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Comparison of vitamin D status and physical activity related to obesity among tertiary education students

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ABSTRACT

University students are young adults who are productive and have relatively high physical activity. Obesity is caused by imbalance between excessive food intake and low physical activity and is a risk factor for vitamin D deficiency. This research aimed to explore vitamin D status and physical activity in the obese and nonobese groups and the relationship between vitamin D status and physical activity. The research design used was cross-sectional using the International Physical Activity Questionnaire and vitamin D status questionnaires. The research location was the campus area of Surabaya and was carried out from March 2018 to January 2019. This study involved 143 respondents consisting of 71 people (49.65%) in the obese group and 72 people (50.34%) in the nonobese group. The results showed that there was a significant difference in physical activity ($p = 0.047$) and vitamin D status ($p < 0.05$) between the nonobese and obese groups. There was a significant relationship ($p < 0.05$) between vitamin D status and physical activity, although the relationship was low (correlation coefficient = 0.326). Therefore, increased physical activity can improve vitamin D status while still paying attention to other factors that affect vitamin D, such as diet and lifestyle. The condition of vitamin D also needs to be confirmed by measuring the 25(OH)D blood test.

INTRODUCTION

The World Health Organization (WHO) declared obesity a global epidemic (Jackson *et al.,* 2020; Jayawardena *et al.,* 2020). Overweight or obesity is a serious public health problem in Indonesia with a continuing increase in its prevalence (Rachmi *et al.,* 2017). Based on the results of the Basic Health Research in Indonesia (2018), it is stated that the prevalence of obesity in adults has increased since the three Riskesdas periods, i.e., by 10.5% (2007), 14.8% (2013), and 21.8% (2018) (Damayanti *et al.,* 2019). Obesity is caused by various factors including genetic, environmental, psychological, and health factors caused by the use of certain drugs and diseases, as well as factors in the development of adipose tissue (Fruh *et al.,* 2017; Panuganti *et al.,* 2021). However, the main cause of obesity is an imbalance between excessive food intake and low physical activity (Jehan *et al.,* 2020; Romieu *et al.,* 2017). Prevention of obesity can be achieved by changing lifestyle (Salam *et al.,* 2020), such as increasing physical activity by exercising diligently and maintaining a healthy diet (Elliot and Hamlin, 2018; Koehler and Drenowatz, 2019).

High physical activity can be useful in the process of preventing obesity (Jakicic *et al.,* 2019; Kim *et al.,* 2017; Lorensia *et al.,* 2021); on the other hand, low physical activity results in an increased prevalence of the risk of noncommunicable diseases such as heart disease, diabetes, and cancer (Ahmed *et al.,* 2019; Saqib *et al.,* 2020). Physical activity is defined as movement of the body by the muscles and skeleton which requires energy expenditure. There are two categories, namely moderate (moderate) and vigorous (strong) physical activity (Füzéki and Banzer, 2018; Hamer and Stamatakis, 2018). Both these types of physical activity provide health benefits and also affect vitamin D status (Skalska *et al.,* 2019; Wiciński *et al.,* 2019). A person with vigorous and moderate activity has a higher vitamin D status than a person with low physical activity (Hall *et al.,* 2018; Orces, 2019; Silva *et al.,* 2019). Vitamin D status is also seen by dietary intake of foods containing vitamin D and daily lifestyle habits

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(Larson-Meyer *et al.,* 2019; Suryadinata *et al.,* 2020; Zadka *et al.,* 2018), such as the use of sunscreen, low intake of milk (Aji *et al.,* 2019), and avoiding sun exposure which causes a decrease in the synthesis of vitamin D by the skin resulting in vitamin D deficiency (Ramasamy, 2020; Suryadinata *et al.,* 2020; Webb *et al.,* 2018).

