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The Relationship of Central Obesity to Vitamin D Levels in Medical Faculty Students of Udayana University in Year 2023

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ABSTRACT

Background: Central obesity is defined as the accumulation of excess fat in the abdomen as a result of an energy imbalance caused by genetic and environmental factors. Obesity may contribute to vitamin D deficiency (<20 ng/mL) and insufficiency (20–29.9 ng/mL). Vitamin D is an important vitamin for the body and is fat-soluble. It can be synthesized by exposure to ultraviolet B light by converting 7-dehydrocholesterol into 1,25-dihydroxyvitamin D3 through hydroxylation in the liver and kidneys and then binding to the vitamin D receptor to carry out its function. Based on previous research, the mechanism for decreasing vitamin D levels in obese people can be explained through three theories: volumetric dilution, sequestration theory, and degradation theory.

Method: The purpose of this study is to determine the relationship between central obesity and vitamin D levels in college students at the Faculty of Medicine, Udayana University, in 2023. This study used a quantitative analytical methodology with a cross-sectional design. The study's dependent variable was waist circumference, while the independent variable was vitamin D levels. A total of 60 college students (28 men and 30 women) as research subjects were taken using a purposive sampling technique. The research was carried out by selecting and collecting identity and anthropometric data on research subjects through questionnaires. Then, research subjects who meet the criteria will have their blood samples taken and their waist circumference measured. Blood samples were examined for vitamin D levels using the BT Lab brand ELISA Kit at the Biochemistry Laboratory, Faculty of Medicine, Udayana University. The research lasted for 4 months, starting in November 2023 and ending in February 2024.

Results: This research found a very weak but not significant positive correlation between body height and vitamin D levels ($r = 0.035$; $p = 0.793$). There is a very weak but not significant positive relationship between height and vitamin D levels ($r = 0.036$; $p = 0.783$). There is a very weak but not significant inverse relationship between BMI and vitamin D levels ($r = -0.034$; $p = 0.796$). In this study, there was an insignificant relationship and a very weak positive correlation between waist circumference, as an indicator of central obesity, and vitamin D levels ($r = 0.001$ and $p = 0.992$).

Conclusion: In this study, it can be concluded that there is no relationship between central obesity and vitamin D levels. Apart from that, a correlation coefficient was

obtained, which showed a very weak correlation and a directly proportional relationship.

***Key words*:** central obesity, waist circumference, vitamin D deficiency, students at the Faculty of Medicine, Udayana University

INTRODUCTION

Central obesity is defined as the accumulation of excess fat in the abdomen as a result of an energy imbalance caused by genetic and environmental factors such as poor dietary habits and a lack of physical activity. [1] According to Riskesdas, a person is considered obese if their BMI exceeds 25 kg/m and centrally obese if their abdominal circumference is above 90 cm for men and above 80 cm for women. [2] Obesity can cause various negative effects on body health, one of which is vitamin D deficiency.

Vitamin D is an essential vitamin for the human health that is fat soluble and is synthesized by the body through exposure to UVB radiation with a wavelength of 290 – 320 nm, which will convert 7-dehydrocholesterol in the skin into vitamin D3 and then undergo hydroxylation in the liver with the help of the enzyme 25-hydroxylase becomes 25-hydroxyvitamin D3 as the main metabolite in the circulation then undergoes hydroxylation in the kidneys with the help of the 1-alpha hydroxylase enzyme to become the active form 1,25-dihydroxyvitamin D3 [3] then binds to the Vitamin D receptor (VDR) [4] to carry out several important functions in the body such as calcium metabolism, maintenance of the body's skeleton, control of proliferation and differentiation, and immunity. [5]

Vitamin D deficiency may lead to various orthopedic health problems, metabolic diseases such as diabetes and hypertension, cardiovascular disease, and various immune diseases such as autoimmune diseases and infections. Vitamin D deficiency is a condition where a person's vitamin D level drops below 20 ng/mL or 50 nmol/L. The range for vitamin D insufficiency is 20–29.9 ng/mL.. Meanwhile, normal vitamin D levels range from 30-100 ng/mL. [6]

