Vital Capacity and Haemoglobin Level in Correlation with Endurance of Adolescent Football Athlete

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Abstract: His study was aimed to know the correlation between the vital capacity of lungs and haemoglobin level of erythrocytes toward the maximum aerobic capacity of adolescent football athlete. The research methodology was survey method from Muhardi Football Academy's population in which purposive sampling is the used sampling technique. The population as a sampling was amount 23 of 30 adolescent football athletes that be examined by Spirometer for vital capacity, Nesco multi check for haemoglobin, and Bleep-test method for maximum aerobic capacity. Data were analyzed by using both simple and double correlation and regression techniques with t-test at significant level $\alpha = 0.05$. The result showed that vital capacity and haemoglobin level are able to influence the maximum aerobic capacity of an athlete so that it also sustains in an improvement of cardiorespiratory endurance.

1 INTRODUCTION

Virtually all conditioning and many sports activities planned and structured are performed to improve or maintain components of physical fitness (Caspersen, et al., 1985). Physical activity is an inherent relationship between biomechanical (such as strength, endurance, speed, coordination and flexibility) and physiological (such as the neuromuscular system (nerve), digestion, breathing, blood circulation, bone, and joints) in which the basic components are to enhance cardiorespiratory endurance of athlete (Jalilvand).

Analysis of activities during soccer matches showed that a top-class soccer player covers an average distance of approximately 11 km during a match but it differs highly between players and is partly related to the position in a team (Bangsbo, 1994); Therefore, one of the fundamental prerequisites of being a soccer player is requiring good physical condition, especially the aspect of cardiorespiratory endurance, in order to survive or play for a long time (Reilly, et al., 1990). Cardiorespiratory endurance is a health-related component of physical fitness that relates to the ability of the circulatory and respiratory systems to supply fuel during sustained physical activity and to eliminate fatigue products after supplying fuel (Caspersen, et al., 1985). Researchers, for over the years, have studied the association between endurance exercise and improving VO2Max (Kenney, et al., 2012); In other words, VO2Max is widely regarded as the best single measurement of cardiorespiratory endurance or aerobic fitness (Kenney, et al., 2012).

VO2Max is a measure of the cardiovascular system's ability to deliver O2 (i.e., blood transport and tissue extraction of O2), referred to hereafter as this system's "functional capacity" (Rowell, 1974). The most important factor related to blood supply is the total blood volume, which may limit venous return and thus the stroke volume, as well as haemoglobin mass (Hbmass), which along with the capacity of muscles to extract and use O2 determines the O2-transport capacity and therefore the arteriovenous O2 difference (Saunders, et al., 2013). The lungs, a vital tool that holds oxygen, responsible for the uptake of O2 and excretion of CO2 in the lungs are explored (Barrett, et al., 2010), then a way of knowing the vital capacity of each athlete's lungs is obtained by measure the maximal volume expiration after maximum inspiration (Sutopo and Lestari, 2001).

The process of respiration is divided into external respiration that is the process of exchange of oxygen and carbon dioxide that occurs in the alveoli of the lungs, and internal respiration that is the process of exchange of oxygen and carbon dioxide that occurs in the other cells of the body (Sutopo and Lestari, 2001).

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The internal respiratory process requires blood as a tool for transporting oxygen and the substances needed to be circulated throughout the body cell tissues (Barrett, et al., 2010). One of the compounds that function to carry and spread oxygen and substances required by cells is the haemoglobin present in erythrocytes (Ganong, 2005). Haemoglobin is a complex protein (globin) composed of polypeptides and a heme compound composed of a circular compound called porphyrin, which which conjugated to a polypeptide (Barrett, et al., 2010). There are approximately 250 million hemoglobin molecules and They have an oxygen-carrying capacity of 20 ml of oxygen per 100 ml (1 dl) of red blood (Kenney, et al., 2012). Based on the above study, the vital capacity of the lungs and athlete's haemoglobin is good to encourage the metabolism process and to ensure the availability of energy to do physical work so that athletes have a good VO2Max.

This research aimed to study and respond the hypothesis of (1) correlation of vital capacity of the lungs with maximum aerobic capacity (VO2Max), (2) correlation of haemoglobin content with maximum aerobic capacity (VO2Max) and (3) correlation of vital lungs capacity and haemoglobin levels with maximum aerobic capacity (VO2Max). The expectation of this study is that maximum aerobic capacity can be increased through vital capacity and haemoglobin levels athlete; Furthermore, the hypothesis can be answered positively.

2 METHODS

2.1 Participants

The sample was obtained by purposive sampling technique that was the determination of the sample with the certain consideration which amounts to 23 athletes from the total population of 30 football club athletes of Muhardi Football Academy (MFA), Tangerang, Banten.

