Abdominal Circumference, Body Fat Percent, and VO\textsubscript{2} Max in Pilgrims of Hulu Sungai Tengah Regency

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Abstract. Maximum oxygen capacity (VO\textsubscript{2} max) is the maximum volume of oxygen that the body processes when carrying out intensive activities. VO\textsubscript{2} max units is milliliters per minute per kilogram of body weight. Factors that determine VO\textsubscript{2} max include age, gender, heart lung function, aerobic muscle metabolism, exercise, genetics, multivitamins, and nutritional status such as BMI, abdominal circumference, and percent body fat. The study is an analytic descriptive. The number of samples is 50 people. Selected using purposive sampling technique. The VO\textsubscript{2} max measurement is done by Rockport test. Data analysis uses frequency distribution. The results showed that the majority of the research subjects were 26-45 years old (33%), female (40%), normal BMI (32%), central obesity (44%), normal body fat percent (28%). Data on abdominal circumference relationships and body fat percent with VO\textsubscript{2} max were analyzed using the chi square test with a confidence level of 95%, p = 0.04 and p = 0.013. The conclusions of this study were that the majority of Hulu Sungai Tengah pilgrims who had VO\textsubscript{2} max enough. There is a significant relationship between abdominal circumference and body fat percent with VO\textsubscript{2} max.

Keywords: pilgrims, VO\textsubscript{2} max, age, gender, BMI, abdominal circumference, body fat percent.

1. Introduction
Indonesia is a country whose population is predominantly Muslim, the Hajj activity which is 70% in the form of physical activity and the remaining 30% is non-physical spiritual worship, and the majority of pilgrims range from young adults to old age. As it is known that the cells of the body begin to degenerate function which result in a decrease in the endurance of the lung heart, flexibility, muscle strength, muscle endurance. So that it requires a good physical condition in order to be able to carry out all the series of activities in the Hajj properly and become a hajj mabrur. To be able to achieve good physical condition means that you must have good physical fitness [1].

Physical fitness has 4 basic components, namely endurance of the heart and lungs (cardiopulmonary), strength and endurance of muscles, flexibility and body composition. Fitness for heart and lung endurance is defined as the maximum capacity for breathing oxygen or abbreviated as VO\textsubscript{2} max. Factors that determine VO\textsubscript{2} max include age, gender, heart lung function, aerobic muscle metabolism, exercise, genetics, multivitamins, and nutritional status such as BMI, abdominal circumference, and percent body fat [2,3].
The peak age of the endurance of the heart and lungs is in the age of 20-30 years old, then it will decrease. This is because the more a person ages, the various sports activities will decrease because someone tends to choose to work, besides the decrease in heart contraction and capacity total, and heart muscle mass also affects [4,5].

VO$_2$ max of men and women is different, the difference in VO$_2$ max is not apparent at a young age and is most evident during adulthood or middle age. The difference between VO$_2$ max male and female is related to differences in body composition and size because the physiological bodies of men and women are different. In addition to the body composition the difference in VO$_2$ max is also due to the different hemoglobin concentrations of men and women. The composition of the female body is more fat than muscle compared to men which causes women has smaller VO$_2$ max. The male hemoglobin concentration is also higher than women. The hemoglobin concentration is closely linked to the binding of oxygen that the body needs for the process of burning energy, so that men can optimally produce energy [6].

Nutritional status can be assessed based on body mass index, abdominal circumference and body fat percent. BMI is obtained by dividing body weight (kg) by the square of height (m). Body weight tends to be inversely proportional to maximum oxygen capacity. This means that the greater the weight (kg), the lower the maximum oxygen capacity. Being overweight is associated with an increase in the amount of fat tissue. The abdominal circumference is the amount of length around a person's body parallel to the navel. The abdominal circumference is generally used as a measure of central obesity. Central obesity is defined as excess fat in the body accompanied by a partial buildup of fat in the visceral part of the stomach. Central obesity is considered a risk factor associated with several chronic diseases [7,8,9].

The lifestyle of people who prefer to eat fast food compared to more nutritious home-made foods causes high rates of obesity [10]. Body fat percent is related to obesity because it is a constituent component of the body besides bone mass, muscle mass, and body water content. describes the condition of the weight or fat mass that is in a person's body in general, both subcutaneous fat and visceral fat (fat contained in organs). At fitness centers, before starting an exercise program, it is usually done checking body composition, one component of which is body fat percent.

2. Method
2.1. Study design
This study uses a analytic descriptive method to describe VO$_2$ max and the factors that influence it and to know the relationship between abdominal circumference and body fat percent with VO$_2$ max in pilgrims. The study was conducted at the Hulu Sungai Tengah District Health Office in May-June 2018.

2.2. Participants
The population of this study included all prospective pilgrims of Hulu Sungai Tengah regency 2018. Of the 319 pilgrims there were 50 people who met inclusion criteria that are physical health, did not take stamina multivitamins one day before the study was held, had no history of chronic heart and lung disease, mild to moderate physical activity, and cooperative.

