

High Proportion of Vitamin D Deficiency in Male Adolescents in Yogyakarta Indonesia

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ABSTRACT

Deficiency of vitamin D in the world is high. Vitamin D deficiency has numerous negative effects. The purpose of this study was to determine the proportion of vitamin D deficiency in male adolescents in Yogyakarta Indonesia. This research is a cross-sectional study. The height, weight, physical activity, lipid profile laboratory data and vitamin D levels of subjects were recorded in the study. Body mass index (BMI) is calculated as body weight divided by height. Moderate exercise in physical is determined as enough activity for 150 minutes in week for moderate exercise and 75 minutes in week for strenuous exercise. Dyslipidaemia is diagnosed as an abnormal lipid level of three criteria: Low-Density Lipoprotein (LDL) ≥ 140 mg/dl, High-Density Lipoprotein (HDL) < 40 mg/dl, and triglyceride ≥ 150 mg/dl.

Vitamin deficiency was determined using the enzymes linked immunoassay method by measuring the activity of 25-hydroxy vitamin D using serum samples of subjects. A total of 60 male adolescents aged 19–25 years participated in the study. A total of 30 subjects (50%) had obesity with an average BMI of 29.65 kg/m². A total of 38 subjects had increased dyslipidaemia, with the highest proportion having low HDL (15%). A total of 39 subjects (65%) had had sufficient physical activity. The proportion of vitamin D deficiency was experienced by 26 subjects (43.3%) while the proportion of vitamin D insufficiency was experienced by 31 subjects (51.7%). Statistical analysis showed there was no correlation between the occurrence of vitamin D deficiency and obesity, dyslipidaemia and physical activity ($X^2 = 0.778$, $p = 0.6779$; $X^2 = 1.8$, $p = 0.4065$; $X^2 = 0.087$, $p = 0.575$). Proportion of vitamin D deficiency and insufficiency was quite high among male adolescents but not related to physical activity. Interventions are needed to treat conditions of vitamin D deficiency and insufficiency.

Keywords: *vitamin D deficiency, obesity, physical activity*

1. INTRODUCTION

The obesity prevalence continues to increase. According to research from the World Health Organisation (WHO), the obesity prevalence in 2016 was 650 million people. About 13% of young adults (>18 years) are obese. This number is three times that of 1975 [1]. The number of obesity cases is increasing in developed countries and developing countries neither. The incidence of obesity has tripled since 1980 in countries in Asia Pacific, China, Australia and the Middle East [2]. The prevalence of obesity in Southeast Asia was 1.7% in 1980 and had increased to 6.2% in 2015 [3].

Young adults are prone to obesity. According to previous studies, obesity is increasing by age from the age of 20, reaches a peak at the age of 50–65 years, then

begins to decline. Obesity is more common in men than women [3]. Data from Riset Kesehatan Dasar (Riskesdas) shows that the proportion of obesity in people aged >18 years is 21.8%. This figure has increased from 10.5% in 2007 compared to 14.8% in 2013 [4].

Obesity is caused by abnormal fat accumulation. It is assessed by BMI, which is the quotient of kilograms of body weight by the meters square of height [1]. WHO defines obesity as BMI ≥ 30 kg/m² and severe obesity as BMI ≥ 40 kg/m² [5]. However, for countries in Asia Pacific, WHO uses a limit of ≥ 25 kg/m² for obesity [6].

Vitamin D plays an important role in maintaining the balance of bone tissue, especially calcium and phosphate levels. A 1,25-dihydroxyvitamin D is active form of vitamin D, not only has a function in

maintaining the skeletal system, but also has non-skeletal functions such as reducing type 1 collagen production, maintaining muscular function, stimulating secretions of insulin, and maintaining the immune system. Vitamin D deficiency is defined as a serum concentration below 50 nmol/L or 20 ng/mL and vitamin D insufficiency is 20 – 29 ng/mL [7]. Both deficiency and insufficiency associated with several diseases. Vitamin D deficiency can cause osteoporosis in children and osteoarthritis in adulthood. In adults, low vitamin D levels can increase the risk of hypertension, diabetes, cardiovascular disease, and some types of cancer. Obese people who have low levels of vitamin D are more at risk of suffering from other diseases related to obesity. Vitamin D deficiency will lead to more severe obesity since enzymes that play a role in lipogenesis depend on vitamin D receptors [8,9].

