ASSOCIATION OF BODY FAT THICKNESS WITH VITAMIN D LEVELS IN OBESE ADOLESCENT

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ABSTRACT Background: The number of obese people in children and adolescents is increasing. Along with that, comorbidity due to obesity will increase. One comorbid in obesity is low vitamin D levels. Obese children and adolescents with vitamin D deficiency have a higher BMI and thicker fat tissue. **Objective:** To determine the relationship between body fat thickness and vitamin D levels in obese adolescents. **Methods:** This study is an analytical cross-sectional study with the subject of obese adolescents, recruited consecutively at several junior secondary schools in the city of Denpasar from September 2016 to June 2017. Measurement of body fat thickness using Holtain Skinfold Caliper and examination of vitamin D levels with chemiluminescent immunoassay. The relationship between body fat thickness and vitamin D levels was tested using linear regression. **Result:** Thirty-three subjects analyzed had mean BMI 30.85 kg/m2 average suprailiac fat thickness is 3.62, with a standard deviation of 0.79. Mean vitamin D levels is 19.23 ng/mL, the standard deviation of 4.14 ng/mL. There was a weak negative relationship between the suprailiac body fat thickness and vitamin D levels ($r=0.390$; $p=0.025$). **Conclusion:** Body fat thickness with vitamin D levels in obese adolescent has a weak negative relationship.

KEYWORDS Adolescent obesity, Body fat thickness, Vitamin D

Introduction

World Health Organization (WHO) data in 2013 shows an increase in the number of overweight and obese children under five years old. It was reported, 20 million obese children in 2005 will increase to 42 million by 2013.[1] Based on Centers for Disease Control and Prevention (CDC) data, the percentage of adolescents aged 12 to 19 which were obese in the United States increased from 5% in 1980 to 21% by 2012.[2] According to data of Basic Health Research (Riskesdas) in 2013 overweight and obesity prevalence in adolescents in Indonesia is still high. The prevalence of overweight in adolescents aged 13-15 years is 8.3%, while the prevalence of obesity in adolescents aged 13-15 years is 2.5%. The prevalence of overweight among adolescents aged 16-18 years in Indonesia generally increases from 1.4% in 2007 to 7.3% in 2013. Bali province has a prevalence of overweight and obesity above the national prevalence for age 13-15 and 16-18 years old.[3] In 2007 the prevalence of more overweight in children age 6-14 years old in Bali was 11.8% and 8.5% for men and women respectively.[4]

Hypertension, atherosclerosis, left ventricular hypertrophy, obstructive sleep apnea, asthma, polycystic ovary syndrome, fatty liver, dyslipidemia, and metabolic syndrome are comorbidities of obesity.[5,6,7] Micronutrient deficiency often occurred in obesity, such as vitamin D, chromium, biotin, and thiamin. The malnutrition conditions of some of these nutrients are related to insulin resistance and type 2 diabetes mellitus in obesity.[8] Vitamin D deficiency in obesity is caused by lack of intake, lack of outdoor activity and sunscreen application on the skin. In obese people, there is a decrease in vitamin D bioavailability due to its

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accumulation in fatty tissue.[9] Low vitamin D levels are also caused by decreased vitamin D synthesis because of decreased intestinal absorption of vitamin D in the digestive tract of obese people. Subcutaneous fats decreased the enzymes for 25-OH vitamin D synthesis, and there is a tendency of decreased 1-α hydroxylase expression.[10]

Vitamin D plays a role in cell growth and differentiation, reducing cell risk to malignant.[11] Vitamin D receptors are found in various body tissues, including the kidneys, macrophages, brain, colon, prostate, breast. Rickettsia disease in children has long been known for lack of vitamin D levels in the patient's body. This is closely related to decreased calcium metabolism in patients with rickets. The role of vitamin D in the active form of metabolism causes vitamin D to be regarded as a hormone.[12] Low vitamin D levels are associated with increased blood pressure, arterial calcification, and the incidence of cardiovascular disease. In Alzheimer's patients found a relationship between mental status with vitamin D levels, and found no association with other vitamin levels. This is probably due to the antioxidant effect of vitamin D and its role in brain metabolism, where vitamin D receptor is also found in the hippocampus.[13]