Based on previous research, the mechanism for decreasing vitamin D levels in obese people can be explained through three theories, namely volumetric dilution, Sequestration theory and degradation theory

Volumetric dilution states that in obese people, vitamin D is distributed in a larger volume, so that the concentration of vitamin D in the serum of obese people becomes lower. Even though the amount of vitamin D synthesized by obese and non-obese people is the same. [7]

Sequestration Theory states that obese people experience failure in converting pre-vitamin D into vitamin D in their skin tissue, where excess fat tissue can sequester fat-soluble vitamin D so that vitamin D cannot be released completely throughout the circulation, which causes a decrease in serum 25-hydroxyvitamin D3 levels in obese individuals. [8]

Degradation theory states that the amount of fat tissue will stimulate the infiltration of activated immune cells, causing inflammation of adipose tissue, which ultimately causes vitamin D degradation in cases of obesity. [9]

Nowadays, the prevalence of central obesity in Indonesia is getting worse. According to Riskesdas data, the prevalence of central obesity in Indonesia is continuously increasing. In 2007, the prevalence of central obesity reached 18.8%, then increased to 26.6% in 2013, and finally, in 2018, it was recorded to have increased to 31%. [2] The level of vitamin D deficiency in Indonesian society is unknown because research, surveys, and checking vitamin D levels are very rarely carried out by Indonesian society. Research on the correlation between vitamin D levels and central obesity in Indonesia is still very rare.

Based on these things, the author considers that further research needs to be carried out regarding the relationship between central obesity and vitamin D levels in Indonesia, especially in research subjects in the late

teenage age category (17–25 years) who experience central obesity.

MATERIALS & METHODS

This research used a quantitative analytical methodology with a cross-sectional study to identify the relationship between central obesity and vitamin D levels in medical faculty students at Udayana University in 2023. This research was conducted on 60 college students at the Faculty of Medicine, Udayana University, Bachelor of Medicine Study Program in 2023 (Class of 2020–2023) who have central obesity as measured by abdominal circumference (specifically, in men above 90 cm and in women above 80 cm) and who meet the study exclusion and inclusion criteria. The research sample was taken using a purposive sampling technique.

Research inclusion criteria: all medical faculty students at Udayana University in 2023; Willing to sign the informed consent sheet and willing to take part in research by having blood samples taken to test vitamin D levels. The study exclusion criteria are as follows: There are diseases that cause vitamin D deficiency, such as thyroid disease, parathyroid disease, chronic kidney failure, and chronic liver disease. There is a history of consuming anti-seizure drugs (penobarbital, phenytoin, carbamazepine), and steroids in the last month; there are infectious diseases such as tuberculosis infections and upper respiratory tract infections; there are autoimmune diseases such as systemic lupus erythematosus; and there is a consumption of vitamin D supplements.

The independent variables in this study are the size of the abdominal circumference (≥ 90 cm for men and ≥ 80 cm for women), and the dependent variable in this study is vitamin D levels. The material used in this study is a 3 cc blood sample taken from the vein of the cubital fossa of the research subject.

In this research, researchers will look for research subjects and, at the same time, collect data using a questionnaire. A questionnaire in the form of a Google Form will be distributed to all college students at the Faculty of Medicine, Udayana University, who are still actively studying in 2023. The data obtained will be used to select research subjects who meet the research exclusion and inclusion criteria. Questionnaire respondents who meet the criteria as a research sample will be contacted, and the research objectives and procedures will be explained. If they agree, the research subject will be asked to sign an informed consent as proof that they have agreed to take part in the research and are willing to have their blood sample taken. Blood samples are taken by a doctor in the vein area of the cubital fossa using a syringe. 3 cc of blood was taken and collected in a tube with a coagulant. The blood sample will then be processed at the Biochemistry Laboratory, Faculty of Medicine, Udayana University, using ELISA with a BT Lab brand reagent kit to obtain results of vitamin D levels in the blood serum.

