

## The Relation Between Hemoglobin Concentration and Maximum Oxygen Volume Levels In Obese Women

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### ABSTRACT

This study aims to analyze the relation between hemoglobin concentration and maximum oxygen volume ( $VO_{2max}$ ) in obese women. This study used a cross sectional study using the subject of 40 obese women aged 18-22 years old, Body Mass Index (BMI) 25-35  $kg/m^2$  and Percentage Body Fat (PBF) above 30%, normal blood pressure, Normal Resting Heart Rate (RHR) and Fasting Blood Glucose (FBG) below 100 mg/dL. Hb concentration measurements used Easy Touch (Easy Touch GCHb, Taiwan) with a unit concentration of g/dL, while  $VO_{2max}$  measurement was using the Astrand 6-minute cycle test method. Data analysis techniques used the Pearson Correlation test with the Statistical Package for Social Science (SPSS). The results obtained mean Hb ( $15.365 \pm 1.467$ ) g/dL and  $VO_{2max}$  ( $28.635 \pm 4.256$ ) mL/kg/min. Based on the results of the study concluded that there is a positive correlation between Hb levels and maximum oxygen capacity in obese women. Further research is needed to explain the physiological mechanism of the relation between hemoglobin concentration and maximum oxygen volume in more detail.

**Keywords:** Hemoglobin concentrate, maximum oxygen volume, obese women

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**BACKGROUND**

Obesity is a major health problem and considered as an epidemic disease that is still increasing worldwide (Zaki *et al.*, 2019). According to the World Health Organization (WHO) (2019) the prevalence of obesity at the age of 18 years old has increased from 1980 by 13% to 24% in 2008 and 26% in 2016. In Indonesia, based on the results of the Basic Health Research (Riskesdas) in 2018 showed that the prevalence of obesity at the age (over 18 years old) reached 21.8%, the number was higher than in 2013 (14.8%) and 2007 (10.5%) (Riskesdas, 2018). The prevalence rate of obesity has been very worrying both in developed and developing countries (Marie *et al.*, 2014; Norheim *et al.*, 2014).

Obesity is a disease that has a high risk of the emergence of very serious health problems that will threaten public health in the world (Gadde *et al.*, 2018). This is due to obesity being one of the main causes of disability and premature death (Rosella *et al.*, 2019; Al-Kibria, 2019) not only in adults but also in adolescents and children throughout the world (Aktar *et al.*, 2017; Khan and Shah, 2017). In addition, obesity also increases the risk of non-communicable diseases, such as type 2 diabetes mellitus, dyslipidemia, non-alcoholic fatty liver disease, coronary heart disease (Park *et al.*, 2012), high blood pressure (Gadde *et al.*, 2018) stroke, several types of cancer, gallstones and osteoarthritis (Bales and Buhr, 2008).

According to WHO (2016) explained that body weight and obesity are characterized by abnormal or excessive fat accumulation. Body fat mass within normal limits will affect cardiorespiration endurance (Sharkey, 2003). According to Dieny *et al.* (2017) hemoglobin has an important role in cardiorespiratory endurance, the main function of hemoglobin is to bind oxygen. Hemoglobin is the main determinant of maximum oxygen volume ( $VO_{2max}$ ). Research conducted by Anwar *et al.* (2013) showed that there was no relationship between hemoglobin levels and maximum oxygen volume ( $VO_{2max}$ ) in high school 1 Pamotan District, Rembang. In addition, research conducted by Bhakare *et al.* (2013) showed that there is a positive correlation between hemoglobin and  $VO_{2max}$  in male and female obese subjects. Based on the background above, the purpose of this study is to analyze the relation between Hb concentration and  $VO_{2max}$  in obese women.

**METHOD**

This study used a cross sectional study using the subject of 40 obese women aged 18-22 years, body mass index (BMI) 25-35 kg/m<sup>2</sup> and percentage body fat (PBF) above 30%, normal blood pressure, resting heart normal rate (RHR) and fasting blood glucose (FBG) below 100 mg/dL. All of these research procedures were approved by the Health Research Ethics Commission of the Faculty of Medicine, Airlangga University, Surabaya number 309/EC/KEPK/FKUA/2019.

Height measurement was using a stadiometer (SECA, Chino, CA). Anthropometric measurements which include body weight, BMI and PBF use TANITA (Body Composition Analyzer DC3607601 (2) -1604 FA, TANITA Corporation of America, Inc., USA). Blood pressure was measured using a OMRON digital blood pressure monitor (OMRON Model HEM-7130 L, Omron Co., JAPAN). Resting heart rate measurements used a Pulse Oximeter (PO 30 Pulse Oximeter, Beurer North America LP, 900 N Federal Highway, Suite 300, Hallandale Beach, FL 33009). FBG measurements used ACCU-CHEK (ACCU-CHEK® Performance, Mannheim, Germany) with mg/dL concentration units, while Hb measurement was using Easy Touch (Easy Touch GCHb, Taiwan) with g/dL concentration units. Measurement of maximum oxygen capacity ( $VO_{2max}$ ) used the

Astrand 6-minute cycle test method using an ergocycle (Monark 828 E, Version 1010 Art. No: 7950-296, Vansbro, Sweden).