2.2 Procedures

The research method used in this study was survey method with correlation technique (Kothari, 2004) that was a research to collect data obtained by measuring and recording the result of measurement consisting of vital capacity in lungs and blood haemoglobin level on December 11, 2014 and Maximum Aerobic capacity (VO_2Max) on December 14, 2014.

2.3 Instruments

Data were collected by conducting several tests and measurements of vital lungs capacity using Spirometer, the level of haemoglobin using *Nesco Multi Check* and maximal aerobic capacity (VO_2Max) using *bleep-test* method. The analysis of data used in this study was the technique of simple correlation and regression followed by the technique of correlation and multiple regression.

3 RESULTS AND DISCUSSION

3.1 Test the correlation of pulmonary vital capacity with maximum aerobic capacity

Based on Figure 1a compared to the average score, the sample in the average class was 10 (43.48%) and below the average class was 7 samples (30.44%) while the sample in above average class was 6 samples (26.08%). The analysis, between Figure 1a and approximately 4.6 litres of the maximum vital capacity of the lungs according to Arthur Guyton and John Hall (Guyton and Hall, 2006), indicated that as many as 23 athletes of Muhardi Football Academy club did not have good vital lung capacity.

The relationship between the vital capacity (VC) of the lung with the maximum aerobic capacity was expressed by the regression equation $\hat{Y} = 24.547 + 0.509X1$ and shown by the correlation coefficient rX1Y = 0.509. The result of significance test of correlation coefficient showed that t-count = 2.707 was bigger than t-table = 2.08 which meant that the correlation coefficient rX1Y = 0.509 was significant and positive. Thus, the vital capacity of the lungs that function optimally makes the athlete able to perform physical work in a long time without experiencing significant fatigue (Wahjoedi, 2001). Moreover, anthropometric measurements also provide significant support for the relationship of vital capacity to endurance performance (Mayhew and McKethan, 1973). The coefficient of determination of the vital capacity of lungs with maximum aerobic capacity was (rx1y2) = 0.2591. This meant that 25.91% of the maximum aerobic capacity was determined by the vital capacity of the lungs (X1).

Table 1: Description of Variable Data of Vital Lungs Capacity.

No.	Class Interval	Median	Frequency	
			Absolute	Relative (%)
1	1.70 – 2.14	1.92	1	4.35%
2	2.15 – 2.59	2.37	6	26.09%
3	2.60 – 3.04	2.82	10	43.48%
4	3.05 – 3.49	3.27	2	8.69%
5	3.50 – 3.94	3.72	4	17.39%
Total			**23**	**100%**

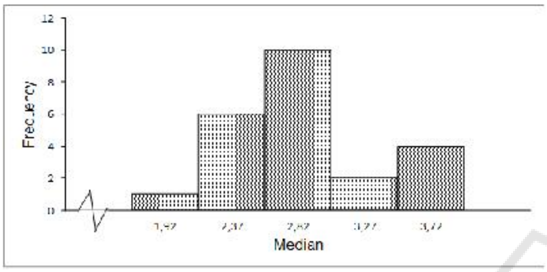

Figure 2: Data of Vital Lungs Capacity.

Table 2: Description of Variable Data on Hemoglobin Levels.

No.	Class Interval	Median	Frequency	
			Absolute	Relative (%)
1	14.70 – 15.32	15.01	1	4.35%
2	15.33 – 15.95	15.64	3	13.04%
3	15.96 – 16.58	16.27	5	21.74%
4	16.59 – 17.21	16.90	10	43.48%
5	17.22 – 17.84	17.53	4	17.39%
Total			**23**	**100%**

Table 3: Description of Variable Data of Maximum Aerobic Capacity.

No.	Class Interval	Median	Frequency	
			Absolute	Relative (%)
1	34.70 – 37.18	35.94	3	13.04%
2	37.19 – 39.67	38.43	5	21.74%
3	39.68 – 42.16	40.92	7	30.44%
4	42.17 – 44.65	43.41	3	13.04%
5	44.66 – 47.14	45.90	5	21.74%
Total			**23**	**100%**

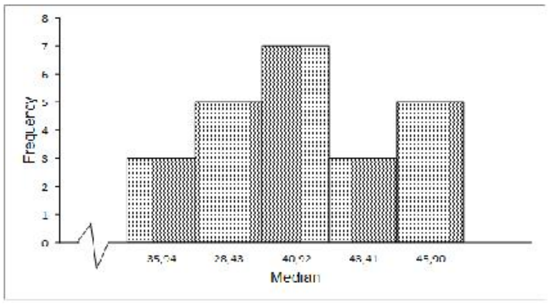

Figure 2: Data of Maximum Aerobic Capacity.