Methods

Study Design

This was an observational analytic study with a cross-sectional study design. Performed in four junior high schools in Denpasar and implemented in September 2016-June 2017. Children with obesity checked fat thickness and 25-OH vitamin D levels. Inclusion Criteria: subjects aged 12-15 years and willing to participate in research. Exclusion Criteria: suffering from significant congenital abnormalities, suffering from genetic abnormality, suffering from hormone disorders, suffering from liver disorders, suffering from kidney disorders and got steroid, anticonvulsive, or antidepressive therapy for more than two weeks. This study was approved by the Research Ethics Committee of Udayana Medical School, Sanglah Hospital, Denpasar.

Definitions of variables

Obesity is Body Mass Index (BMI) being more than 2 SD based on the WHO BMI chart. Body Mass Index (BMI) is the ratio between body weight in kg divided by the square of height in meters (kg/m2) measurements on a numerical scale and expressed in kg/m2, with 0.1 kg/m2. Body fat thickness in adolescent obesity is body fat as measured by using callipers, expressed in numerical scale with units of millimetres (mm). Vitamin D levels are the measured 25 (OH) D level of a blood sample, expressed on a numerical scale with nanogram/ millilitre (ng/mL) units.

Statistical Analysis

Data obtained were analyzed by a computer program. Data analysis took place in several stages as follows:

1. Descriptive analysis of the basic characteristic of the nominal and numerical scale, the results are presented in the tabular and narrative form.

2. Normality test on all numerical research variables. Data distribution is said to be normal when the test results find p> 0.05. Test normality with Shapiro-Wilk.

3. The descriptive analysis aims to describe the characteristics of research samples and variables studied. Variables scaled numerical data will be displayed in the form of average (SB) or median with minimum and maximum values if the data is not normally distributed. Categorical data-scale variables will be displayed regarding relative frequency (number and percent). The results of the descriptive analysis are presented using a single distribution table.

4. Test associations between variables, using the linear regression test if the data is normally distributed, and using non-parametric regression test if not normally distributed. The correlation that was considered statistically significant was when p <0.05.

Table 1 Subject Characteristics

Variable	n=33
Age, years, mean(SD)	14,21 (0.54)
Sex, male (%)	20 (60.6)
Weight, kg, mean (SD)	77.66 (11.18)
Height, cm, mean (SD)	157.10 (8.17)
BMI, kg/m^2, median (min-max)	30.85 (26.66-39.13)
Waist circumference, cm, mean (SD)	101.77 (8.00)
Bicep skinfold thickness, cm, mean (SD)	3.00 (1.50-6.20)
Tricep skinfold thickness, cm, mean (SD)	3.49 (0.71)
Subscapular skinfold thickness, cm, mean (SD)	3.40 (0.78)
Suprailiac skinfold thickness, cm, mean (SD)	3.62 (0.79)
TSA skinfold thickness, cm, median (min-max)	3.60 (2.30-9.50)
Vitamin D level, ng/mL, mean (SD)	19.23 (4.14)
Vitamin D intake, IU, median (min-max)	133.88 (48-240)
SD: standar deviation; min: minimum; max: maximum	

Result

The research was conducted from September 2016 until the sample was fulfilled in June 2017. The research sample was obtained by searching to several junior high schools in Denpasar City using consecutive sampling method. Subjects that have been collected and meet inclusion criteria as many as 33 obese adolescents with age 13 to 15 years. In this study men subject with mean age 14,20 (s.b. 0,523) and women with mean age 14,23 (s.b. 0,599). The normality test of Shapiro-Wilk shows the results of measurement of body weight, height, abdominal circumference, tricep fat thickness, the thickness of scapular fat, the thickness of suprailiac fat, vitamin D levels in a normal distribution. The results of body mass index calculations, measurements of bone fat thickness, triceps surae area fat thickness, were not normally distributed. Most of the subjects included in the category of deficiency are 63.6%, insufficiency of 33.3% and only 3.1% included in the sufficient category. With a description of the characteristics of the subject can be seen in table 1.