2.3. Physical test
Before measuring VO$_2$ max, data collection and informed consent were carried out. Informed consent included the approval of the research subjects to take measurements of VO$_2$ max. The measurement of VO$_2$ max uses the rockport method by means of the study subjects warming up and stretching the muscles first in the form of walking slowly 5-10 minutes, then walking fast constantly along the 1.6 km track. Travel time (in minutes and seconds) is measured using a stopwatch and the results are matched with the available VO$_2$ max tables.

Calculation of body mass index by measuring height and weight. Height measurement is carried out with the subject standing against the wall and below the measuring instrument, the measuring
instrument is pulled up to the top of the head, the number seen above that is indicated by the measuring line is the subject's height. Measurements of body weight were carried out by means of subjects being asked to rise above the weighing instrument with the position of the feet right in the middle of the weighing device but not covering the reading window, calmness, and the head not looking down, the numbers on the weigher will appear and wait until the numbers do not change.

Measurement of abdominal circumference is performed on subjects with a standing position and breathing normally (normal expiration) using a measuring tape. Examination is done by feeling the last rib of the subject to set the measurement point of the lower edge of the rib cage. Next, the end point of the pelvis, and the midpoint of measurement are between the last rib point and the end point of the hip bone. Measurements of the abdominal circumference are taken from the midpoint and then parallel horizontally around the waist and abdomen back towards the midpoint.

Measuring body fat percent using carada scan body fat gauge by entering the identity of the research subjects such as age, gender and height. Then the research subjects put their feet on the sensor until the measurement results appear.

3. Result and Discussion
The characteristics of the study subjects consisted of age, gender, body mass index, abdominal circumference and body fat percent.

| Characteristic                  | n  | %  |
|--------------------------------|----|----|
| Age (years)                    |    |    |
| 1. 26-45                       | 19 | 38 |
| 2. 46-65                       | 31 | 62 |
| Gander                         |    |    |
| 1. Men                         | 19 | 38 |
| 2. Women                       | 31 | 62 |
| BMI                            |    |    |
| 1. Underweight                 | 2  | 4  |
| 2. Normal                      | 24 | 48 |
| 3. Overweight                  | 9  | 18 |
| 4. Obesity                     | 15 | 30 |
| Abdominal circumference        |    |    |
| 1. Normal                      | 16 | 32 |
| 2. Obesity                     | 34 | 68 |
| Persen Lemak Tubuh             |    |    |
| 1. Normal                      | 13 | 26 |
| 2. Obesity                     | 37 | 74 |

| VO2 maksi  | n  | %  |
|------------|----|----|
| Low fit    | 12 | 24 |
| Moderate fit | 31 | 62 |
| High fit   | 7  | 14 |

Table 2 shows that the majority of prospective pilgrims have enough VO2 max.
Table 3. VO₂ max distribution of pilgrims based on age.

| Age (years) | VO₂ maks | Low fit | Moderate fit | High fit |
|-------------|----------|---------|--------------|---------|
|             | n %      | n %     | n %          |         |
| 26-45       | 6 12     | 12 24   | 1 2          |         |
| 46-65       | 1 2      | 19 38   | 11 22        |         |

Based on Firman's research on Nganjuk district soccer athletes in 2016 stated that the risk of physical fitness of athletes aged 18-35 years had physical fitness 42 times higher than athletes aged over 45 years. The difference in VO₂ max between adult and elderly in the study subjects was caused by a decrease in the function of the heart, lung and blood vessels. The decrease in the average VO₂ max per year is 0.46 ml / kg / minute for men, and 0.54 ml / kg / minute for women. So, at the age of 55 years VO₂ max is 27% lower than the age of 25 years. In addition, heart muscle mass factors, and decreased heart contractions also have an effect [13,14].

Table 4. VO₂ max distribution of pilgrims based on gender.

| Gender | VO₂ maks | Low fit | Moderate fit | High fit |
|--------|----------|---------|--------------|---------|
|        | n %      | n %     | n %          |         |
| Men    | 4 8      | 11 22   | 4 8          |         |
| Women  | 8 16     | 20 40   | 3 6          |         |

Differences in male and female maximal VO₂ are related to differences in body size and body composition because the physiological bodies of men and women are different. The composition of the female body is more fat than muscle compared to men which causes women to have smaller VO₂ max. The difference between VO₂ max between men and women apart from body composition is one of them also because of the different hemoglobin levels of men and women. Higher hemoglobin levels in men than women cause differences in blood transport capacity which causes men to get far more oxygen during the training process so that their aerobic capacity is better, due to lower oxygen transport and greater percentage of body fat then women tend to show lower VO₂ max values than men [15,16].

