0.601; t-cal = 4.672, p-value = 0.000 < 0.05, or H0 is rejected, which means there is a positive direct effect between haemoglobin on cardiorespiratory endurance.

***Discussion***

Body mass index and haemoglobin are two factors where there is a direct effect on cardiorespiratory endurance. In fact, it has been demonstrated that lower haemoglobin levels have been associated with physical performance (Penninx et al., 2003). However, to our knowledge, no one has explored whether lower haemoglobin levels and anaemia are associated with muscle and fat mass and strength differences in elderly people. We hypothesised that anaemia and haemoglobin levels would be associated with muscle mass, fat mass, and skeletal muscle strength. Lower haemoglobin levels might enhance and accelerate age-related muscle and fat mass modifications leading to physical performance loss (Cesari et al., 2004). Body fat as predicted by body mass index is an additional factor for developing cardiovascular diseases.

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**Conclusion**

Based the result of data processing and analysis, the conclusions are: (1) body mass index directly affects cardiorespiratory endurance with $\rho y_1 = 0.705$, (2) haemoglobin directly affects cardiorespiratory endurance with $\rho y_2 = 0.946$, and (3) body mass index directly affects haemoglobin with $\rho_{21} = 0.923$.

**REFERENCE**

Aryadi, T., & Sukeksi, A. (1989). Perbedaan Hasil Pemeriksaan Kadar Haemoglobin Metode Cyanmeth Langsi'Ng Dan Tidak Langsung. *J Urna l. u Nimus.Ac.Is*.

Badriah, D. L. (2009). *Fisiologi Olahraga Edisi II*. Bandung: Multazam.

Bohlen, A., Boll, M., Schwarzer, M., & Groneberg, D. A. (2015). Body-Mass-Index. *Diabetologe*. https://doi.org/10.1007/s11428-015-1388-8

Bosquet, L., Léger, L., & Legros, P. (2002). Methods to determine aerobic endurance. *Sports Medicine*. https://doi.org/10.2165/00007256-200232110-00002

Centers of disease control. (2011). Body mass index: Considerations for practitioners. *Cdc*.

Cesari, M., Penninx, B. W. J. H., Lauretani, F., Russo, C. R., Carter, C., Bandinelli, S., … Ferrucci, L. (2004). Haemoglobin Levels and Skeletal Muscle : Results From the InCHIANTI Study, *59*(3), 249–254.

De Gonzalez, A. B., Hartge, P., Cerhan, J. R., Flint, A. J., Hannan, L., MacInnis, R. J., … Thun, M. J. (2010). Body-mass index and mortality among 1.46 million white adults. *New England Journal of Medicine*. https://doi.org/10.1056/NEJMoa1000367

Haqiyah, A. (2015). Korelasi Antara Status Gizi (Indeks Massa Tubuh Dan Haemoglobin) Dengan Daya Tahan Kardiorespirasi Atlet Pencak Silat Kota Bekasi. *Motion: Jurnal Research Physical Education*, *6*(2), 123–140.

Haqiyah, A. (2019). *Pencak Silat*. Jakarta: PT. Rajagrafindo Persada.

Inzucchi, S. E. (2012). Diagnosis of diabetes. *New England Journal of Medicine*. https://doi.org/10.1056/NEJMcp1103643

Kadir. (2015). *Statistika Terapan*. Jakarta: PT. Rajagrafindo Persada.

Lubis, J. H. W. (2014). *Pencak Silat Edisi Kedua*. Jakarta: Rajagrafindo.

Muhamad, Memet; Aridhotul, H. (2015). *Diktat statistik olahraga*. FKIP: UNISMA Bekasi.

National Obesity Observatory, N. (2009). Body Mass Index as a measure of obesity. *National Health Service*.

Nurhasan. (2000). *Tes dan Pengukuran Pendidikan Olahraga*. Bandung: FPOK UPI.

Penninx, B. W. J. H., Guralnik, J. M., Onder, G., Ferrucci, L., Wallace, R. B., & Pahor, M. (2003). Anemia and decline in physical performance among older persons. *American Journal of Medicine*. https://doi.org/10.1016/S0002-9343(03)00263-8

Prentice, A. M., & Jebb, S. A. (2001). Beyond body mass index. *Obesity Reviews*. https://doi.org/10.1046/j.1467-789x.2001.00031.x

Rieck, T., Jackson, A., Martin, S. B., Petrie, T., & Greenleaf, C. (2013). Health-related fitness, body mass index, and risk of depression among adolescents. *Medicine and Science in Sports and Exercise*. https://doi.org/10.1249/MSS.0b013e3182831db1

Tangkudung, J. (2012). *Kepelatihan Olahraga*. Jakarta: Cerdas Jaya.

WHO. (2016). *Obesity and overweight: Fact sheet*. *WHO Media Centre*.