Test the relationship between body fat thickness with vitamin D levels in this study using linear regression test, which showed a weak positive relationship, shown in table 2.

Table 2 Association of body fat thickness with vitamin D levels.

Variabel	r	p
Vitamin D levels	0.390	0.025
Body fat thickness (Suprailiaca skinfold)		

Discussion

Thirty-three obese teenagers ages 13 to 15 take research up to the analysis phase. The mean age of the subject is 14 years 2 months, and the results are similar to the study by Lenders et al. (2009) that is 14.9 years.[14] The proportion of male sex is obtained in greater outcomes than in women and is similar to that of obese teenagers in India by Khadgawat et al. (2012) with the proportion of men is 56.4%.[15]

Body mass index (BMI) subjects in this study obtained 30.85 kg / m2. Various results were obtained from several other studies in different regions of the world. Research by Alemzadeh et al. (2008) conducted in the United States obtained an average IMT of 37.1.16 The subjects consisted of several races, namely 38.6% Caucasian race, 30.7% Hispanic race, and Afro-American race 30.7%. A similar study conducted in India found a lower mean IMT of 29.3.15 The mean difference of BMI can be due to different racial characteristics of the subject of each study. Body mass index describes the whole of the mass-forming components of the body, so the difference in body shape and muscle component and bones are responsible for racial differences.[17,18]

Research by Ramirez-velez et al. (2016) in Columbia, at the age of 12-14.9 years of age, the limit of triceps fat thickness in obese men was 21.6 mm and the female was 24.6 mm.[19] The thickness of subscapular fat in men is 15.9 mm and 23.2 mm in women. In this research, the mean of triceps and subscapular fat thickness was 34,9 (SB 7,1) mm and 34,0 (SB 7,8) mm. The results showed that the mean body fat thickness of our study subjects was above the category limit included in obesity.

Food recall results obtained data average daily vitamin D intake on the subject of this study was 133.88 IU per day. The average vitamin D intake in this study was lower when compared to previous studies. Research by Lenders et al. (2009) obtained an average intake of vitamin D 229 + 194 IU per day.14 In this study, vitamin D intake in the deficiency group was 154 + 33 IU per day. The difference in mean vitamin D intake compared with this study may be due to differences in patterns and types of foods from the sample. Different types of foods that can affect one of them is fresh milk in packs are often given additional vitamin D. Obese people are more likely to consume foods containing fat and carbohydrates and consume fewer foods rich in vitamins.

The results of measurement of vitamin D levels in the blood obtained most of the subjects included in the category of deficiency is 63.6%, insufficient of 33.3% and only 3.1% included in the category sufficient. Harel et al. (2011) who conducted a study with obese adolescent subjects found low levels of vitamin D in women by 100% and in men by 91%. In the women, subjects found 72% had vitamin D deficiency and 28% had vitamin D levels falling under the category of insufficiency. In the subject men were 69% vitamin D deficient, 22% had vitamin D levels of insufficiency and 9% included in the sufficient category. In the study also obtained differences in mean vitamin D levels in different races. Subjects of the Caucasian race had mean vitamin D levels of 21 + 3 ng / mL, subjects that were African-American race with 18 + 1 ng / mL and subjects who were Hispanic had a mean of 17 + 2 ng / mL.[20] In our study with mature skin subjects, vitamin A levels of 19.23 ng / mL were found, which were included in the deficiency category. Differences in skin colour lead to different levels of vitamin D. The darker skin colour causes the lesser intensity of sunlight into the skin tissue, resulting in lower amounts of vitamin D synthesis in the skin.