A previous study showed that obesity in all age groups is at risk of developing vitamin D deficiency. Vitamin D deficiency in obesity is caused by several factors. The first factor is the dilution of vitamin D in fat tissue. People with obesity tend to rarely do outdoor activities, and exposure to sunlight reduces vitamin D synthesis. Lack of vitamin D intake can also lead to vitamin D deficiency. Another possible mechanism is impaired hepatic enzyme 25-hydroxylation in obesity, which interferes with the process of vitamin D synthesis [8–10].

Some studies showed that vitamin D has related to lipid profile [11,12]. As vitamin D was increases intestinal calcium absorption, it reduces intestinal fatty acid absorption then lowering cholesterol level. Vitamin D also reducing triglyceride and low-density lipoprotein level [13]. Previous studies showed that people with sufficient vitamin D supplementation tend to have higher high-density lipoprotein level [14]. However, there is no clear evidence of direct mechanism as many factors could influencing.

The aim of this study was to determine the proportion of vitamin D deficiency among male adolescents in Yogyakarta Indonesia and their correlation with obesity, lipid profile, and physical

2. METHODS

This research is a cross-sectional study. It is the third report of a study entitled ‘The Effect of Obesity on Low Physical Activity’. This research was funded by the Directorate of Research and Community Service, Directorate General of Research and Development Strengthening, Ministry of Research, Technology and Higher Education, Indonesia.

The subjects of this study were male adolescents who were categorised according their BMI based on Asia Pacific criteria. BMI was calculated by dividing body weight by height squared (kg/m^2). Underweight is defined as $\text{BMI} < 18,5 \text{ kg}/\text{m}^2$. Male with $\text{BMI} 18.5 - 22.9 \text{ kg}/\text{m}^2$ is defined as normal BMI. Male who

overweight have $\text{BMI} 23.0 - 24.9 \text{ kg}/\text{m}^2$. BMI in range $25.0 - 29.9 \text{ kg}/\text{m}^2$ is obese I and $\geq 30 \text{ kg}/\text{m}^2$ is obese II [6]. The inclusion criteria for this study were males aged 18–30 years.

Subject recruitment was carried out through open announcements on social media starting in June 2018. Data collection was carried out at the Universitas Islam Indonesia, Yogyakarta. This research was approved by the Ethics Committee of the Faculty of Medicine, Universitas Islam Indonesia and obtained ethical approval with document number 48 / Ka.Kom.Et / 70 / KE / V / 2018.

The subjects’ height and weight were measured by the nurse. Subsequently, the subjects filled out a questionnaire for exercise history and motivation. Blood was then taken from subjects to measure vitamin D levels using the enzyme linked immunoassay method. Data analysis used the Medcalc version 19.6, and $p < 0.05$ was significant result

3. RESULTS AND DISCUSSION

A total of 60 male adolescents aged 19–25 years participated in this study. None of subjects were underweight, meanwhile only 20 subjects (33,33%) with normal BMI. Most of the subjects were having $\text{BMI} > 23 \text{ kg}/\text{m}^2$. The baseline characteristics of the subjects can be seen in Table I. The mean age of the subjects was 21.5 years. The mean BMI of the subjects was $25.06 \text{ kg}/\text{m}^2$. A total of 33.34% of subjects had a frequency of exercise of 1 time/week, followed by 26.67% of subjects with a frequency of exercise of 2 times/week, 20% with 1 time/month, 13.34% with 3 times/week, and only 3.34% who exercise with a low intensity < 1 time/week and a high intensity > 3 times/week. Most of the subjects (53.34%) did exercise with a duration of 60–120 minutes, and only 11.67% of subjects exercised with a long duration of more than 120 minutes.

Physical activity is categorized to moderate exercise (150 minutes activity per week) and vigorous exercise (75 minutes per week). Based on the above definition, 65% of the subjects had had sufficient physical activity (Fig. 1). However, 35% of the subjects did not meet the criteria for sufficient physical activity.

WHO defines physical activity as body movement by skeletal muscles that requires energy [15]. People who not enough for physical activity will have higher risk factor for non-communicable diseases [16]. Data shows that 23% of the world’s population is not active enough [17]. Previous research data shows that socio-demographic factors, psychological factors and health status affect the desire for physical activity. Individual and socio-demographic factors are the most supportive of obesity [18]. In this study, 50% of the subjects had obesity; however, 35% of the subjects had not done sufficient physical activity. These results indicate that

most of the obese subjects had done sufficient physical activity.