The obtained data will then be processed and descriptively analyzed using the SPSS computer software and then analyzed with appropriate statistical tests, namely: descriptive statistical analysis to describe the characteristics of the research subjects, namely: age, gender, BMI, abdominal circumference, obesity condition, and vitamin D levels.

After that, a normality test was performed on the data to verify its normality. Since there were more than 50 samples, the Kolmogorov-Smirnov normality test was used. The relationship between vitamin D levels and obesity conditions was then examined using a correlation analysis. If the data are normally distributed, the Pearson correlation test was used for correlation. The Spearman's rho correlation test is the analysis used, though, if one or both of the variables are not normally distributed.

This research has received ethical clearance from the Research Ethics Commission of the Faculty of Medicine, Udayana University, with number 2530/UN14.2.2.VII.14/LT/ 2023.

RESULTS

This study was a cross-sectional study with 60 students of the Faculty of Medicine Udayana Undergraduate Medicine Study Program Batch (2020-2023) who experienced central obesity and met the research criteria as research subjects.

Based on the data in Table 1, 28 people (46.7%) of the research subjects were male, and 32 other people (53.3%) were female. The mean vitamin D level in men was 45.32, with an SD of 3.29. This figure is slightly higher than the average vitamin D level in women of 43.97 with SD (±3.29). The average vitamin D level among all research subjects was 44.60 ng/mL, SD (±9.31), with a median of 44.15 ng/mL, a minimum of 16.95 ng/mL, and a maximum of 64.76 ng/mL.

All research subjects had a median body weight of 70 kg, with a minimum of 54 and a maximum of 115. The average height of all research subjects was 164.92, with a standard deviation of ±8.95. The mean BMI in this study was 26.55, with a standard deviation of (±3.29). Also, the average waist circumference in this study was 91.24 with a standard deviation of (±8.33).

The normality test results revealed that body weight had an abnormal data distribution (p = 0.015), while other data such as height (p = 0.200), BMI (p = 0.062), waist circumference (p = 0.089), and vitamin D levels (p = 0.200) are normally distributed because (p value > 0.05).

Table 1. Sample Characteristics and Analysis Descriptive Research Data

Gender	**N**	**%**
Laki-laki	28	46,7
Perempuan	32	53,3
Variable	Mean(±SD)/ Median	*p*
Body Weight (kg)	70 (54-115)	0,015
Height (cm)	164,92 (±8,95)	0,200
Body Mass Index (kg/m^2)	26,55 (±3,29)	0,062
Waist Circumference (cm)	91,24 (±8,33)	0,089
Vitamin D Level (ng/mL)	44,60 (±9,31)	0,200

According to table 2, the Spearman's rho test results show a very weak positive correlation but there is no significant correlation among body weight and vitamin D levels (r = 0.035; p = 0.793).

Furthermore, the Pearson test revealed extremely weak but not significant positive relationship among height with vitamin D levels (r = 0.035; p = 0.783). However, there is a very weak but not significant negative correlation in the association involving BMI and Vitamin D levels with a value of (r = -0.034; p = 0.796).

In the end, the correlation between waist circumference and vitamin D has a very weak positive correlation but it is not significant (r = 0.001; p = 0.992).