More than one billion people worldwide are deficient in vitamin D (Sizar *et al.,* 2021). About 30%–50% of children and adults in the United Arab Emirates, Australia, Turkey, India, and Lebanon are deficient in vitamin D (Zarooni *et al.,* 2019). The risk of vitamin D deficiency can occur in dark-skinned people, elderly patients, pregnant women, babies, people who do not get enough sun exposure, and obese individuals (Sizar *et al.,* 2021; Suryadinata *et al.,* 2021; Wacker and Holick, 2013). The body can get vitamin D by consuming milk, fish and fish oil, egg yolks, liver, and yeast (Maurya and Aggarwal, 2017; Polzonetti *et al.,* 2020), exposure to sunlight, and taking vitamin D supplements (Kift *et al.,* 2018; Lee *et al.,* 2020). Vitamin D functions in the formation and maintenance of bones, so vitamin D deficiency results in bone abnormalities, namely rickets in children and osteomalacia in adults (Michigami, 2018; Takeuchi, 2018; Umar *et al.,* 2018). Vitamin D deficiency also contributes to the development of cancer, especially breast, prostate, and colon cancer as well as heart disease, stroke, and autoimmune diseases (Charoenngam and Holick, 2020; Hassanalilou *et al.,* 2017; Wang *et al.,* 2017).

Early identification of vitamin D deficiency can be used as a preventive measure related to the risk of vitamin D deficiency (Aji *et al.,* 2019; Pilz *et al.,* 2019; Sizar *et al.,* 2021). The indicators used to determine the status of vitamin D include blood tests, dietary food intake containing vitamin D (Aji *et al.,* 2019; Lorensia *et al.,* 2020a; Pilz *et al.,* 2019), and questionnaires (Bolek-Berquist *et al.,* 2009; Larson-Meyer *et al.,* 2019). Evaluation of vitamin D status using a questionnaire is easier to carry out and more economical than blood serum examination. In addition, when compared to blood tests, clinical questionnaires can be used to identify long-term vitamin D status (Aji *et al.,* 2019; Annweile *et al.,* 2017; Bolek-Berquist *et al.,* 2009). The questionnaire can be used to identify patients who are at high or low risk of experiencing vitamin D deficiency (Bolek-Berquist *et al.,* 2009). Obesity as a risk factor for vitamin D deficiency (Paschou *et al.,* 2019) needs to get prevention efforts as early as possible considering the dangers of vitamin D deficiency and low physical activity as causes of obesity which affect the development of chronic diseases and decreased quality of life (Kavadar *et al.,* 2015; Kim *et al.,* 2018; Oh *et al.,* 2017).

This study involved young adult respondents because adults were of productive age and relatively had high physical activity. However, nowadays, there are many young adults who actually experience vitamin D deficiency and rarely do physical activity (Lorensia *et al.,* 2019). This research was conducted on university students because education can affect a person's physical activity and lifestyle (Kotarska *et al.,* 2021). It was, therefore, necessary to identify vitamin D status and physical activity in obese and nonobese adults so that pharmacists can provide education to the public, both obese and nonobese adults, as a form of health workers' responsibility in early prevention efforts related to the risk of deficiency of vitamin D and other health problems.

METHODS

Research design

The design of this study was cross-sectional and was conducted on a group of students with nonobese and obese nutritional status in the campus area of the University of Surabaya. The research location chosen to conduct the research was the campus area in South Surabaya, Rungkut district, East Java, Indonesia, and the study was carried out from March 2018 to January 2019. This study was approved with Ethical Test No. 034/KE/I/2018 at Universitas Surabaya.

Research variable

The independent variable in this study was a group of obese and nonobese respondents. The dependent variables in this study were vitamin D status and physical activity. Vitamin D status can be defined as the presence of vitamin D in a certain amount in the body which was influenced by the intake of foods containing vitamin D, sun exposure, and consumption of vitamin D supplements. A person was said to be positive (+) (at risk) of vitamin D deficiency if the total answer score was ≥15 and negative (−) if the total answer score was <15. Vitamin D deficiency is a health problem related to vitamin D status. The risk of vitamin D deficiency in nonobese and obese respondents is calculated using the prevalence odds ratio equation.

Physical activity was defined as body movement by the muscles and skeleton which requires energy expenditure, including activities carried out while working, playing, doing household chores, traveling, and recreation. Physical activity in adults can be measured using the International Physical Activity Questionnaire (IPAQ) (Cleland *et al.,* 2018; Kavadar *et al.,* 2015; Sember *et al.,* 2020). This can be measured by asking seven questions related to daily activities. The data scale obtained from the measurement of physical activity was an ordinal data scale, where the results obtained from the patient questionnaire were categorized into low, medium, and high physical activity (Table 1).

