Factors Related to Estimated Maximal Oxygen Uptake (VO_2Max) Among Faculty of Health Sciences Students in Universitas Indonesia 2016

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The Asian Undergraduate Research Symposium 2016
Official Conference Proceedings

Abstract

Estimated VO_2Max (Volume Oxygen Maximum) value, which is the maximum oxygen capacity a body can use in a minute, is regarded as the best indicator to measure one's level of cardiorespiratory fitness. The objective of this research is to get information about the mean value of estimated VO_2Max among Faculty of Health Sciences (Rumpun Ilmu Kesehatan) Students in Universitas Indonesia and its correlation with sex, physical activity, body mass index, body fat percentage, micro and macronutrient intake, sleep quality, also stress level.

This research is a cross-sectional study with 122 samples. Estimated VO_2Max value was measured by using Queens College Step Test method. The mean value from all samples was 38.9±6.9 mL/kg/min which differs significantly between each sex group (male = 43.9±7.9 mL/kg/min on men and women = 35.4±2.8 mL/kg/min ; p value<0.05). Bivariate analysis showed that there are positive significant correlation between physical activity, energy intake, protein intake, fat intake, carbohydrate intake, vitamin B1, B2 and Fe intake with estimated VO_2Max value, respectively. While it showed negative significant correlation between body fat percentage with estimated VO_2Max value. Bivariate analysis also showed that there are no significant correlation between BMI, vitamin C intake, sleep quality, and stress level with estimated VO_2Max value, respectively.

Keywords: VO_2Max, Queens College Step Test, Students, Physical Activity, Intake

Introduction

Estimated VO_2Max (Volume Oxygen Maximum) value, which is the maximum oxygen capacity a body can use in a minute (Hoeger and Hoeger, 2011; Romero-Fallas, Soto-Arias, and Moncada-Jimenez, 2012), is regarded as the best indicator to measure one's level of cardiorespiratory fitness (Hoeger and Hoeger, 2011). Cardiorespiratory fitness can affect overall health, life quality, life expectancy, and also daily productivity (Wuest and Fisette, 2012).

Researches about VO_2Max have been done in many countries. Previous findings in 10 cities across Europe showed that the average of estimated VO_2Max among girls in adolescents age group is 37.1 mL/kg/min, which still is not categorized as good based on Hoeger and Hoeger (2011) fitness category for stated age group (Ortega, *et al*., 2011). Previous findings among college students in United States also showed that the average of estimated VO_2Max value among adolescents and/or college students had not reached good cardiorespiratory fitness category (Lepp, *et al.*, 2013).

Previous findings in Indonesia that has been done towards college students who undergo regular physical training showed that those college students' average estimated VO_2Max value also had not been categorized as good yet (below 39 mL/kg/min for female and below 44 mL/kg/min for male) (Hoeger and Hoeger, 2011; Trisnasari, 2015). Next findings by Sinamo (2012), whose research had been done towards college students majoring Nutrition Science in Universitas Indonesia, showed that the average of estimated VO_2Max value is 29,6 ± 5,9 mL/kg/min.

Previous findings by Sinamo showed that part of Faculty of Health Sciences (*Rumpun Ilmu Kesehatan*) in Universitas Indonesia still has low average of estimated VO_2Max value. In addition to that, Faculty of Health Sciences (*Rumpun Ilmu Kesehatan*) students in Universitas Indonesia will be the next medical staffs and health teams who will collaborate to serve patients and public, and also will be needed in developing health in Indonesia, for which each individual health status should be maintained since earlier age. Therefore, it is important to do further research on estimated VO_2Max value (as a health related fitness indicator) towards Faculty of Health Sciences (*Rumpun Ilmu Kesehatan*) students in Universitas Indonesia.

This research is aimed to get information about the mean value of estimated VO_2Max among Faculty of Health Sciences Students and its correlation with sex, physical activity, body mass index, body fat percentage, micro and macronutrient intake, sleep quality, also stress level.

Literature Review

Cardiorespiratory fitness, indicated by VO_2Max (Volume Oxygen Maximum) value, is regarded as the most important component among all health related fitness (Wuest nad Fisette, 2012). Good cardiorespiratory fitness can decrease cardiovascular diseases risks, increase daily productivity, also increase life quality and life expectancy (Wuest and Fisette, 2012).

VO_2Max value is the maximum oxygen capacity a body can use in a minute while doing physical activity (Hoeger and Hoeger, 2011). VO_2Max, with mL/kg/min as its unit, is the best indicator that can be used to determine individual's cardiorespiratory fitness (Hoeger and Hoeger, 2011).

VO_2Max can be measured directly and indirectly. Direct measurement (laboratory measurement) of VO_2Max is a costly method which needs long time to be done and trained personnel so it is considered not really practical to do (Nieman, 2011). Indirect measurement of VO_2Max can be done with much more easy methods which still considered valid, as their validities are already confirmed beforehand, to substitute direct measurement (Nieman, 2011).