Table 1. Baseline Characteristics

| Characteristics | Median (min-max) | N (%) |
|-----------------------------|---------------------|-------------|
| Age (years) | 21.50 (19–25) | |
| BMI (kg/m ²) | 25.06 (19.36–39.18) | |
| Underweight | | 0 |
| Normal | | 20 (33,3%) |
| Overweight | | 11 (18,3%) |
| Obese I | | 20 (33,3%) |
| Obese II | | 9 (15,0%) |
| Physical Activity Frequency | | |
| <1x/month | | 2 (3.34%) |
| 1x/month | | 12 (20.00%) |
| 1x/week | | 20 (33.34%) |
| 2x/week | | 16 (26.67%) |
| 3x/week | | 8 (13.34%) |
| >3x/week | | 2 (3.34%) |
| Physical Activity Duration | | |
| > 120 minutes | | 7 (11.67%) |
| 60–120 minutes | | 32 (53.34%) |
| 30–60 minutes | | 13 (21.67%) |
| <30 minutes | | 8 (13.34%) |

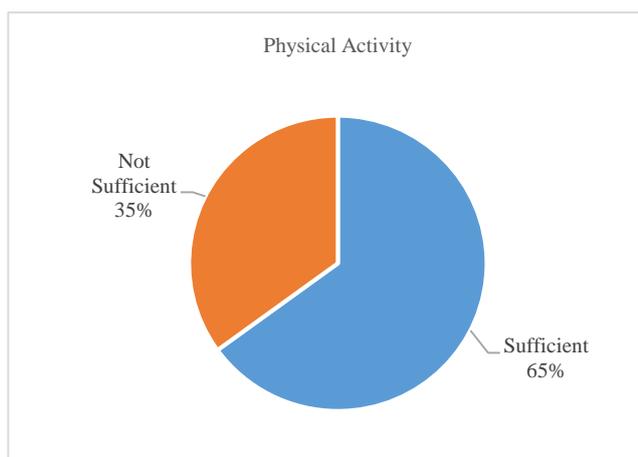


Figure 1. Physical Activity Sufficiency

From the examination of the lipid profile, the mean total cholesterol of the subjects was 180.73 mg/dl, with 26.7% of the subjects having high total cholesterol. A total of 36.7% of subjects had high triglyceride levels, with an average triglyceride level of 116.5 mg/dl. The

mean high-density lipoprotein (HDL) was 42.58 mg/dl, with 31.7% of subjects having low HDL. The mean low-density lipoprotein (LDL) was 121.75 mg/dl, with 25% of subjects experiencing an increase in LDL levels (Table II). Fig. 2 shows that 38 subjects (63%) had dyslipidaemia, with the highest proportion of subjects having low HDL (15%).

Table 2. Characteristics of Lipid Profile

| Characteristics | Mean ± SD/Median (min-max) | N (%) |
|---------------------------|----------------------------|------------|
| Total Cholesterol (mg/dl) | 180.73 ± 35.59 | |
| High | | 16 (26.7%) |
| Normal | | 44 (73.3%) |
| Triglyceride (mg/dl) | 116.50 (37–348) | |
| High | | 22 (36.7%) |
| Normal | | 38 (63.3%) |
| HDL (mg/dl) | 42.58 ± 7.06 | |
| Low | | 19 (31.7%) |
| Normal | | 41 (68.3%) |
| LDL (mg/dl) | 121.75 ± 34.17 | |
| High | | 15 (25.0%) |
| Normal | | 45 (75.0%) |