Low levels of vitamin D in people with obesity may be caused by poor diet. Obesity diet is often more dominant consist of carbohydrates and fats. The vitamin D source of food has little role in meeting the total vitamin D requirement in the body. Low levels of vitamin D in the body are caused by low exposure to sunlight.[21] Obese people often avoid physical activity, especially outdoor activities. The low physical activity outside the house because obese people have difficulty in the activity due to excess body weight. Adolescent obesity will tend to withdraw from social intercourse because of low self-esteem, so they are more likely to dislike activities outdoors.

Fatty tissue is where the buildup of vitamin D in the body. Obese people will have fat tissue that is thicker than a normal person. Research by Wortsman et al. (2000) obtained results that despite the amount of vitamin D synthesis that did not differ between lean subjects compared to obese, obese subjects would have increased levels of vitamin D in the blood fewer after given the treatment of sun exposure and vitamin D supplementation when compared with skinny subjects.[22] As one fat-soluble vitamin, vitamin D will accumulate in fat tissue, causing the level of vitamin D in the blood will decrease. Fatty tissue not only stores vitamin D passively, but fat tissue also has a role in vitamin D metabolism. Wamberg et al. (2012) found differences in gene expression by enzymes that play a role in vitamin D metabolism among obese women compared with skinny ones.[23]

Various methods are performed to measure body fat thickness. One of the simplest and cheapest methods of measurement is the measurement of fat thickness by using calliper which can be done in several locations on the body. Research by Demura and Sato (2007) in Japan that measured at several locations of body fat thickness obtained results that the smallest error on the prediction of body density is on examination of suprailiac body fat thickness. The thickness of suprailiac body fat is found as a good predictor of body fat density, especially in obese people.[24]

The results of the analysis found a relationship between body fat thickness with vitamin D levels. Logistic regression analysis obtained p = 0.025 with r = -0.390. In this study found there is a weak relationship between body fat thickness with vitamin D levels. The reverse relationship states that if the body fat is getting thicker, the vitamin D levels will be lower. The results of this study are similar to those of Garanty-Bogacka et al. (2011) in Poland found that higher body mass, fatty tissue compositions more associated with lower vitamin D levels.[25] Research by Lenders et al. (2009) found that there was an increased risk of vitamin D deficiency of 1.78 per 1 percent increase in fat mass.[14] Other studies found no relationship between 25 (OH) D with body fat. This is likely because the subjects used are children with the risk of obesity.[9]

The weak association in this study may be due to other factors that also affect vitamin D levels in the body. Influential factors include sun exposure and vitamin D intake from food. Sun exposure is a major source of vitamin D and is considered a major factor affecting vitamin D levels.[11] Factors that affect sun exposure to the skin will affect the levels of vitamin D in the body, such as skin colour and long exposure to sunlight.

Provision of vitamin D supplementation in obese adolescents may be considered. Supplementation will be more effective to increase vitamin D levels in the body if accompanied by efforts to reduce weight. Weight loss in obese people will lead to decreased fat in the body. Intervention studies in obese children were obtained by a decrease of 1 kg / m2 IMT will be accompanied by an increase in serum 25 (OH) D level of 12.5 nmol/l.[26]

Obese people have a higher risk of developing metabolic diseases such as type 2 diabetes mellitus, cardiovascular disease, and cancer.[17,27,28,29] Obese people also have a higher risk of developing allergic diseases.[30] This may be associated with low levels of vitamin D in obese people because vitamin D is considered a hormone.31 Low levels of vitamin D can cause health problems that often occur in obese people, but this needs further investigation.

Limitation of this study is used consecutive sampling methods so it has not described the incidence of vitamin D deficiency and insufficiency. Food recall method used to determine the intake of vitamin D has a high error rate because it only uses the ability of memory of the subject of research. This study has not considered the difference in sun exposure obtained by the subject so that it can act as a confounder of research results.

Conclusion

This study proves that there is a weak negative relationship between body fat thickness and vitamin D levels in obese adolescents aged 12 to 15 years.

Conflict of Interest

Authors declare that there is no conflict of interest.

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