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SHORT REPORTS

Association between Physical Activity Level and Hemoglobin Concentration in Male College Students

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Abstract

Increased physical activity is useful for reducing the risk of most non communicable diseases. However, the effect of high physical activity on hematological profile is not established yet. The aim of this study is to investigate the association of physical activity and hemoglobin concentration in college students. This cross-sectional study involved 67 male students of Faculty of Medicine and Health Science, Atma Jaya Catholic University of Indonesia. The physical activity was evaluated using International Physical Activity Questionnaire (IPAQ). Hemoglobin concentration was measured using a hemoglobinometer. Anova test with LSD post hoc analysis was applied to compare the hemoglobin concentration between groups. Significance was set at $p<0.05$. There were 17 students (25.4%) with low physical activity, 20 students (29.8%) with moderate physical activity, and 30 students (44.8%) with high physical activity. The hemoglobin concentrations were 15.6g/dL in low physical activity, 14.8 g/dL in moderate physical activity, and 15.2 g/dL in high physical activity. LSD post hoc analysis showed that hemoglobin in low physical activity is significantly higher than in moderate ($p=0.027$). Students with moderate physical activity had the lowest hemoglobin concentration, and significantly lower than students with low physical activity.

Keywords: *Physical Activity Level, College Students, Hemoglobin Concentration, Anemia*

Introduction

Physical inactivity has become a major concern worldwide. A study involving large amount of participants over 15 years old, reported that about 20% did not engage in sufficient physical activity (Dumith, Hallal, Reis, & Kohl, 2011). A study in US also reported that large portion of population had insufficient amounts of physical activity (Tucker, Welk, & Beyler, 2011). Physical inactivity is also commonly found in young people. Concern is increasing due to physical inactivity is also commonly found in young people. A meta-analysis study revealed that about 40%-50% college students did not have sufficient physical activity (Keating, Guan, Piñero, & Bridges, 2005). In addition, most people spend their average of 8 hours per day taking part in sedentary behaviors (Schuna Jr, Johnson, & Tudor-Locke, 2013).

Physical inactivity raises many problems on health, especially on non-communicable diseases. Sedentary behaviors are attributed to increased risk of metabolic syndrome in young adults (Salonen et al, 2015). A study by Warren et al reported men who drove car 10 hours or more per week had a greater possibility of CVD mortality than those who drove fewer than 4 hours per week (Warren et al, 2010). Physical inactivity is also related with malignancy. Shoemaker et al reported physical inactivity as a modifiable risk factor for cancer in young adult both male and female (Shoemaker et al., 2017). Sedentary behavior is considered as the fourth highest risk factor leading to death after hypertension, tobacco use, and high blood glucose (WHO, 2018).

Otherwise, it has been reported widely the numerous advantages of increased physical activity on health. The benefits of exercise have been documented, including reducing the risk for all-cause mortality, heart disease, high blood pressure, stroke, type 2 diabetes and some cancers (Kushi et al, 2012). The effects of exercise on body's organ system are usually positive and in single form. For example, the effect of exercise on vascular system is to diminish peripheral resistance and to lower blood pressure. There has been no evident an

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inverse effect. However, exercise has a distinct effect on hematologic profile. A study by Pourghardash & Nikseresht reported that aerobic exercise increased hemoglobin (Hb) concentration and hematologic factors in young females (Pourghardash & Nikseresht, 2017). The increased Hb lead to increase oxygen carrying capacity and maximal oxygen capacity. In the other hand, Çiçek (2018) found an opposite result in his study. Exercise decreased red blood cells (RBC), hemoglobin (Hb), and hematocrit (Hct) in sedentary women (Çiçek, 2018). This conflicting result is an interesting subject to study. Thus, the purpose of this study was to find an association between level of physical activity and hemoglobin concentration.

Methods

This cross-sectional study was conducted on 67 students of Faculty of Medicine and Health Science, Atma Jaya Catholic University of Indonesia. Only male students were invited to follow the study. Exclusion criteria consisted of: tobacco use, having chronic blood diseases or other chronic diseases, consumption of blood booster vitamins or supplements as well as drugs affecting hematologic profile, and under blood administration therapy. Each participants gave their informed consent after receiving a written information. The study was approved by the ethics commission of Faculty of Medicine, Atma Jaya Catholic University of Indonesia, Jakarta, Indonesia(No: 22/12/KEP-FKUAJ/2017).

Level of physical activity was assessed by a short version of International Physical Activity Questionnaire (IPAQ). The IPAQ is applicable for people aged 15-69 years old. Subjects were asked to record their kinds of physical activity for last 7 days which is classified into vigorous, moderate, walking, and sitting. Frequency (day/week) and duration (minutes) of each classification is recorded. The intensity of physical activity is expressed in MET-minutes a week. Level of physical activity was categorized into high, moderate and low according to the scoring rule of IPAQ (Cleland, Ferguson, Ellis, & Hunter, 2018).

Hemoglobin was analysed using a portable device (Quik-Check® hemoglobinometer, London). Hemoglobinometer was calibrated prior to the study according to the factory manual handling. The device requires only 10 μL blood from peripheral capillaries. The results is obtained in 15 seconds with wide Hb measurement range of 4.5-25.6 g/dL

The numerical data was presented as mean ± standard deviation (SD) while categorical data as frequency and percentage. Anova test continued with LSD post hoc analysis was applied to evaluate Hb concentration between groups of physical activity level. Statistical analysis was processed by using the statistical package program STATA 14.2 (StataCorp, Texas, USA). P value of <0.05 was considered significant.

