

Relationship of Knowledge and Attitudes on Vitamin D Status in Active Smokers

Amelia Lorensia^{1*}, Marthy Meliana Ariyanti Jalnav², Eva Amilia¹, Amirah Dyandra Sybil¹

¹ Faculty of Pharmacy, Universitas Surabaya (UBAYA), Jl. Raya Kalirungkut, Surabaya 60292, Jawa Timur, Indonesia

² Universitas Kristen Petra, Jl. Siwalankerto No.121-131, Siwalankerto, Kec. Wonocolo, Surabaya 60236, Jawa Timur, Indonesia

doi <https://doi.org/10.24071/jpsc.v23i1.1077>



J. Pharm. Sci. Community, 2026, 23(1), 18-34

Article Info

Received: 2024-10-15

Revised: 2025-02-10

Accepted: 2025-07-12

***Corresponding author:**
Amelia Lorensia

email:
amelia.lorensia@gmail.com

Keywords:
Active smoker; vitamin D status; knowledge; attitude

ABSTRACT

Systemic exposure to cigarette smoke adversely affects the metabolism of vitamin D. An individual's understanding of smoking can significantly shape their attitude towards it. This study sought to explore the correlation between knowledge and attitudes regarding vitamin D levels among active smokers. This cross-sectional research was conducted in the Mejoyo area, in April-July 2023. Respondents were male active smokers who completed the questionnaire and do not have allergies to fish, eggs and milk, by using a purposive sampling technique. Respondents were asked to provide complete demographic data, and fill out a knowledge and attitude questionnaire, as well as a vitamin D status questionnaire. The relationship between knowledge, attitudes and vitamin D status was tested using chi-square tests with $p < 0.05$ as significant. The total number of respondents was 124 people. Most respondents had low level of knowledge (82.40%) and medium attitude level (92.80%). The risk of vitamin D deficiency was 54.80% and no risk of vitamin D deficiency was 45.20%. With the chi-square test, there was no significant relationship between knowledge ($p=0.173$) and attitude ($p=0.960$) related to vitamin D and the risk of vitamin D deficiency. Therefore, further research is needed on the factors that influence vitamin D by increasing knowledge and attitudes.

INTRODUCTION

There are currently 1.2 billion smokers globally, with over 800 million residing in developing nations. According to the World Health Organization (WHO), Indonesia ranks third in the world for the highest number of smokers, following China and India (Holipah *et al.*, 2020). The resulting cigarette smoke will cause local inflammation in the lungs, systemic inflammation involving several organs, systemic oxidative stress, vasomotor changes, changes in endothelial function and increased levels of several procoagulant factors (Bernard *et al.*, 2019; Rounds & Lu, 2018).

Exposure to cigarette smoke can interfere with the metabolism of vitamin D and cause harm to the renal tubules and liver. The

levels of vitamin D in the blood are linked to the parathyroid hormone (PTH) which results in impaired vitamin D metabolism, so that serum 25(OH)D levels are significantly reduced in active smokers (Mousavi *et al.*, 2019). Vitamin D can be obtained from both food sources and exposure to sunlight (Itkonen *et al.*, 2016). Several factors such as age, body mass index, sun exposure, dietary intake, and smoking behavior significantly affect an individual's vitamin D status (Santana *et al.*, 2022). The primary factors contributing to vitamin D deficiency include reduced synthesis in the skin resulting from insufficient sun exposure, advancing age, specific medications that may lower vitamin D levels, and obesity (Raymond-Lezman & Riskin, 2023). In addition, reduced concentrations of vitamin D in

the bloodstream may lead to vitamin D deficiency among smokers, as smoking can stimulate enzymes that enhance metabolic processes in the liver (Yang *et al.*, 2021; Uzrail *et al.*, 2021).