Queens College Step Test is one of the indirect tests that can measure estimated VO_2Max value which was developed by McArdle, Katch, dan Katch (1994). The instruments needed for this tests are 16¼ inch bench, metronome (set at 96 bpm for males and 88 bpm for females) and a stopwatch (Hoeger and Hoeger, 2011; Nieman, 2011). Participants are expected to step up and down the bench following the rhythmic on the metronome for three minutes and their heartbeat are to be counted for 15 seconds afterwards (Hoeger and Hoeger, 2011; Nieman, 2011). The time gap between the end of the stepping and the beginning of the heart beat counting is five seconds (Hoeger and Hoeger, 2011; Nieman, 2011). Thus, the heart beat counting is inserted to this following equation to get the estimated VO_2Max value (McArdle, Katch, dan Katch, 1994; Nieman, 2011).

Estimated VO_2Max for Males:
VO_2Max (mL/kg/min) = 111.33 – (0.42 x Heart Rate)

Estimated VO_2Max for Females:
VO_2Max (mL/kg/min) = 6.81 – (0.1847 x Heart Rate)

(*Queens College Step Test)*

Figure 1: Queens College Estimated VO_2Max Equation

There are some factors correlated with VO_2Max, such as sex, physical activity, body mass index, body fat percentage, macronutrient intake, micronutrient intake (Vit. B_1, Vit. B_2, Vit. C, Iron) sleep quality, also stress level. Tammelin (2005) in previous study about physical activity stated that there are strong correlation between high level physical activity and good cardiorespiratory level (Zimmermann-Sloutkiss *et al*., 2010). Sex is also a factor that correlated with VO_2Max (Hoeger and Hoeger, 2011; Trisnasari, 2015). Another findings in Korea showed that Body Mass Index (BMI) is also a factor that is correlated with VO_2Max (Kim dan So, 2013).

Another findings by Scott (1992) showed that body fat percentage is also a factor that is correlated to VO_2Max. Nutrient intake, as it is showed in previous research by Cuenca-Garcia, *et al.* (2012) is also correlated to VO_2Max. Lee and Lin (2007) found that sleep quality is also correlated to VO_2Max, where in their research it showed that a group of women who have bad sleep quality tends to have low level of fitness. Another research also showed that women and men with higher psychologic stress

tends to have less physical activity (Muhsen, *et al.*, 2010), which resulting in decreasing level of fitness (Countryman, *et al.,* 2013).

Methodology

This research is a cross sectional research which aimed to determine whether or not there are any correlation between independent variables (sex, physical activity, body mass index, body fat percentage, macronutrient intake, micronutrient intake (Vit. B_1, Vit. B_2, Vit. C, Iron) sleep quality, also stress level) with dependent variable VO_2Max.

Data collecting was done in Faculty of Health Sciences in Universitas Indonesia from April to May 2016. Population target in this research is all college student currently studying in Faculty of Health Sciences in Universitas Indonesia at that time. Faculty of Health Sciences in Universitas Indonesia consisted of Faculty of Medicine, Faculty of Dentistry, Faculty of Public Health, Faculty of Nursing, and Faculty of Pharmacy. Population study in this research is college student in regular program starting from batch 2014 to 2015.

Eligible subject was then determined by using inclusion and exclusion criteria. Inclusion criteria is active college students in regular program in Faculty of Health Sciences batch 2014 to 2015 who aged more than 18 years old at that time. The exclusion criteria is college students who was sick, have some cardiac condition, or have physical activity limitation do to certain condition which can disturb the VO_2Max test. After that, sample was chosen by using stratified random sampling method with proportional sampling allocation among college students in regular program of Faculty of Health Sciences batch 2014 to 2015.

The data that used for this research was primary data. Estimated VO_2Max value was measured by using Queens College Step Test. Sex, physical activity, sleep quality, and stress level data were gathered by using questionnaire. Body fat percentage data were gathered by using *Bioelectrical Impedance Analysis* (BIA). Body mass index data were gathered by measuring body weight and body height. Finally, the micro and macro nutrient intake data were gathered by collecting dietary history using 2x24 Hours Recall method.

Discussion

The number of total respondents in this research is 122 respondents. Based on the sex, the respondents consist of 73 females (60%) and 49 males (40%). The difference of estimated VO_2Max value between males and females are further explained on table 1.

Variables	Sex	n	Mean±SD	p value
Estimated VO_2Max value	**Male**	49	43.9±7.,9	0.0001*
	Female	73	35.4±2.8	

Table 1: Average Differences of Estimated VO_2Max Value Based on Sex (n=122)

Based on the table 1, the result showed that the average estimated VO_2Max for males almost reached good category for individuals aged below 29 years old, for females, it

is showed that the average of estimated VO_2Max value has not categorized as good yet. As for the difference, it is showed that there are significant difference between male and female estimated VO_2Max value (p value < 0.005).