Table 2. Relationships Anthropometrics with Vitamin D Levels

Information	***r***	***p***
Body Weight (BB)	0.035	0.793
Height (TB) *	0.036	0.783
Body Mass Index (BMI) *	-0.034	0.796
Circumference Waist (LP)*	0.001	0.992

Correlation test results Pearson

DISCUSSION

This study was a cross-sectional study with 60 students from the Udayana Faculty of Medicine, Bachelor of Medicine Study Program Batch (2020-2023), who experienced central obesity and met the research criteria as research subjects. A total of 28 (46.7%) research subjects were male, and 32 other people (53.3%) were female. Based on the research results, the average normal vitamin D level in all research subjects was 44.60 ng/mL SD (±9.31), with a median of 44.15 ng/mL, a minimum value of 16.95 ng/mL, and a maximum value of 64.76 ng/mL. The findings of this investigation align with the findings of Wang's study, which shows that women are more susceptible to vitamin D deficiency and insufficiency than men (71.9% vs. 51.9%, p < 0.001). [10]

Many factors contribute to high and low vitamin D levels, especially the amount of sun exposure received and the amount of vitamin D intake both from food and supplements consumed daily. Apart from that, other factors, such as age, medications for liver and kidney disease, and malabsorption syndrome, can also cause

vitamin D deficiency. All research subjects had a median body weight of 70 kg, with a minimum value of 54 and a maximum value of 115. Body weight data has a data distribution that is not normal, with a p-value of 0.015. Therefore, the Spearman's rho test was carried out to see the relationship between body weight and vitamin D and found a very weak positive correlation, but not significant, with a value of r = 0.035 (p = 0.793).

The average height of all research subjects was 164.92, with a standard deviation of ±8.95. This data has a normal distribution with a p-value of 0.200. The Pearson correlation test result indicated that there was a very weak but not significant positive correlation between body height and vitamin D levels, with a value of r = 0.035 and p = 0.783.

The mean BMI in this study was 26.55, with a standard deviation of (±3.29). Numerous studies demonstrate that vitamin D levels decrease with increasing BMI. A correlation test was used in this investigation to determine the correlation between vitamin D levels and BMI. According to the results of the Pearson correlation test, the correlation between BMI and vitamin D levels has a very weak but insignificant inverse correlation, with values of r = -0.034 and p = 0.796.

The results of this investigation are in line with those of the Hamza et al. study, which did not find any evidence of a significant relationship between vitamin D levels and BMI (p = 0.205). [11] Zhang's research also revealed an insignificant relationship (r = 0.004, p > 0.05) in post-menopausal female subjects. [12] Additionally, Han's research also revealed an insignificant correlation found between BMI and vitamin D in male subjects (p = 0.450) or female subjects (p = 0.077). [18] However, numerous studies also demonstrate a significant inverse correlation between vitamin D levels and BMI. One of these is a study by Ong et al. that discovered a significant inverse relationship (r = -0.31). [13] The study conducted by Zhao and colleagues also revealed a highly significant inverse relationship (ß = −0.96, 95% CI: −1.40, −0.51, p <0.001). [14] Additionally, Hermawan's study also revealed a significant inverse relationship (p = 0.008; r = -0.338). [15] The findings of this investigation are consistent with those of Zhang's study, which found a significant relationship between pre-menopausal female subjects (r = -0.159, p < 0.05) and male subjects (r = -0.350, p < 0.05). [12]

Volumetric dilution is the most probable explanation for the opposite relationship found between vitamin D levels and BMI, according to Vranic and colleagues. Despite identical levels of vitamin D synthesis in both groups, in obese subjects, vitamin D is dispersed in greater volume, so serum concentration becomes lower. [7] The Sequestration and Degradation Theory may also explain the mechanism of low vitamin D levels in obese subjects based on BMI. [9]

Central obesity is allegedly more influential as a cause of vitamin D deficiency compared to obesity based on BMI because the amount of fat tends to accumulate in the abdominal area, so the size of the abdominal circumference is considered more influential than BMI. [16] The average waist circumference in this research is 91.24, with a standard deviation of ±8.33. This figure is higher than the research conducted by Zhang et al., namely 82.79 (± 9.08) [12] and also higher than the research conducted by Afifi et al., with a mean waist circumference of 89.8 cm. [17]

The waist circumference and vitamin D levels have been found to be strongly inversely correlated in numerous prior studies. However, some research also demonstrates the opposite. [16] In this study, a correlation test was performed to analyze the relationship between vitamin D levels and waist circumference as an indicator of central obesity. The correlation test used was the Pearson test because data on vitamin D levels and waist circumference were normally distributed.