Knowledge about smoking will influence the person's attitude towards smoking. This pattern shows that a person's attitude towards smoking still depends on a person's knowledge about smoking (Trofor *et al.*, 2019). An individual possessing extensive knowledge about the health implications of smoking and the associated risks is likely to maintain a generally negative and not favorable perspective on the subject. Furthermore, the greater the understanding one has regarding smoking, the more effectively they can influence the attitudes of those in their vicinity concerning smoking and its consequences (Haq *et al.*, 2019). Based on previous research, Uzrail *et al.* (2021) regarding knowledge and attitudes towards vitamin D and Trofor *et al.* (2019) regarding knowledge and attitudes towards smokers, it can be seen that there are similar studies with this study. An individual's behavior is significantly shaped by their knowledge; as a person's understanding improves, so too does their conduct. One of the factors that causes changes in attitudes to behavior is knowledge. It can be said that before it becomes a behavior there will be a change in attitude that comes from the knowledge a person has. Knowledge and attitudes are two factors that can be observed or assessed and even possibly used for intervention (Uzrail *et al.*, 2021; Trofor *et al.*, 2019). This research aimed to see a person's understanding regarding smokers' knowledge and attitudes regarding lifestyle or living patterns, namely vitamin D intake for the body and the impacts it can have. A questionnaire was employed as a measurement tool to assess the level of knowledge and attitudes concerning vitamin D intake. This instrument specifically focused on individuals' understanding and perspectives related to vitamin D (Jamil *et al.*, 2019).

In previous research by Lee *et al.* (2015), to examine the relationship between vitamin D and smoking on inflammatory markers, vitamin D levels were used to determine the amount of vitamin D in the body, namely by taking blood samples for the concentration of 25(OH)D. The level of vitamin D in serum needed to avoid health problems ranges from 30-100 ng/mL (Amrein *et al.*, 2020). Another alternative for measuring vitamin D using blood samples is by using a questionnaire as a measurement of vitamin D status. Research from Kuwabara *et al.* (2019), in observing a simple questionnaire to

predict vitamin D deficiency in adults in Japan with a total of 649 subjects, concluded that the results of the questionnaire contained a number of questions such as age, gender, medication history, food intake and sunscreen use were relevant to previously observed serum 25(OH)D concentrations. Apart from that, research conducted by Lorensia *et al.* (2020), in observing the profile of vitamin D status, physical activity and lung health in builders also used a questionnaire as a parameter for measuring vitamin D status. The questionnaire consisted of 15 questions containing light exposure, sun, how long you get exposure to sunlight, protective equipment from the sun, use of sunscreen, cosmetics containing SPF, consumption of fish, eggs, milk, and vitamin D supplements, signs and symptoms of vitamin D (Lorensia *et al.*, 2022; Lorensia *et al.*, 2024).

The vitamin D status questionnaire used had previously been administered in a study in Indonesia and had been translated and validated from previous research by Suryadinata *et al.* (2019). The parameters for assessing vitamin D status through the questionnaire include a variety of inquiries. These encompass details regarding sun exposure, the duration of such exposure, the use of sun protection measures, application of sunscreen, and the presence of cosmetics with Sun Protection Factor (SPF). Additionally, the questionnaire addresses dietary intake of fish, eggs, and milk, along with the use of vitamin D supplements, as well as any signs and symptoms associated with vitamin D deficiency (Lorensia *et al.*, 2020). Therefore, research was conducted regarding the vitamin D status of active smokers using a questionnaire to provide initial data regarding the picture in the community and help in understanding information previously received by pharmacists which could then be used as a first step in educating the public. Based on the description of the problem formulation above, this research aims to determine the relationship between knowledge and attitudes towards vitamin D status in active smokers.

METHODS

Research Design

This quantitative research was conducted with cross-sectional methods to identify vitamin D status in active smokers. This research was conducted in the Mejoyo area, in April-July 2023 with ethical approval granted in No. Ethics 128/KE/V/2023 from the University of Surabaya.

Research Variable

The variables in this study are knowledge and attitudes regarding vitamin D, and vitamin D status in active smokers. Active smokers are people who consume cigarettes regularly, no matter how small, even if it is just one cigarette a day (Hackshaw *et al.*, 2018). Active smokers, as defined by the Centers for Disease Control and Prevention (CDC), are individuals who have smoked a minimum of 100 cigarettes throughout their lifetime and currently engage in daily smoking (United States Public Health Service Office of the Surgeon General; National Center for Chronic Disease Prevention and Health Promotion (US) Office on Smoking and Health, 2020). Smoking classification based on the Brinkman Index is divided into three categories, namely light smokers with a Brinkman Index of 0-199, moderate smokers with a Brinkman Index of 200-599, and heavy smokers with a Brinkman Index ≥ 600 (Supriyanto & Damayanti, 2023).