Obesity was characterized by the accumulation of excess body fat tissue (De Lorenzo *et al.,* 2019). Determination of obesity status in individuals was based on the measurement of body mass index (BMI), a person's body weight (in kg) divided by the square of height (in m). The International Association for Study of Obesity Organization, International Obesity Task Force, and WHO determined the category of obesity for the Asian population if the BMI was ≥25 kg/m^2. Therefore, in this study, BMI points ≥25 kg/m^2 were used to determine the obesity category.

Population and sample

The population used in this study was all students at the University of Surabaya with a nutritional status of obesity or nonobesity. The sample used in this study was active students at the University of Surabaya with a nutritional status conditions of obesity or nonobesity who met the criteria, including 18–25-year-olds, those with no special diet (such as fasting or vegetarianism), those who did not have certain diseases like cardiovascular disorders such as angina, renal, and hepatic disorders (such as cirrhosis of the liver), and individuals who have no motoric problems. The sampling technique used was the purposive

Table 1. Guidelines for assessment of physical activity based on the IPAQ.

Type of physical activity	Description
Low physical activity	No reports of physical activity carried out
	Activities carried out not sufficient to meet the criteria for the type of moderate physical activity
Moderate physical activity (one of the three criteria)	Within 3 days or more doing high-intensity (vigorous) activity for 20 minutes per day
	Within 5 days or more doing moderate-intensity activity (moderate) or walking for 30 minutes
	Within 5 days or more doing a combination of walking, moderate-intensity activity, and vigorous activity of at least 600 MET-minute per week
High physical activity (one of the three criteria)	Performing vigorous activity for 3 days with a total MET accumulation of at least 1,500 MET-minute per week
	For 7 days or more doing a combination of walking and moderate-intensity or vigorous activity at a minimum of 3,000 MET-minute per week

Description: MET (multiples of the resting metabolic rate): the amount of energy released that is equivalent to 1 kcal/kg/hour (Cleland *et al.,* 2018; Kavadar *et al.,* 2015; Sember *et al.,* 2020).

sampling method, in which the sampling process was based on previously known characteristics or characteristics of the population and the consideration of the researcher.

Data collection methods and analysis

Measuring instruments used in the study were the vitamin D status questionnaire to identify vitamin D status and the IPAQ for physical activity data. Measurements of weight and height were carried out using a digital weight scale and a Microtoise stature meter, respectively. There were two types of questionnaires given, namely the vitamin D status questionnaire (Bolek-Berquist *et al.,* 2009; Cairncross *et al.,* 2017; Nabak *et al.,* 2014) and the IPAQ (Cleland *et al.,* 2018; Kavadar *et al.,* 2015; Sember *et al.,* 2020).

We conducted a trial or pilot study where data collection was preceded by testing the research instruments on 30 respondents. The questionnaire was validated using internal and external validity methods. Internal validity was enforced in a review step based on professional opinion judgments in the field of community pharmacy, while external validation was carried out by testing the questionnaire on the subject. Then, the results were analyzed using the Statistical Package for the Social Sciences (SPSS) version 24.0 computer program. The questionnaire was said to be valid if the value of $r_{count} > 0.361$. The questionnaire was rehabilitated using a single trial method technique with the alpha method (Cronbach), namely testing the reliability of the questionnaire once on respondents who have criteria such as research subjects, but these subjects are not used as samples. A reliability test can be carried out on valid questions. The calculation of the reliability coefficient uses the SPSS version 24.0 software. The questionnaire was declared reliable if the Cronbach's alpha value was >0.70.

Comparative analysis of the risk of vitamin D deficiency was based on vitamin D status in the obese and nonobese groups of respondents using the prevalence odds ratio. Meanwhile, differences in vitamin D status and physical activity in the obese and nonobese respondent groups used the chi-square test. We then proceeded to test the relationship between vitamin D status and physical activity in the groups of obese and nonobese respondents using a contingency coefficient.

RESULTS

The data obtained in this study were obtained through a vitamin D status questionnaire and the IPAQ. The data collection process uses instruments that are valid and reliable. Based on the data obtained, there were 143 respondents consisting of 2 groups, namely the obese group consisting of 71 people (49.65%) and the nonobese group consisting of 72 people (50.34%).