The higher estimated VO_2Max for males in compared to females are related to the higher haemoglobin levels on males, the lower fat level, and the bigger heart size the males have compared to females (Hoeger and Hoeger, 2011). The lower fat level on males resulting on the more muscle mass males have which can produce more aerobic energy than women (Hoeger and Hoeger, 2011). Males also have approximately 5 – 10 % more haemoglobin concentrate than women which resulting in more oxygen circulation while doing physical activity which affect the VO_2Max to be more than the females' (Katch, McArdle, dan Katch, 2011).

Correlation results between independent variables and dependent variables are further showed in table 2.

Independent Variables	Dependent Variable (Estimated VO_2Max Value)		
	r	R^2	*P value*
Physical Activity	0.461	0.212	0.0001*
Body Mass Index	-0.022	0.0001	0.809
Body Fat Percentage	-0.505	0.255	0.0001*
Energy Intake	0.272	0.074	0.002*
Protein Intake	0.217	0.047	0.017*
Fat Intake	0.179	0.032	0.049*
Carbohydrate Intake	0.273	0.075	0.002*
Vitamin B_1 Intake	0.288	0.083	0.001*
Vitamin B_2 Intake	0.253	0.064	0.005*
Vitamin C Intake	0.005	0.0001	0.957
Iron/Fe Intake	0.217	0.047	0.016*
Sleep Quality	0.103	0.011	0.257
Stress Level	0.110	0.012	0.230

**Correlation is significant at 0.05 level*

Table 2: Correlation Test Result between Independent and Dependent Variables (n=122)

Bivariate analysis (table 2) showed that there are positive significant correlation between physical activity, energy intake, protein intake, fat intake, carbohydrate intake, vitamin B_1, B_2 and Fe (Iron) intake with estimated VO_2Max value, respectively. While it showed negative significant correlation between body fat percentage with estimated VO_2Max value. Bivariate analysis also showed that there are no significant correlation between BMI, vitamin C intake, sleep quality, and stress level with estimated VO_2Max value, respectively.

Physical activity is one of the variables that is showed to have significant correlation with estimated VO_2Max value. Positive significant correlation means that higher the level of physical activity individuals have, the higher the estimated VO_2Max value individuals tend to be have. Physical activity that one's done regularly can strengthen the cardiac muscles to pumps blood throughout the body which can result in the more oxygen the body can received in one pump (Corbin, *et. al.*, 2008). Another variables which have positive significant correlation is energy and fat intake. Previous findings also showed that respondents with higher energy intake have higher fitness levels than the other with lower energy intake with significant difference (p value <0.05). More energy intake, which also affected by fat, will affect body to provides more energy while doing physical activity so it will not be disturbed and the body will not get tired easily (Corbin, *et al*., 2008).

Protein intake is also a variable that have significant correlation with estimated VO_2Max value. Protein produce haemoglobin in human body. The more protein individual's have, the more haemoglobin can be produced which can affect the oxygen circulation in the body (Katch, McArdle, dan Katch, 2011). Carbohydrate as the main source of energy when doing physical activity is also has significant correlation with estimated VO_2Max value (Kenney, Wilmore, dan Costill, 2012). Glycogen, which is produced by Carbohydrate can prevent fatigue when doing physical activity with high intensity (Kenney, Wilmore, dan Costill, 2012).

Micronutrient intake (vitamin B_1, B_2 and Iron) has positive significant correlation with estimated VO_2Max value. Vitamin B1 is needed in fat metabolic, protein metabolic, and also takes a main part in carbohydrate metabolism (Almatsier, 2009). Wardlaw stated that Vitamin B2 is on of micronutrient that can increase cardiorespiratory fitness (Komala, 2013). Iron is function as component structure of myoglobin which can store oxygen in muscle tissue (Kenney, Wilmore, dan Costill, 2012).

Body fat percentage has negative significant correlation with estimated VO_2Max value. This correlation means that the lower body fat percentage an individual has, the higher estimated VO_2Max value an individual tends to has. Excess body fat can burden the work of cardio thus disturb the oxygen pickup from muscles. The higher the body fat also result in the lower muscle mass which makes the total aerobic energy lower (Hoeger and Hoeger, 2011).

Conclusions

Positive significant correlation between physical activity, energy intake, protein intake, fat intake, carbohydrate intake, vitamin B_1, B_2 and Fe intake with estimated VO_2Max value, respectively, encourage students to increase their physical activity and micronutrient intake as well as taking care of their macro nutrient intake to make sure that those are adequate. It is also advised to do nutritional status routine check up.

Negative significant correlation between body fat percentage with estimated VO_2Max value, showed that students need to take care of their body fat percentage to not be over because the higher percentage of body fat individual has, the lower the value of estimated VO_2Max tends to be.

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