The knowledge questionnaire on vitamin D consists of 12 questions which contain knowledge about the relationship between bone disease and a lack of vitamin D, sources of information about vitamin D, sources of vitamin D, the best time for the body to be exposed to sunlight, parts of the body that need to be exposed to the sun, the risk of deficiency vitamin D in people who work in buildings, food sources that contain vitamin D, sunlight can help produce vitamin D in the body, the best time to be exposed to sunlight, and the length of exposure depends on skin type (Jamil *et al.*, 2019). This attitude survey towards vitamin D is to determine good or bad attitudes regarding vitamin D intake in smokers. The attitude questionnaire towards vitamin D consists of 12 questions which include bone health, the effect of sun exposure on the risk of bone disease, how often you travel or walk under direct sunlight, the length of time you are exposed to direct sunlight, lack of activities that can reduce someone's chances of getting vitamin D exposure to sunlight, use of sunscreen, need for vitamin D supplements, products fortified with vitamin D, and avoiding or not avoiding exposure to direct sunlight (Jamil *et al.*, 2019).

Vitamin D status is a condition caused by a balance between food intake and exposure to sunlight which is needed by the body for metabolism. The measurement of the vitamin D status questionnaire used was adapted based on previous research regarding sun exposure, vitamin D supplements and milk consumption, signs and symptoms of vitamin D deficiency, and foods containing vitamin D. The vitamin D status questionnaire used has previously been part of a

study conducted in Indonesia and has been translated and validated from previous research by Suryadinata *et al.* (2019) and Lorensia *et al.* (2020). The vitamin D status questionnaire consists of 15 questions and is divided into 4 categories, namely length of exposure to sunlight, consumption of foods containing vitamin D, consumption of fish oil and supplements, and signs and symptoms of vitamin D deficiency (Lorensia & Suryadinata, 2020).

Population and Sample

The population in this study was male active smokers aged ≥ 19 years in the Mejoyo area. The samples in this study were taken from the part of the population who were willing to take part in the research with proof of filling out a questionnaire and not having allergies to fish, eggs and milk. In this study, the population size for adult active smokers was 125 smokers from previous feasibility studies. In order to calculate the minimum sample size, the Slovin formula was used ($n = \text{required sample size}$; $N = \text{population size of 125 adult active smokers}$; $e = 5\% = \text{critical value of accuracy limit}$). Based on the results of these calculations, the number of respondents determined in this study is 95 respondents, so the minimum number of respondents in this study must include data of at least 95 respondents. The method of collecting respondents that will be used in this research is by using a purposive sampling technique.

Collecting Data Method

Respondents will be asked for approval to become subjects by providing Informed Consent, filling in demographic data, filling out a knowledge and attitude questionnaire, as well as a vitamin D status questionnaire. The relationship between knowledge, attitudes and vitamin D status was tested using chi-square. If the p value < 0.05 , this result means there is a significant relationship between the two variables.

Before the questionnaire can be used as a research measuring tool, it is necessary to conduct a validation test first consisting of content and construct validity assessments. Validity is a measure that shows the levels of validity or validity of an instrument. Content validity is the validity of adapting a foreign language questionnaire and then translating it into Indonesian, then giving it to three experts in the field related to the questionnaire to obtain suitability in the Indonesian context. The content contained in the questionnaire is examined to obtain a match regarding the language and

content in the questionnaire. Construct validation is validity where a questionnaire that has passed content validity will be tested on 30 potential respondents, to find out whether the questionnaire can be used in research. Reliability defines a questionnaire as a tool that can be trusted and remains consistent in providing the same results in two or more measurements with the same measuring instrument. Reliability calculations are done on questions that have been validated. Reliability figures can be calculated based on Cronbach's alpha. The questionnaire will be declared reliable or acceptable if the Cronbach's alpha value is ≥ 0.6 .