Validity and reliability of the IPAQ

The original IPAQ was available in English. The validation process was carried out by translating the questionnaire into Indonesian and then giving it to three professional judges in the field of community pharmacy. The validity was enforced in the analysis step based on the opinion of professional judges in the field of community pharmacy.

Validity and reliability of the vitamin D status questionnaire

The reliability of the questionnaire was determined based on Cronbach's alpha value. The questionnaire was declared reliable if Cronbach's alpha value was >0.60. The Cronbach's alpha value of the vitamin D status questionnaire was 0.735, so the questionnaire was declared reliable. The questionnaire validation process used the SPSS version 24.0 program. The validation process was carried out on 30 respondents. Based on the Pearson product–moment r_{table} with a significance of 0.05 with a two-sided test and the amount of data (n) = 30, it was known that r_{table} value was 0.361 so that $r_{count} > 0.361$, and it can be concluded that the questionnaire was valid.

Respondent characteristics

In this study, the respondents included were students with a stratum 1 education level with an age range of 18–25 years. Table 2 explains the distribution of respondents' age, sex, and BMI.

The results of the answers to the two groups of respondents were classified into sections regarding sun exposure

Table 2. Characteristics of respondents.

Characteristics		Nonobese group (n = 72)		Obese group (n = 71)	
		Frequency	Percentage (%)	Frequency	Percentage (%)
Gender	Male	19	26.38	38	53.52
	Female	53	73.61	33	46.47
Age (years)	18	5	7.04	6	8.33
	19	14	19.72	7	0.72
	20	17	23.94	22	30.56
	21	20	28.17	14	19.44
	22	11	15.49	15	20.83
	23	4	5.63	4	5.56
	24			3	4.17
	25			1	1.39
BMI (kg/m^2)	Thin (<18.50)	12	16.66		
	Normal (18.50–22.90)	40	55.55		
	At risk (23.00–24.90)	20	27.77		
	Obese type I (25.00–29.90)			42	59.15
	Obese type II (≥30.00)			29	40.84
History of disease[a]	Respiratory tract disorders	3	4.16	6	8.45
	Digestive tract disorders	13	18.05	9	12.67
	Blood disease	5	6.94	3	4.22
	Infectious disease	7	9.72	5	7.04
	Others	9	12.50	4	5.63
	Does not have a history of disease	45	62.50	48	67.60
History of medicine[a]	Multivitamins	7	9.72	6	8.45
	Antibiotic	3	4.16	0	0.00
	Immune system booster	3	4.16	2	2.81
	Digestive tract disorders drugs	1	1.38	2	2.81
	Others	9	12.50	9	12.67
	Does not use drugs or supplements	52	72.22	52	73.23

[a] The answer can be more than 1 in the category.

(Table 3), foods containing vitamin D (Table 4), and signs of vitamin D deficiency (Table 5).

The nonobese group had a more positive vitamin D status (≥15) (76.39%) than the obese group. At the same time, the level of activity in the nonobese group was dominated by moderate (55.55%) compared to the obese group, which was dominated by low activity levels (61.97%) (Table 6).

Based on the results of the analysis with the chi-square test to see the difference in vitamin D status between the nonobese and obese respondent groups, it was found that there was a significant difference (p-value <0.05) in the vitamin D status of the nonobese and obese groups of respondents (Table 7).

Based on the results of the analysis with the chi-square test to see the difference in physical activity between the groups of nonobese and obese respondents, it was shown that there was significant difference between the two (p-value <0.05) (Table 8).

Based on the contingency coefficient correlation test for vitamin D status and physical activity in the nonobese and obese respondent groups, the approximate significance value of 0.000 (p = 0.000) indicated that there was a significant relationship between vitamin D status and physical activity and the relationship has a correlation value of 0.326, so it can be concluded that there is a significant relationship between physical activity and vitamin D status in the nonobese and obese respondent groups, but the relationship was low or weak (Table 9).