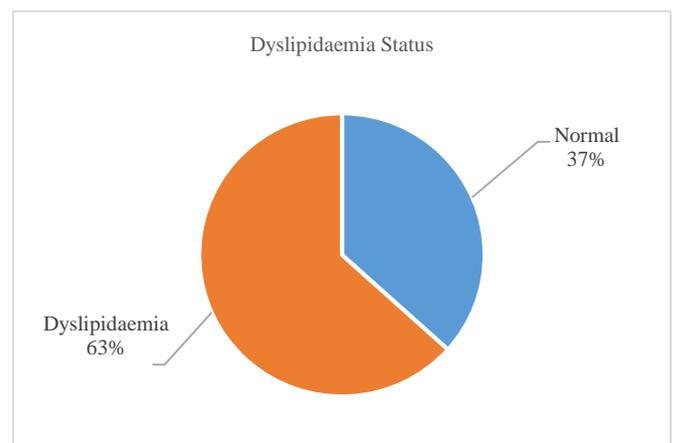


Figure 2. Dyslipidaemia status

Dyslipidaemia is defined as a group of metabolic disorders characterised by one or a combination of increased LDL cholesterol (LDL-C), increased total cholesterol, increased triglycerides, and low HDL cholesterol (HDL-C) [19]. Dyslipidaemia is a risk factor for metabolic syndrome. Research shows that subjects with dyslipidaemia have a high risk of cardiovascular events [20]. Furthermore, dyslipidaemia is closely related with the incidence of insulin resistance. This will result in worsening the metabolic process. The final effect of this combination is the failure of body metabolism [21]. The results of this study indicate that most of the subjects have dyslipidaemia. Although 65% of the subjects had carried out adequate physical activity, the number with dyslipidaemia was still high. Low HDL is associated with insulin resistance when it is associated with Apo A1. Apo A1 catabolism is

increased in diabetes mellitus patients with low HDL through the mechanism of increasing hepatic lipase activity [20].

The incidence of vitamin D deficiency was experienced by 26 subjects (43.3%) while the incidence of vitamin D insufficiency was experienced by 31 subjects (51.7%) (Fig. 3). Table III shows the results of statistical analysis using the Chi Square test. The Chi Square analysis for the incidence of vitamin D status with obesity showed no relationship ($X^2 = 0.778$, $p = 0.6779$). The result of the same analysis for the incidence of vitamin D deficiency with dyslipidaemia was $X^2 = 1.8$, $p = 0.4065$, which means there is no relationship between the two. The analysis for each component of the lipid profile also showed no relationship with vitamin D status. Furthermore, the analysis for physical activity variables showed no relationship between vitamin D status and physical activity ($X^2 = 0.087$, $p = 0.575$).

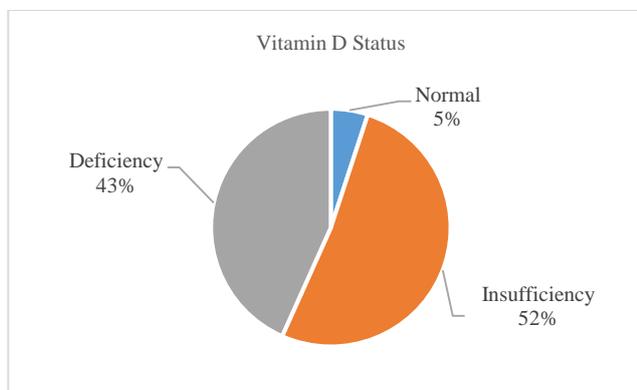


Figure 3. Vitamin D status

Tabel 3. Correlation of Vitamin D Status with BMI, Lipid Profile, and Physical Activity

| VARIABLES | X ² | p |
|-------------------|----------------|--------|
| BMI | 1,501 | 0,9594 |
| Lipid Profile | 1.8 | 0.4065 |
| Total cholesterol | 0.557 | 0.7571 |
| Triglyceride | 2.155 | 0.3405 |
| HDL | 4.267 | 0.1184 |
| LDL | 0.173 | 0.9171 |
| Physical Activity | 0.087 | 0.9575 |

Vitamin D deficiency is experienced by over a billion people worldwide. Results of previous studies showed that vitamin D deficiency occurs in 34% of the population in tropical countries. Several factors cause this high proportion, including the perception of beauty from white skin and concerns about the adverse effects of sunlight [20]. Sun exposure is a major source of vitamin D. It takes 15–20 minutes of exposure to produce sufficient vitamin D. Data from a previous study in Indonesia showed that 82.8% of pregnant women were deficient in vitamin D [22]. The existence of this deficiency condition results in important metabolic disorders of the body. Several conditions are

associated with vitamin D deficiency, including obesity, impaired immunity, and impaired growth in children [8,9,23].

Vitamin D regulates calcium metabolism and inhibits the Parathyroid hormone (PTH). It was hypothetically that as sufficient vitamin D levels, the calcium concentration increase and lower PTH secretion. Both conditions resulted in lower cholesterol and increasing lipolytic activity [12,13]. However, there is no correlation of lipid profile and vitamin D status in this study. Many factors contributing to this result such as age, outdoor activity, and physical activity types.

Results of this study indicate high proportion of vitamin D deficiency. Age, outdoor activity, and perceptions related to beauty standards may be the causes. However, the proportion of vitamin D deficiency was high in this study

4. CONCLUSIONS

The proportion of vitamin D deficiency and insufficiency was quite high among male adolescents but not related to obesity, lipid profile, and physical activity. Interventions are needed to treat conditions of vitamin D deficiency and insufficiency.

CONFLICT OF INTEREST

The authors declare that the study was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

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