Data Analysis Method

The main method used in this descriptive research was namely by collecting quantitative data. The quantitative data in this research was analyzed using the Statistical Package for Social Sciences (SPSS) Version 29 program (IBM Corp., Chicago, USA). Data were collected on the level of knowledge and attitudes of active smokers regarding vitamin D among active smokers. The data obtained from the questionnaire were analyzed by giving a score for each question from the knowledge and attitude questionnaire about vitamin D. The score category for the answers given to each question from the questionnaire: High=75-100% (9 questions correct); Moderate=51-74% (7-8 questions correct); Less=10-50% (1-6 questions correct). In the knowledge questionnaire, each number will be given a value. Correct answer=1; Wrong answer and do not know=0. Maximum value was if all correct = 12. In the attitude questionnaire, each number was assessed using a Likert scale with 5 answers ranging from 'strongly disagree' to 'strongly agree'. Scores were given on a scale of 1-5 with a higher score for positive attitude answers. Maximum value was if all correct=60. Data on vitamin D status in active smokers were analyzed from each question for answers that are non-deficiency were given a score of 0 while answers that are deficient were given a score of 1. The total score of answers from respondents was then analyzed descriptively using SPSS 29 to determine the median cut-off point value.

RESULTS AND DISCUSSION

Validity and reliability test data for Knowledge and Attitudes Regarding Vitamin D questionnaire

The validity and reliability test of the vitamin D status questionnaire in this study was taken from the journal Suryadinata *et al.* (2019) which was validated and is reliable for all

questions from four categories. The validity test in this research was done by filling out a questionnaire by 35 people with the same criteria as the sample. Based on the results of the validity test, it can be concluded that there are 10 valid questions and 2 invalid questions because $r_{\text{count}} < r_{\text{table}} (0.334)$. The questionnaire items in this study were tested for reliability, namely there were 10 valid questions that had previously been tested for validity. A reliability test can be said to be reliable if the Cronbach's Alpha value is ≥ 0.6 . The questionnaire questions in this questionnaire can be said to be reliable because they have a Cronbach's Alpha i value of 0.741 (Table 1). The validity test in this research was done by filling out a questionnaire by 35 people with the same criteria as the sample. Based on the results of the validity test, it can be concluded that there are 10 valid questions and 2 invalid questions because $r_{\text{count}} < r_{\text{table}} (0.334)$. The questionnaire questions in this study were tested for reliability, namely the number of valid questions that had previously been tested for validity. A reliability test can be said to be reliable if the Cronbach's Alpha value is ≥ 0.6 . The questionnaire questions in this questionnaire can be said to be reliable because they have a Cronbach's Alpha i value of 0.631 (Table 1). All questionnaire knowledge questions that are answered correctly were given a value of 1 point, and if they were wrong and do not know, they were given a value of 0. Furthermore, the respondents' answers were divided into three categories consisting of high, moderate, and less.

Validity and reliability test data for Vitamin D Status questionnaire

The validity and reliability tests of the vitamin D status questionnaire in this study were taken from the research conducted by Suryadinata *et al.* (2019) which was validated and considered reliable for all questions from four categories.

Respondent Characteristics

Data collection was conducted from April-July 2023 in the Mejoyo area by respondents filling in a questionnaire to measure vitamin D status. One respondent met the exclusion criteria, namely being allergic to fish and eggs so they did not consume them at all. A total of 124 respondents met the research inclusion requirements and were willing to complete the informed consent form and questionnaires. The largest number of respondents were adults with an age range of 19-44 years, as many as 66 respondents (53.23%). In terms of body mass