DISCUSSION

Respondents who were involved in this study were 143 people and consisted of male sex at 39.86% (57 people) and female sex at 60.13% (86 people). The group of respondents in the category of male obesity were as many as 53.52% (38 people) and female sex as many as 46.47% (33 people) and for respondents with nonobesity categories, male respondents as many as 26.38% (19 people) and women 73.61% (53 people). Gender can affect vitamin D status; the female sex has a low vitamin status compared to the male sex (Annweiler *et al.,* 2017; AlQuaiz *et al.,* 2018; Sanghera *et al.,* 2017) due to avoiding sun exposure and dress habits are one of the main factors (Kift *et al.,* 2018; Lee and Lee, 2020) such as wearing long-sleeved shirts, long skirts, and headscarves (Judistiani *et al.,* 2019; Pulungan *et al.,* 2021). Gender

Table 3. Distribution of respondents' answers regarding length of exposure and hours of sun exposure.

Component in question			Nonobese group (*n* = 72)		Obese group (*n* = 71)	
			Frequency	Percentage (%)	Frequency	Percentage (%)
Duration of exposure and hours of sun exposure						
Duration of exposure (minute)	<15		20	27.77	21	29.57
	>15		52	72.22	50	70.42
Hours of exposure	07.00–09.00 am and 03.00–05.00 pm		35	48.61	41	57.74
	10.00–11.00 am		37	51.38	30	42.25
Use of protective equipment						
Use of protective equipment	Does not use protective equipment		5	6.94	15	21.12
	Using protective equipment[a]	Umbrella	8	11.11	8	11.26
		Hat	7	9.72	8	11.26
		Jacket	52	72.22	56	78.87
		Sunblock/sun cream	48	66.66	40	56.33
		Others (gloves, masks, etc.)	6	8.33	4	5.63
How often to use	Always or every day		46	63.88	34	47.88
	Sometimes		10	13.88	15	21.12
	Rarely		11	15.27	17	23.94
	Never		5	6.94	5	7.04
Applications use of protective equipment	When leaving the house/boarding house		34	47.22	35	49.29
	After 12 pm		28	38.88	25	35.21
	When driving		9	12.50	10	14.08
	Time at the beach		1	1.38	1	1.40
Use of closed clothing and body parts that are protected from sun exposure						
Use of closed clothing	Not wearing closed clothes		30	41.66	44	61.97
	Using closed clothes		42	58.33	27	38.02
	Description of closed clothing	Using the hijab	12	16.66	3	4.22
		Jackets and trousers	17	23.61	14	19.71
		Long sleeves and trousers	13	18.05	10	14.08
Body part covered[a]	Face		45	62.50	38	53.52
	Hand		49	68.05	45	63.38
	Sleeve		41	56.94	45	63.38
	Feet		35	48.61	30	42.25
	Back and shoulders		72	100.00	71	100.00
Use of sunblock/sun cream						
Use of sunblock/sunscreen cream	Does not use sunblock/sun cream		24	33.33	31	43.66
	Menggunakan sunblock/krim tabir surya		48	66.66	40	56.33
How often to use sunblock/sun cream	Always or every day		27	37.50	10	14.08
	Often		4	5.55	6	8.45
	Sometimes		6	8.33	9	12.67
	Rarely		11	15.27	15	21.12
Duration of use of sunblock/sunscreen cream	1–3 hours		28	38.88	28	39.43
	3–6 hours		8	11.11	4	5.63
	>6 hours		12	16.66	8	11.26
Repeated use of sunblock/sun cream in a day	No		62	86.11	67	94.36
	Yes	<4 hours	1	1.38	1	1,40
		>4 hours	9	12.50	3	4,22
Use of cosmetics containing SPF	Yes		50	69.44	38	53.52
	No		14	19.44	28	39.43
	Does not know		8	11.11	5	7.04

[a] One respondent can have more than one.

Table 4. Distribution of respondents' answers regarding foods containing vitamin D.