3.2 Test the correlation of haemoglobin level with maximum aerobic capacity

Based on Figure 1b compared to the average, the sample in the average class was 5 (21.74%) and below the average class was 4 samples (17.39%) while the sample in above the average class was as much as 14 samples (60.87%). The analysis, between Figure 1b and average 14 g/dl for women and 16 g/dl for men as normal haemoglobin levels (Barrett, et al., 2010), indicated that as many as 23 athletes of Muhardi Football Academy club had normal haemoglobin levels.

The relationship between haemoglobin with maximum aerobic capacity was expressed by the regression equation $\hat{Y} = 26.546 + 0.469X2$ and shown by the correlation coefficient rX2Y = 0.469. The result of significance test of correlation coefficient showed that t-count = 2.433 was bigger than t-table = 2.08 which meant the correlation coefficient rX2Y = 0.409 was significant and positive. In addition, findings from other studies also support that athletes who were part of training interventions on altitude increased Hbmass and VO2Max by ~3% such that each 1% change in Hbmass will result in a 0.6–0.7% change in VO2Max (Saunders, et al., 2013). Thus, athletes with good haemoglobin are able to meet their oxygen consumption or need so that the athlete will have and be able to increase cardiorespiratory endurance marked with progressive maximum aerobic capacity (VO2Max). The coefficient of haemoglobin determination with maximum aerobic capacity was (rx2y2) = 0.2200. This meant that 22% of the maximum aerobic capacity was determined by haemoglobin (X2).

3.3 Test the correlation of pulmonary vital capacity and hemoglobin level with maximum aerobic capacity

Based on Figure 1c compared to the average score, the sample in the average class was 7 (30.44%) and below the average class was 8 samples (34.78%) while the sample in above the average class was 8 samples (34.78%). The analysis between Figure 1c and Table 1 showed that there were 8 athletes who had enough VO2Max and 15 athletes who had less VO2Max than the total sample of athlete club of Muhardi Football Academy as many as 23 athletes.

Table 4: Standard Value of VO2Max of Athlete (Tim Seleksi Prima).

Category	Male	Female
Very Good	> 56.8	> 49.5
Good	49.4 - 56.8	43.6 - 49.5
Fair	41.8 - 49.3	35.4 - 43.5
Less	31 - 41.7	29.9 - 35.3
Very Less	< 31	< 29.9

The relationship between the vital capacity of the lungs (X1) and the haemoglobin (X2) with the maximum aerobic capacity (Y) was expressed by the regression equation $\hat{Y} = 13.3 + 0.397X1 + 0.337X2$ and shown by the double correlation coefficient ry1-2 = 0.60. The result of significance test of double correlation coefficient showed that F-count = 5.625 was bigger than F-table = 3.49 which meant double correlation coefficient ry1-2 = 0.60 was significant and positive. Although both variables have a positive and significant relationship, all athletes do not have a good maximal aerobic capacity or more. VO2Max is probably the single most important factor determining success in an aerobic endurance sport; However, within the same person, peak oxygen transport is specific to a given type of activity such as the position of the athlete (Hoff and Helgerud, 2004). Thus, the concurrent endurance training program together with regular football training is needed to result in considerable improvement of the players ' physical capacity and so may be successfully introduced to elite football players (Helgerud, et al., 2011). The coefficient of determination of haemoglobin level and vital capacity of the lungs with maximum aerobic capacity was (ry1-2) = 0.3600. This meant that 36% of maximal aerobic capacity was determined by the vital capacity of the lungs (X1) and haemoglobin (X2) levels.

4 CONCLUSIONS

Maintenance of vital capacity of the lungs and haemoglobin levels as a determinant factor can provide positive implications for the maximum aerobic capacity of progressive soccer athletes. One way to maintain the vital capacity of the lungs and haemoglobin levels is through intensive exercise. Based on the results of data analysis above showed that there was a relationship between the vital capacity of the lungs and haemoglobin level with a maximum aerobic capacity in football athletes of Muhardi Football Academy (MFA) of 36%. In addition, there are 23 athletes lacking good vital lung capacity, 23 athletes have normal haemoglobin level and 8 athletes have maximum aerobic capacity in sufficient category and 15 athletes in the less category. Thus, the variables studied should be of concern to athletes and other relevant parties, especially variables of the vital capacity of the lungs to increase the maximum aerobic capacity of the athlete. Further research needs to be done because there are other factors, such as stroke volume, cardiac output, pulse rate, and so on which has implications of 64% to maximum aerobic capacity of athletes.

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