Table 1. Results of Knowledge and Attitude Validity Tests About Vitamin D

Results Test Validity Knowledge About Vitamin D					
Domain	No.	Question	r _{count}	r _{table}	Information
Vitamin D	1	Bone disease is related to osteoporosis with a lack of vitamin D.	0.412	0.334	Valid
	2	Vitamin D can be produced from sunlight .	0.364	0.334	Valid
Sun Exposure	3	In Indonesia, the ideal time for the body to be exposed to sunlight is before the hour 10 a.m.	0.475	0.334	Valid
	4	The face is the only part of the body which needs exposure to sunlight.	0.403	0.334	Valid
	5	Persons with dark skin require more time to produce vitamin D from sunlight compared to people with skin which is brighter (white).	0.282*	0.334	Invalid
	6	Persons working in a building have low risk to be lacking in vitamin D.	0.128*	0.334	Invalid
	7	Using a sun veil is enough to prevent entry of sunlight into the skin.	0.767	0.334	Valid
Source of vitamins D	8	Fish with high fat content such as salmon, tuna, and sardines are included in food sources which contain vitamin D.	0.690	0.334	Valid
	9	Egg yolks are not a food source which contains vitamin D.	0.669	0.334	Valid
	10	Vegetables are included in food sources which contain vitamin D.	0.571	0.334	Valid
	11	Milk products are included in examples of drinks which are enriched by vitamin D.	0.556	0.334	Valid
	12	Cod fish heart oil is not an example of a supplement which contains vitamin D.	0.370	0.334	Valid
Results Test Validity Attitudes About Vitamin D					
Domain	No.	Question	r _{count}	r _{table}	Information
Bone health	1	Osteoporosis is a serious bone disease.	0.394	0.334	Valid
	2	I still have time to improve my bone health status.	0.490	0.334	Valid
Sun Exposure	3	Sun exposure can reduce risk of osteoporosis.	0.155*	0.334	Invalid
	4	We need to dry our body in sunlight every day.	0.538	0.334	Valid
	5	Urbanization (moving from village to city) can reduce opportunities for exposure to sunlight .	0.497	0.334	Valid
	6	Public recreation parks reduce opportunities to be exposed to sunlight.	0.383	0.334	Valid
	7	Lack of campaigns that focus on the benefits of sunlight hinder production of vitamin D which the body needs.	0.393	0.334	Valid
	8	With work all day inside a building you can prevent the production of vitamin D needed by the body.	0.321*	0.334	Invalid
	9	Doing work inside the house instead of outdoors reduces exposure to sunlight.	0.524	0.334	Valid
	10	Use of sunscreen and hat shield must be applied every time before outside activities, even if only for a short time .	0.627	0.334	Valid
Vitamin D	11	Supplements with vitamin D are only necessary if a person's sunlight exposure is low.	0.491	0.334	Valid
	12	Prices of milk enriched with vitamin D are considered expensive.	0.372	0.334	Valid

Information: *) Invalid if r_{count} < r_{table}

index (BMI) characteristics, the highest number of respondents was those with normal BMI, with 55 respondents (44.35%). In the disease history table above, the same results were obtained for respondents, namely 3 respondents (2.42%) for

hypertension, dyslipidemia and type 2 diabetes mellitus (Table 2). Based on Table 2, the highest number of respondents smoked cigarettes ≥ 10 years, namely 90 respondents (72.58%), while the highest number of cigarettes smoked was in

the range 11-24, namely 60 respondents (48.38%). The degree of Brinkman index was highest in light smokers with as many as 57 respondents (46.00%).

Knowledge and Attitude Profile Regarding Vitamin D

Based on **Table 3**, in the knowledge profile about vitamin D, it can be concluded that the domain "vitamin D" was the one that most respondents could answer correctly. With the following results in question no. 1, there were 52.42% who answered correctly and in question no. 2, those who answered correctly were as much as 63.71%. Meanwhile, the question with the fewest correct answers was number 3 with only 4.84% correct answers. In the attitude profile about vitamin D, the question that was most agreed upon by respondents was number 4 in the domain "sun exposure" as much as 73.39%. Meanwhile, the question most respondents disagreed with was number 9 in the same domain, as much as 26.61%.

Based on **Table 4**, it can be inferred that the area with the highest knowledge regarding vitamin D is "vitamin D" itself, with a percentage of 44.00%. Conversely, the area with the least knowledge was "sun exposure," which stands at 0.80%. Overall, the data indicated that a significant majority of respondents, specifically 82.40%, possess a low level of knowledge. In terms of attitudes towards vitamin D, the domain reflecting the highest level of attitude was "bone health," recorded at 60.80%. In contrast, both "sun exposure" and the overall "total attitude"

are at the lowest level, each at 4.80%. The total attitude assessment reveals that a predominant 92.80% of respondents exhibit a medium level of attitude.