Component in question		Nonobese group (n = 72)		Obese group (n = 71)	
		Frequency	Percentage (%)	Frequency	Percentage (%)
Fish					
Consumption of fish in a week	Ate fish	53	73.61	47	66.19
	Did not eat fish	19	26.38	24	33.80
Type of fish consumed	Fish high in vitamin D (tuna, salmon, mackerel)	39	54.16	37	52.11
	Fish did not contain much vitamin D (salted fish, pindang, mujaer)	33	45.83	34	47.88
How the consumed fish was processed	Fried	48	66.66	50	70.42
	Burned	7	9.72	10	14.08
	Sushi	2	2.77	5	7.04
	Boiled	2	2.77	3	4.22
	Other	11	15.27	15	21.12
Where the food (fish) was acquired	Cook by myself	7	9.72	9	12.67
	Restaurant	27	37.50	40	56.33
	Catering	2	2.77	1	1.40
	Supermarket	20	27.77	16	22.53
Purpose of consuming fish	Love the taste	49	68.05	46	64.78
	Get health benefits	23	31.94	28	39.43
	Lose weight	3	4.16	6	8.45
	Price lower or more affordable	9	12.50	8	11.26
	Incidentally a fish dish available to eat	24	33.33	23	32.39
	Other	1	1.38	2	2.81
Egg and milk					
Consumption of milk (in the past 1 week)	Did not consume milk	20	27.77	25	35.21
	Consumed milk	52	72.22	46	64.78
Consumption of egg (in the past 1 week)	Did not consume egg	64	88.88	68	95.77
	Consumed egg	8	11.11	3	4.22
The portion of the egg consumed	Egg whites	9	12.50	1	1.40
	Egg yolk	0	0.00	1	1.40
	White and yellow	63	87.50	69	97.18
How the eggs consumed was processed	Fried	62	86.11	68	95.77
	Boiled	17	23.61	16	22.53
	Other	3	4.16	1	1.40
Behavior frequency of consumption of food and beverages containing vitamin D					
Egg	Often	18	25.00	29	40.84
	Rare	54	75.00	42	59.15
Fish	Often	5	6.94	5	7.04
	Rare	67	93.05	66	92.95
Milk	Often	19	26.38	21	29.57
	Rare	53	73.61	50	70.42
Behavior of consumption of fish oil and vitamin D supplements					
Consumption of fish oil	Did not consume fish oil	64	88.88	70	98.59
	Consumed fish oil	8	11.11	1	1.40
Consumption of supplements	Did not consume vitamin D supplements	52	72.22	52	73.23
	Consumed vitamin D supplements: Containing vitamin D	2	2.77	0	0.00
	Consumed vitamin D supplements: Not containing vitamin D	18	25.00	0	0.00

Table 5. Distribution of respondents' answers regarding signs of vitamin D deficiency.

Component in question	Nonobese group (n = 72)		Obese group (n = 71)	
	Frequency	Percentage (%)	Frequency	Percentage (%)
Muscle pain including lower back pain	27	37.50	30	42.25
Pain in the pelvis, back, and legs	23	31.94	28	39.43
Muscle weakness	8	11.11	10	14.08
Easy to get into a bad mood or get depressed easily	30	41.66	34	47.88
Low immunity, such as frequent colds in winter	23	31.94	26	36.61
Not at all experienced any of the conditions above	7	9.72	5	7.04

A respondent can experience more than one sign and symptom.

Table 6. Cross-tabulation of vitamin D status and physical activity in the nonobese and obese respondents.

Category		Nonobese group (n = 72)		Obese group (n = 71)	
		Frequency	Percentage (%)	Frequency	Percentage (%)
Vitamin D status (deficiency)	Negative	17	23.61	39	54.93
	Positive	55	76.39	32	45.07
Physical activity	Low physical activity	30	41.67	44	61.97
	Moderate physical activity	40	55.55	25	35.21
	High physical activity	2	2.78	2	2.82

Table 7. Risk analysis and differences test of vitamin D deficiency related to vitamin D status in nonobese and obese respondents.

Respondent group	Vitamin D status		Total	Odds ratio	Chi-square test
	Nondeficiency	Deficiency			
Nonobese (n = 72)	17	55	72	POR = 0.254 CI 95% (0.124–0.520)	p = 0.000 (p < 0.05)
Obese (n = 71)	39	32	71	Conclusion: The nonobese group had a 0.2-fold risk of vitamin D deficiency compared to the obese group	Conclusion: There were significant differences in vitamin D status in the obese and nonobese groups
Total	56	87	143		

Table 8. Risk analysis and differences test in physical activity in nonobese and obese respondents.

Respondent group	Physical activity			Total	Chi-square test
	Low	Moderate	High		
Nonobese (n = 72)	30	40	2	72	p = 0.047 (p < 0.05)
Obese (n = 71)	44	25	2	71	Conclusion: There was significant difference in physical activity in the obese and nonobese groups
Total	74	65	4	143	

Table 9. Results of analysis of the relationship between vitamin D status and physical activity.