The test results show that there is a very weak positive correlation, but it is not significant, with values of r = 0.001 and p = 0.992. According to the study's results, there isn't

any significant correlation between vitamin D levels and waist circumference.

Similar to Han's research, there was an insignificant association between waist circumference and vitamin D levels in men ($p = 0.459$) or women ($p = 0.149$). Although body fat mass had a significant inverse correlation with vitamin D levels ($p < 0.001$).[18] Research by Zhang also showed an insignificant relationship in postmenopausal females ($r = 0.126$, $p > 0.05$). [12]

Many previous studies have shown that people with central obesity are more susceptible to vitamin D deficiency, such as Zahra et al., who conducted a meta-analysis of cross-sectional studies. This study found an 82% higher risk of serum vitamin D deficiency and insufficiency (<30 ng/mL) (OR: 1.82; 95% CI: 1.34, 2.49; $p < 0.001$). [16]

The research results of Nikolova et al. also show that there is a significant inverse correlation between waist circumference and vitamin D levels, with an r value of -0.231. [19] The results of Afifi et al.'s research also showed a significant inverse relationship in male central obesity subjects ($p < 0.05$, $r = -0.36$) and in pre-menopausal women ($p < 0.05$, $r = -0.90$). [17] Zhang et al.'s research also showed a significant inverse relationship between male subjects ($r = -0.310$, $p<0.05$) and pre-menopausal female subjects ($r = -1.160$, $p<0.05$). [12]

The sequestration hypothesis proposed by Wortsman et al. is the most appropriate mechanism for explaining vitamin D deficiency in centrally obese people.[20] This theory proposes that, while the production of vitamin D synthesis through the skin is the same in both groups, obese subjects have a smaller increase in plasma 25-hydroxyvitamin D3 levels right after UV radiation and oral vitamin D supplementation than normal-weight subjects. [7]

Research by Zhang et al. encouraged this theory, declaring that central obesity may be caused by increased vitamin D sequestration in the body due to increased visceral fat in people with central obesity. [12] It is caused by the characteristics of vitamin D, which is a fat-soluble vitamin that can become accumulated and stay trapped in fat tissue so that vitamin D is not released completely throughout the circulation, which ultimately causes a decrease in serum 25-hydroxyvitamin D3 levels in obese people. [7]

Apart from the volumetric dilution and sequestration theory, the degradation theory can also explain the mechanism that causes vitamin D deficiency. This theory states that a large amount of fat tissue will stimulate the infiltration of activated immune cells, which will cause inflammation of adipose tissue, which causes a degradation of vitamin D levels in cases of obesity. A negative feedback mechanism from 1,25-dihydroxyvitamin D3 is what leads to vitamin D degradation. The more T cells and B cells are activated, the higher the VDR is expressed. Simultaneously, 1 α hydroxylase is expressed by activated immune cells, enabling it to change 25-hydroxyvitamin D3 into 1,25-dihydroxyvitamin D3, which can attach to VDR for utilization locally. [9]

CONCLUSION

It can be concluded that in this study there is no significant relationship between central obesity and vitamin D levels. Apart from that, the correlation coefficient was obtained which shows a very weak correlation and a directly proportional relationship.

SUGGESTION

Based on the discussion and conclusions in this study, it is recommended that further research be carried out to see the relationship between central obesity and vitamin D levels based on gender.

Declaration by Authors

Ethical Approval: Approved by the Research Ethics Commission of the Faculty of Medicine, Udayana University with number 2530/UN14.2.2.VII.14/LT/2023.

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