In the "vitamin D" domain, the majority of respondents answered correctly, 52.42% and 63.71% (**Table 3**). This result is different from previous research by Lorensia *et al.* (2020c) from 118 smokers who worked as construction workers. Most respondents did not know much about vitamin D (67.80%), and did not know that the sun is the biggest source of vitamin D (72.88%). However, this research is similar to respondents who have chronic respiratory diseases, such as by Lorensia *et al.* (2019), of 26 patients with asthma, the majority of respondents had received information about vitamin D as much as 92.31%, which was generally obtained at school (61.54%) and family (26.92%). Most respondents understood that the sun is the largest source of vitamin D (73.08%), and vitamin D provides benefits for bone structure (80.77%). Vitamin D plays an important role in maintaining calcium homeostasis, namely by increasing calcium absorption in the intestines and mobilizing calcium from bones in conditions of inadequate calcium intake. An adequate amount of calcium is very important to maintain calcium balance and is a protective factor against osteoporosis. Adequate vitamin D is important for bone health and optimal function of body organs and tissues (Rebelos *et al.*, 2023; Khammissa *et al.*, 2018).

Table 2. Frequency Distribution of Respondents Characteristic

Respondent Characteristics	Frequency (n=124)	Percentage (%)	
Age (Years)	Adults (19-44)	66	53.23
	Pre-elderly (45- 59)	46	37.10
	Elderly (60 and above)	12	9.68
Body Mass Index (BMI) (Haam <i>et al.</i> , 2023)	Underweight (<18.5)	11	8.87
	Normal body weight (18.5-22.9)	55	44.35
	Overweight with risks (23-24.9)	17	13.71
	Obesity 1 (25-29.9)	35	28.23
	Obesity 2 (≥ 30)	6	4.84
Disease History	Hypertension	3	2.42
	Dyslipidemia	3	2.42
	Type 2 Diabetes Mellitus	3	2.42
	Rheumatoid Arthritis	1	0.81
	No disease history	114	91.94
Length of time smoking cigarettes (years) (Pleasants <i>et al.</i> , 2020)	<10	34	27.42
	≥10	90	72.58
Number of cigarettes smoked (rods) (Hrabovsky <i>et al.</i> , 2019)	1-10 per day	50	40.32
	11-24 per day	60	48.39
	More than 24 per day	14	11.29
Brinkman Index (Herath <i>et al.</i> , 2022)	Light smoker (0-199)	57	45.97
	Medium smoker (200-600)	53	42.74

Table 3. Profile of Knowledge and Attitudes Regarding Vitamin D Intake of Respondents

Profile Knowledge about Vitamin D								
Domain	No	Statement	Total respondents answered (n=124)					
			Correct		Wrong/Not know			
			Frequency	Percentage (%)	Frequency	Percentage (%)		
Vitamin D	1	Bone diseases such as osteoporosis are associated with a lack of vitamin D.	65	52.42	59	47.58		
	2	Vitamin D can be produced from sunlight.	79	63.71	45	36.29		
Sun Exposure	3	In Indonesia, the ideal time for the body to be exposed to sunlight is before 10'clock in the morning.	6	4.84	118	95.16		
	4	The face is the only part of the body that needs to be exposed to sunlight.	35	28.23	89	71.77		
	7	Use enough sun protection to prevent direct sunlight exposure on the skin.	36	29.03	88	70.97		
Source of vitamin D	8	Fish with high fat content such as salmon, tuna, and sardines are food sources which contain vitamin D.	43	34.68	81	65.32		
	9	Egg yolks are not a food source which contains vitamins D.	44	35.48	80	64.52		
	10	Vegetables are included in food sources which contain vitamin D.	9	7.26	115	92.74		
	11	Milk products are examples of drinks which are enriched by vitamin D.	52	41.94	72	58.06		
	12	Cod fish heart oil is not an example of a supplement which contains vitamin D.	30	24.19	94	75.81		
Profile Knowledge About Vitamin D								
Domain	No	Statement	Total respondents answered (n=124)					
			Agree-Strongly Agree		Do not know		Don't agree-Strongly Disagree	
			Frequency	Percentage (%)	Frequency	Percentage (%)	Frequency	Percentage (%)
Bone health	1	Osteoporosis is a serious bone disease.	81	65.32	41	33.06	2	1.61
	2	I still have time to improve my bone health status.	87	70.16	32	25.81	5	4.03
Sun Exposure	4	We need exposure to sunlight every day.	91	73.39	22	17.74	11	8.87
	5	Urbanization (moving from village to city) can reduce opportunities for sunlight exposure.	37	29.84	61	49.19	26	20.97
	6	Public recreation parks reduce opportunities to be exposed to sunlight.	35	28.23	61	49.19	28	22.58
	7	Lack of campaigns that focus on the benefits of sunlight hinder production of vitamin D which the body needs.	61	49.19	53	42.74	10	8.06
	9	Doing work inside the house instead of outdoors reduces exposure to sunlight.	33	26.61	47	37.90	44	35.48
	10	Use of sunscreen protection must be done every time before activities, even if only for a short time.	34	27.42	72	58.06	18	14.52
Vitamin D	11	Supplements with vitamin D are only necessary if exposure to sunlight is low.	46	37.10	60	48.39	18	14.52
	12	Prices of milk enriched with vitamin D are considered expensive.	40	32.26	72	58.06	12	9.68