Vitamin D status	Physical activity			Total	Correlation test
	Low	Moderate	High		
Deficiency	30	40	2	72	(p = 0.000) KK = 0.326
Nondeficiency	44	25	2	71	Conclusion: There was a significant relationship with vitamin D status and physical activity, but the relationship was low or weak
Total	74	65	4	143	

not only affects vitamin D status but also affects physical activity (Fernandes and Junior, 2017; Wiciński *et al.,* 2019). History of disease and use of drugs have a relationship with vitamin D status in the body. Certain pathological conditions, such as Crohn's disease, cystic fibrosis, celiac disease, and surgical removal of parts of the stomach or intestines that play a role in fat absorption, can trigger vitamin D deficiency. Anticonvulsant drugs are also called antiepileptic drugs. The long duration of some antiepileptic drugs, such as phenobarbital, phenytoin, and carbamazepine, and the antimicrobial agent rifampin can cause osteomalacia, which is a condition caused by vitamin D deficiency. This is triggered by the induction of 1,25-dihydroxyvitamin D catabolism (Saket *et al.,* 2021). Men tend to be more active than women, because spend more time sitting and doing activities that smell of cosmetic, Women tend to be inactive compared to men. Women spend more time sitting and doing activities that smell of cosmetic while the male sex prefers to do sports so the activities carried out are higher than women (Sharifi *et al.,* 2016).

All respondents involved in this study were aged 18–25 years and were active students. This study uses young adult respondents because based on previous research young adults are known to be at risk of vitamin D deficiency which is influenced by habits such as consumption of vitamin D below the recommended limit per day, lack of outdoor physical activity, increased use of sunblock/sunscreen cream, and low milk intake (Bolek-Berquist *et al.,* 2009). In addition to young adults, the elderly are also one of the age groups that have a low risk of vitamin D status. Low vitamin D status can cause muscle weakness (Gunton and Girgis, 2018; Sizar *et al.,* 2021) and increase the risk of fractures in the elderly (Thanapluetiwong *et al.,* 2020).

Obesity is a risk factor for vitamin D deficiency (Paschou *et al.,* 2019) based on the research by Kavadar *et al.,* (2015) that found a relationship between obesity and low vitamin D status, which has an impact on the risk of insulin resistance. The mechanism of vitamin D deficiency in obese patients is not precisely known, but several researchers have hypothesized that, related to the mechanism of vitamin D deficiency in obese patients, high fat accumulation results in a decrease in vitamin D bioavailability, where a lot of vitamin D is stored in fat cells in adipose tissue and increases vitamin D deficiency. Oxidative reactions, due to the fat-soluble nature of vitamin D, cause a decrease in the release of vitamin D from fat into the systemic circulation (Wimalawansa, 2019) in obese patients. One of the causes of obesity is excessive food intake, low physical activity (Romieu *et al.,* 2017), and lack of rest hours; besides that, there is a relationship between age and workplace characteristics on the risk of becoming obese (Hruby *et al.,* 2016). Low physical activity is found in obese people (Kim *et al.,* 2017); therefore, increasing physical activity can be used as an appropriate step to prevent the risk of obesity and weight loss (Jakicic *et al.,* 2019).

Long exposure can affect the synthesis of vitamin D by the body; an exposure time of 15 minutes can synthesize vitamin D of 10,000–25,000 IU over a large area of the body surface and is characterized by a change in skin color to pink (Suryadinata *et al.,* 2021). In this study, the results showed that, in the two groups of respondents who were obese and nonobese, those who received longer sun exposure (>15 minutes) were the nonobese group of 36.36% (52 people) compared to the obese group of 36.36% (52 people). The most dominant group with less exposure to sunlight (<15 minutes) was the obese group at as much as 14.68% (21 people) and then the nonobese group at 13.98% (20 people). One of the factors that influence the duration of exposure to vitamin D synthesis is skin type (Wacker and Holick, 2013). Different skin types affect the length of time it takes the skin to synthesize vitamin D. Dark skin type (type IV skin) requires a long exposure time of six times longer than skin type I (Wacker and Holick, 2013). This is influenced by the pigment in the skin called melanin which functions as a natural sunscreen that can block the absorption of sunlight by the skin (Solano, 2020). Asian skin is in skin type IV or V; therefore, Asian people need a longer exposure time than other skin types. The recommended exposure time is more than 15 minutes or even up to 2 hours (Webb *et al.,* 2018). Exposure time is also an important factor in the process of vitamin D synthesis (Suryadinata *et al.,* 2021). It is known from the results of this study that the highest Ultraviolet B (UVB) intensity occurs from 11.00 am to 01.00 pm (Lorensia *et al.,* 2020b). UVB rays obtained from sunlight can help the synthesis of vitamin D in the skin (Wacker *et al.,* 2013; Lee and Lee, 2020).