Statistical analysis used statistical software packages for social science (SPSS). The normality test uses the Shapiro-Wilk test. Data that were normally distributed were tested using Pearson correlation with a significant level ( $p < 0.05$ ). All data are displayed with mean $\pm$ SD.

## RESULT

The result of characteristic descriptive analysis and correlation analysis between Hb levels and  $VO_{2max}$  can be seen in Table 1 and 2.

**Table 1.** The result of descriptive analysis of research subject characteristics

Variabel	n	Mean	Std. Deviation
Age (years)	40	20.775	1.209
Weight (kg)	40	69.740	9.400
Height (m)	40	1.562	0.052
Body mass index (kg/m <sup>2</sup> )	40	28.472	3.331
Percentage body fat (%)	40	42.112	7.736
Systolic blood pressure (mmHg)	40	113.000	4.641
Diastolic blood pressure (mmHg)	40	76.000	5.454
Resting heart rate (bpm)	40	79.200	9.704
Fasting blood glucose (mg/dL)	40	88.275	7.165

**Table 2.** Correlation between Hb levels and  $VO_{2max}$

Variabel	n	Mean $\pm$ SD	Pearson r	P-value
Hb (g/dL)	40	15.365 $\pm$ 1.467	0.567	0.000*
$VO_{2max}$ (ml/kg/min)	40	28.635 $\pm$ 4.256		

Based on Table 2, the Pearson correlation test results show that there is a relationship between Hb concentration and  $VO_{2max}$  in obese female subjects with positive correlation direction ( $r=0.567$ ) and ( $p=0.000$ ).

## DISCUSSION

Based on Table 2, the Pearson correlation test results show that there is a relationship between Hb concentration and  $VO_{2max}$  in obese female subjects. These results are in line with the results of research conducted by Putra *et al.* (2017) that there is a significant relationship between Hb concentration and  $VO_{2max}$  after high intensity interval training. Likewise the results of research by Bhakare *et al.* (2013) concluded that there is a positive correlation between hemoglobin and  $VO_{2max}$  in male and female obese subjects. The results of this study are reinforced by the statement of Doewes *et al.* (2011) explained that the oxygen-carrying system (hemoglobin) had a contribution of 49.3% to  $VO_{2max}$ . Hemoglobin is the main molecule responsible for transporting oxygen from the lungs to the peripheral tissues and transporting carbon dioxide from the peripheral tissues to the lungs. In this study shows there is a positive correlation, this is likely due to  $VO_{2max}$  influenced by supply factors and consumption factors. Supply factors include ventilation and oxygen transport systems involving the airways, circulatory system to be in the

mitochondria of cells that need them, while consumption factors refer to the mechanism of phosphorylation or the use of oxygen by the mitochondria in cells (Putra *et al.*, 2017).

$VO_{2max}$  is the maximum ability of the body that starts from cells in using oxygen during activities or sports maximum unity of time. When activating important respiratory organs, the lungs need to get oxygen to meet metabolism in the body. Oxygen is carried from the lungs to all the tissues of blood cells in the body and brings back carbon dioxide from all cells to the lungs to be removed from the body, and last but not least this process is a compound that carries oxygen, that is, hemoglobin in the blood cells. red, so that when hemoglobin levels are low, the oxygen carried by red blood cells is also small (Anwar *et al.*, 2013). Hemoglobin is one of the factors that influences the value of  $VO_{2max}$ . Based on the point of view of oxygen supply and distribution factors to the mitochondria of cells, hemoglobin becomes the oxygen-carrying medium in the circulatory system (Sherwood, 2015) through the activation of 5-AMP-activated protein kinase (AMPK) and p38 mitogen-activated protein kinase (p38-MAPK), both kinases are directly involved in the process of phosphorylation and activation of the peroxisome proliferator-activated receptor gamma coactivator (PGC-1 $\alpha$ ) which plays a central role in the regulation of energy metabolism at the cellular level (Liang and Ward, 2006). The increase in PGC-1 $\alpha$  is thought to support the activation of transcription factors (TF) which increase the transcription of mitochondrial genes, resulting in more mitochondrial protein accumulation. The greater number of mitochondria causes the number of organelles of aerobic metabolism actors to increase. The increase in aerobic metabolism allows aerobic metabolic activity that occurs in cells to increase. Increased aerobic metabolic activity in cells can cause the amount of oxygen demand used for metabolism to increase, so that the capacity or ability to use oxygen ( $VO_{2max}$ ) of each cell also increases. Based on this theory it is possible that  $VO_{2max}$  increases due to the number of mitochondria. In addition, there are internal and external factors that can affect  $VO_{2max}$ . Internal factors include age, gender and genes, while external factors include physical exercise, activity, smoking, health conditions, adequate rest, hemoglobin status, body fat, body mass index (BMI) and nutrient intake (Sharkey, 2003; Nurhasannah, 2005).

## CONCLUSION

Based on the results of the study concluded that there is a positive correlation between hemoglobin concentration and maximal oxygen volume in obese women. Further research is needed to explain the physiological mechanism of the relationship between hemoglobin concentration and maximal oxygen volume in more detail. Further research is needed to determine the relationship between hemoglobin concentration and  $VO_{2max}$  in subjects with thin, normal, overweight and obese body mass index (BMI) in both men and women.

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