Table 4. Classification Level of Respondents' Knowledge and Attitudes Regarding Vitamin D

	Domain	Level Category Knowledge					
		Good (75-100%)		Medium (51-74%)		Poor (10-50%)	
		n	Percent age (%)	n	Percent age (%)	n	Percent age (%)
Knowledge related to Vitamin D	Vitamin D	55	44.35	0	0	69	55.65
	Sun exposure	1	0.81	17	13.71	106	85.48
	Source vitamin D	12	9.68	18	14.52	94	75.81
	Total Knowledge	3	2.42	19	15.32	102	82.26
Attitudes related to Vitamin D	Bone health	76	61.29	47	37.90	1	0.81
	Sun exposure	6	4.84	97	78.23	21	16.94
	Vitamin D	9	7.26	85	68.55	30	24.19
	Total Attitude	6	4.84	116	93.55	2	1.61

In the "sun exposure" domain, the majority of respondents had a low level of knowledge, as many as 85.60% (Table 4). The optimal period for the body to receive sunlight exposure is between 10:00 AM and 2:00 PM, with the duration tailored to individual skin types. During this timeframe, the intensity of ultraviolet B (UVB) rays surpasses that of ultraviolet A (UVA) rays. After 2:00 PM, the proportion of UVA rays increases significantly. UVA rays are known to inflict prolonged skin damage as they penetrate deeper into the skin compared to UVB rays. They can adversely affect the DNA within dermal cells, compromise cell membranes, and alter the proteins responsible for collagen and elastin production, which are essential for maintaining the skin's structural integrity. This degeneration can lead to skin laxity and the formation of wrinkles. Furthermore, UVA exposure is associated with an increased risk of developing skin cancer. The body needs exposure to sunlight but it should not be too frequent or too long (Lorensia *et al.*, 2019; Lorensia and Suryadinata, 2020). The parts of the body that can increase the synthesis of vitamin D in the skin by exposure to sunlight are the areas of the skin on the face and the back of both hands, which are equivalent to an area of 600 cm². As well as areas of facial skin, the back of both hands, shoulders or back are photosensitive, and several parts of the arms or legs which are equivalent to an area of 1200 cm² (Lorensia *et al.*, 2019; Lorensia and Suryadinata, 2020).

In the "source of vitamin D" domain, most respondents had a low level of knowledge, as many as 76.00% (Table 4). This finding is similar to previous research by Lorensia *et al.* (2023), out of 30 students in health sector, the results showed that the almost all of respondents had a good level of knowledge about vitamin D (97.00%). They understand that the source of vitamin D is the sun (77.00%) and food (such as

vegetables (4.00%), meat (7.00%)), and vitamin supplements (4.00%). Vitamin D is the only type of vitamin produced by the body. UVB rays on the skin that come from exposure to sunlight will be synthesized when body heat converts previtamin D, namely 7-dehydrocholesterol, which is distributed throughout the body into a more active final form. If there are other factors that can limit maximum exposure to sunlight on the skin, this will greatly affect vitamin D production. The body's need for vitamin D can be met by 80-100% by vitamin D which is synthesized in the skin when exposed to direct sunlight (Raymond-Lezman and Riskin, 2023).