One source of vitamin D is fish. The highest amount of vitamin D is found in fish liver (2–477 mg/kg), a maximum of 1,200 mg/kg and depending on the type of fish (Schmid and Walther, 2013). A total of 66.19% (47 people) of the obese respondent group, who consumed fish within the past week, consumed fish with vitamin D content of 52.11% (37 people), while in the nonobese respondent group of a total of 73.61% (53 people) who consumed fish as many as 54.16% (39 people) consumed fish with vitamin D content. The obese respondent group (7.04%) and the nonobese respondent group (6.94%) often consumed fish in the last week The frequency of fish consumption can affect vitamin D status. In

Japan, fish is the main source for obtaining vitamin D (Nakamura *et al.,* 2002). The cooking process does not really affect the vitamin D content in food products because vitamin D is resistant to heat (Schmid and Walther, 2013), but the fish processing process also affects the amount of vitamin D.

Eggs are a source of vitamin D (Schmid and Walther, 2013). The obese respondents who consumed eggs were 95.77% (68 people), and the nonobese respondents who consumed eggs were 88.88% (64 people). The respondents from the obese group who often consumed eggs within 1 week were 40.84% (29 people), and the respondents from the nonobese group were 25% (18 people). Vitamin D in eggs is found in the yolk at as much as 20 IU of vitamin D3 or D2 per egg yolk (Schmid and Walther, 2013). In addition to eggs and fish, milk is also a fortification product that contains vitamin D (Lorensia *et al.,* 2020b; Schmid and Walther, 2013). Someone with low milk consumption can experience vitamin D deficiency (Bolek-Berquist *et al.*, 2009).

Based on the results of the analysis with the chi-square test, the *p*-value of 0.047 (p-value <0.05) can be concluded so it can be concluded that there is a significant difference in physical activity between the nonobese and obese groups of respondents. This is supported by evidence from previous studies which showed that there was a significant difference in physical activity in the normal group compared to the obese group, where the obese group had a longer sitting time than the nonobese group, and obesity had a significant relationship with low physical activity and physical function (Hong *et al.,* 2016).

In the analysis of the relationship between vitamin D status and physical activity using the contingency coefficient correlation test, we obtained an approximate significance value of 0.000 (*p*-value = 0.000), which indicates that there is a significant relationship between vitamin D status and physical activity and the relationship has a correlation value of 0.326. Based on the contingency coefficient table, the two variables have a low or weak relationship but are definitely related so it can be concluded that there is a relationship between vitamin D status and physical activity in the nonobese and obese respondent groups, but the relationship is low or weak. This is in accordance with previous research which showed that a person with low physical activity has a low vitamin D status (Aji *et al.,* 2019). In addition, high outdoor physical activity can increase vitamin D status (Lorensia *et al.,* 2021). Outdoor physical activity, which is in exposure to sunlight, is statistically significant in increasing vitamin D status (Lorensia *et al.,* 2020a). Therefore, physical activity and dietary intake of vitamin D should be increased in an effort to prevent vitamin D deficiency and other health problems such as metabolic risk factors (Lorensia *et al.,* 2020a). There are some limitations in this research, including the existence of variables that can affect the results of the study such as the uneven distribution of sexes between the two groups of respondents being compared, and there is no examination of serum 25(OH)D for determining vitamin D levels.

CONCLUSION

There is a significant difference in vitamin D status in the obese and nonobese groups of respondents, and there is a significant difference in physical activity in the obese and nonobese groups of respondents. In addition, there is a significant relationship between vitamin D status and physical activity, but the relationship between the two is low or weak.

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CONFLICTS OF INTEREST

The authors declare no conflicts of interest.

DATA AVAILABILITY

All data generated and analyzed are included within this research article.

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