Results

Subjects' characteristics are presented in table 1. Most participants had high and moderate physical activity level (44.8% & 29.8%), while only 25.4% had low physical activity.

Table 1. Characteristics of the participants

Variables	Mean±SD
Age (years)	19.9±0.8
Physical activity level (MET min a week)	
Low (n=17)	346.2±205.2
Moderate (n=20)	1170.4±248.3
High (n=30)	3516.3±1271.1
Total mean	2011.6+1641.9
Hemoglobin (g/dL)	15.2±1.1

Note: MET - metabolic equivalent; Mean – arithmetic mean; SD – standard deviation

Table 2 demonstrates the distribution of participants according to the physical intensity. Subjects might be involved in more than one type of activity. There were only small numbers of students participated in vigorous activity 3 days or more (19.4%) and much smaller in moderate activity for 5 days or more in a week (3%). As many as 49.3% students reported walking more than 5 days a week.

Table 2. Physical activity level and type of activity intensity

Intensity	Frequency (%)
Level of physical activity	
Low	17 (25.4%)
Moderate	20 (29.8%)
High	30 (44.8%)
Vigorous	
No	38 (56.7%)
<3 days	16 (23.9%)
3 days or more	13 (19.4%)
Moderate	
No	42 (62.7%)
<5 days	23 (34.3%)
5 days or more	2 (3.0%)
Walking	
<5 days	34 (50.7%)
5 days or more	33 (49.3%)

The hemoglobin concentration between groups of physical activity level was compared (table 3). Anova test indicated that there was significant difference at least between two groups (p=0.04). Post hoc analysis using LSD revealed that Hb level in low physical activity was significantly higher than in moderate physical activity (p=0.027). The Hb level between low physical activity and high physical activity, and between moderate physical activity and high physical activity were not significantly different (p=0.139 and p=0.319, respectively).

Table 3. Comparison of hemoglobin level between groups

Level of physical activity	Hb concentration (g/dL)	95% CI	p
Low physical activity	15.7±1.1	15.1-16.2	.040
Moderate physical activity	14.8±1.0	14.4-15.3	
High physical activity	15.2±1.2	14.7-15.6	

Note: Hb - hemoglobin; CI - confident interval.

Discussion

Study on the effect of exercise on hemoglobin concentration is fascinating due to distinct results between studies. Researchers are challenged to conduct a study on that topic to confirm and to compare the results of previous studies. Our study also attempted to reveal the association between level of physical activity and hemoglobin concentration in male college students. The results showed that students with low physical activity had the highest Hb level and significantly higher compared to those with moderate physical activity.

The influence of exercise on Hb concentration has been hypothesized. Exercise, especially aerobic or endurance training increases red blood cells volume. However, increased Hb does not occur due to higher increased of plasma volume which also happens following exercise (Wilmore, Costill, & Kenney, 2008). Instead, increased plasma volume exceeding increased red blood cells causes a decrease in Hb, resulting in a slight reduces in hematocrit and creates a relatively lower concentration of Hb called pseudoanemia (Wilmore, Costill, & Kenney, 2008).

Many studies have shown a low Hb value due to the effect of exercise. A study by Sharpe et al (2002) reported that hematocrit values below 44% was found in more than four fifth of the female athletes and one fifth of male athletes (Sharpe et al, 2002). Heinicke et al (2001) also reported an inverse correlation between hematocrit and training status in elite athletes, in which the more trained the athletes, the lower the hematocrit. A study by Alam et al (2014) demonstrated that intense exercise could reduce the hemoglobin concentration and red blood cells volume significantly compared to the control group. Regarding the effect of type of exercise on blood profile, an investigation by Çiçek (2018) found hemoglobin, hematocrit, and red blood cells reduced significantly after strength training compared to aerobic training. Results of our study supported those previous studies. Hemoglobin concentration in subjects with moderate physical activity was significantly lower than those with low physical activity.

Some previous studies reported an opposite result. Sazvar et al investigated the effect of aerobic training three times a week for 8-weeks. The results showed that the total number of red blood cells and hemoglobin concentration increased significantly (Sazvar, Mohammadi, Nazem, & Farahpour, 2013). Results from study by Pourghadash et al also established the increased hemoglobin concentration following 8-week of aerobic exercise (Pourghardash & Nikseresht, 2017). A study in women with rheumatoid arthritis (RA) also found hemoglobin, hematocrit and red blood cells slightly increased after 8-week exercise (Shapoorabadi, Vahdatpour, Salesi, & Ramezanian, 2016). Several factors are attributed with different changes of blood profile in response to exercise. In the other hand, higher Hb concentration in high physical activity is not easily understood. Allegedly, increased Hb in those with high physical activity is related to an increase in circulating red blood cells due to splenic contraction (Piccione, Casella, Panzera, Giannetto, & Fazio, 2012).

Physical inactivity has become an important issue worldwide. The devastating consequences of inactivity and sedentary makes everyone aware of action to improve physical activity especially in young people. A complete understanding of exercise is required to minimize adverse effect of exercise. People must know the hematological change following exercise is physiological and no adverse effect on health to worry about.

Some limitations are found in this study. Dietary habit was not recorded as hemoglobin was affected by food nutrients. Other hematologic parameters were not examined as they were required to obtain a comprehensive understanding on the effect of exercise. Sample size might be too small to obtain a more reliable level of physical activity. Also, self-evaluation of physical activity is less valuable than exercise intervention in an experimental study.

In conclusion, physical activity had an association between with hemoglobin concentration in college students. We recommend performing further studies by including dietary habit and other hematologic parameters in a larger sample.

Conflicts of Interest

Authors declare there is no conflict of interest in any form.

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