Table 5. VO₂ max distribution of pilgrims based on BMI.

| BMI      | VO₂ maks | Low fit | Moderate fit | High fit |
|----------|----------|---------|--------------|---------|
|          | n %      | n %     | n %          |         |
| Underweight | 0 0 2 4 0 0 |         |              |         |
| Normal   | 4 8 16 32 4 8 |         |              |         |
| Overweight | 1 2 6 12 2 4 |         |              |         |
| Obesity  | 8 16 6 12 1 2 |         |              |         |
The VO$_2$ max level in obese people is always lower than the normal BMI because obese individuals will find it harder to move which will result in an increase in the amount of fat tissue in the body. Excess fat tissue will inhibit the function of the cardio respiration system to take enough oxygen. Excessive amount of body fat provides a burden that does not benefit and inhibits heart function, especially when on the move. In obese people there is an increase in type II muscle fiber and a decrease in type I muscle fiber which has the effect of reducing oxygen absorption [17].

| Table 6. VO$_2$ max distribution of pilgrims based on abdominal circumference. |
|----------------|----------------|----------------|
| Abdominal circumference | Low fit | Moderate fit | High fit |
|----------------|-------|-------------|---------|
| Normal | 2 | 4 | 9 | 18 | 5 | 10 |
| Obesity | 10 | 20 | 22 | 44 | 2 | 4 |

The greater the waist hip ratio, the lower the level of VO$_2$ max. This is related to more fat tissue not only as a place to store triglycerides, but as a producer of bio-active substances called adipokines namely leptin which can affect the cardiovascular system [18].

| Table 7. VO$_2$ max distribution of pilgrims based on body fat percent. |
|----------------|----------------|----------------|
| Body fat percent | Low fit | Moderate fit | High fit |
|----------------|-------|-------------|---------|
| Normal | 2 | 4 | 6 | 12 | 5 | 10 |
| Obesity | 10 | 20 | 25 | 50 | 2 | 4 |

Based on table 7 shows the research subjects with percent of normal body fat and VO$_2$ max which is less or less than the study subjects who have percent of obesity body fat. Based on Susilo's research, people who have percent of normal body fat will have a high cardiorespiratory endurance and conversely people who have a percentage of obesity body fat will have low cardiorespiratory endurance [11].

According to Chatterjee et al, the percentage of excessive body fat will have an impact on decreasing cardiac output while doing activities. The excessive amount of fat tissue will cause narrowing of the arteries and peripheral resistance. As a result, the pumped blood becomes less so that the maximum oxygen capacity also decreases and causes a decrease in cardiovascular ability [19].

| Table 8. The relationship between VO$_2$ max with abdominal circumference of pilgrims. |
|----------------|----------------|----------------|----------------|----------------|----------------|
| Abdominal circumference | VO$_2$ max | Total | p Value |
|----------------|-------|-------------|---------|
| Low fit | Moderate fit | High fit | n | % | n | % | n | % | p Value |
| Normal | 2 | 4 | 9 | 18 | 5 | 10 | 16 | 100 | 0,04 |
| Obesity | 10 | 20 | 22 | 44 | 2 | 4 | 34 | 100 |   |

Based on the statistical test obtained p = 0,04 this states that there is a significant relationship between abdominal circumference and VO$_2$ max. The results of this study are in line with Nurlim's research in 2012 Physiotherapy students at Hasanuddin University medical school, stating that there was a significant relationship between abdominal circumference and VO$_2$ max (p = 0,002) [20]. The 2012 Ramba study showed a significant relationship between central obesity and VO$_2$ max to
Makassar Polytechnic Physiotherapy students (p = 0.002). In students, central obesity is generally caused due to obesity in childhood which persists into adolescence. Incorrect eating patterns and low physical activity in childhood cause obesity in adolescence. If this condition persists, it will increase the risk of obesity in advanced adulthood, where there is a decrease in metabolism and disposition of fat tissue [21].

| Body fat percent | VO2 max |   |   |   |   |   |   |   |   |   |   | p Value |
|------------------|---------|---|---|---|---|---|---|---|---|---|---|---------|
|                  | Low fit | Moderate fit | High fit | Total |   |   |   |   |   |   |   |         |
| Normal           | n | % | n | % | n | % | n | % | p |         |
| Normal           | 2 | 4 | 6 | 12 | 5 | 10 | 13 | 100 | 0.013 |   |         |
| Obesity          | 10 | 20 | 25 | 50 | 2 | 4 | 37 | 100 |   |         |   |         |

Based on statistical tests, it was found that p = 0.013, this stated that there was a significant relationship between percent body fat and VO2 max. These results are in line with previous research which states that there is a relationship between physical fitness and body fat in the gymnastics group (p = 0.02) and non-gymnastic groups (p = 0.41) [22] and there is a strong correlation (r = -0.75) between percent body fat and VO2 max, in this study it was concluded that an increase in percent body fat was associated with a decrease in maximal oxygen capacity [23].

4. Conclusion
Based on the description obtained in this study, it can be concluded that most of the prospective pilgrims of Hulu Sungai Tengah regency in 2018 are aged 26-45 years (33%), female sex (40%), normal BMI (32%), central obesity (44%), percent of normal body fat (28%) has enough VO2 max. There was a significant relationship between abdominal circumference with VO2 max p = 0.04 and a significant relationship between body fat percent with VO2 max p = 0.013. Pilgrims should prepare their physical 1 to 2 years before departure and the government should hold regular physical training for pilgrims.

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