In the "bone health" domain, the majority of respondents had a low attitude level of 60.80% (Table 4). This result is similar to previous research by Lorensia *et al.* (2024), of the 52 adults, the majority of respondents had a low attitude towards vitamin D, as many as 98.08%. Most subjects with asthma had unfavorable attitudes (96.15%), and all non-asthmatic subjects had unfavorable attitudes. Bone density disorders or osteoporosis is a major health problem caused by many factors. Osteoporosis is a disease characterized by low bone mass and deterioration of bone tissue, causing increased fragility and risk of bone fractures. This bone density disorder often appears without any real symptoms and is only realized after the fracture, or what is known as the 'silent disease' (Sözen *et al.*, 2017). The attitude towards this question was considered good as seen from the large number of respondents who answered strongly agree/agree, which could be due to someone's personal experience with this matter, where they know that osteoporosis is a serious bone disease. Apart from that, the influence of other people on a person can cause a person's attitude to believe that osteoporosis is a serious bone disease. Bone mass will decrease over time. The risk of osteoporosis increases with age, after passing the

peak bone mass formation, bones will experience a decrease in bone density. Bone mass begins to decrease in the early 30s with a small amount of reduction in trabecular bone in the spine (Sözen *et al.*, 2017; Voulgaridou *et al.*, 2023). By being exposed to sunlight, consuming foods that contain vitamin D and taking vitamin D supplements can prevent deterioration in bone health (Lorensia and Suryadinata, 2020).

In the "sun exposure" domain, the majority of respondents had a medium attitude level of 77.60% (Table 4). Adults who live in rural areas have higher exposure to sunlight compared to adults who live in urban areas. Based on previous research conducted by Nagelhout *et al.* (2021) regarding sun exposure in rural and urban areas, the results showed that rural adults in this study were more likely to work outdoors or in motorized vehicles (compared to indoors), which may explain the higher dose of midday sun exposure. The high level of sun exposure obtained can also be caused by types of outdoor activities (e.g., outdoor work, outdoor recreational activities) and attitudinal factors (e.g., feeling more attractive when sunbathing) which may differ between rural and urban residents. The attitude to this question was rated as moderate, which can be seen from the number of respondents who answered that they did not know, which could be due to a person's personal experience with this matter, where a person's move from the village to the city can result in reduced opportunities for exposure to the sun. Additionally, mass media such as newspapers or other communication media can also influence a person's attitude, where news that should be delivered factually is delivered objectively, the lack of information provided means that there are still many people who do not know about this news. Apart from that, the influence of other people on a person can cause a person's attitude to believe that urbanization will reduce their exposure to sunlight.

In the "vitamin D" domain, the majority of respondents had a medium attitude level of 68.00% (Table 4). Many people avoid direct exposure to the sun, doing work outside the home can increase the opportunity to be exposed to sunlight, even if only briefly. Exposure to sunlight cannot penetrate the skin when the skin is supposed to form vitamin D, but many people avoid direct sunlight. The best duration of sun exposure is 15 minutes to 2 hours per day depending on skin type. Doing more physical activity can help make movement easier, keep the body's muscles loose (flexible) and the joints functioning well (Lorensia and Suryadinata, 2020).

Cross Tabulation of Knowledge and Attitudes

Based on Table 5, the results of the cross tabulation of total knowledge with total attitudes which have the highest frequency are in the poor knowledge category with 95 respondents (76.00%) with moderate attitudes. The results of the chi-square test are used to see the relationship between total knowledge and total attitudes. The results of the cross tabulation between total knowledge and total attitude in the chi-square test were obtained asymp values. The results of the chi-square test are considered invalid because the expected frequency is less than 5 or cannot be more than 20% on categories, so the Fisher exact test was used. The sig is 0.935 (>0.05) which proves that there was no significant relationship between knowledge and attitudes related to vitamin D.

From the information below the table, it can be seen that this assumption is not met because there are 7 cells (77.8%) that have an expected frequency below five and the lowest expected frequency was 0.07. Accordingly, it can be said that the chi-square test cannot clearly see the relationship between knowledge and attitudes based on the table above.

Table 5. Cross tabulation of Total Knowledge with Total Attitudes

Total Knowledge	Total Attitude						TOTAL	Fisher test (p value)	
	High (100%-75%)		Moderate (74%-51%)		Less (50%-10%)				
	n	Percent age (%)	n	Percent age (%)	n	Percent age (%)			
High (100%-75%)	0	0.00	3	2.41	0	0.00	3	2.41	0.935*
Moderate (74%- 51%)	1	0.81	18	14.52	0	0.00	19	15.32	
Less (50%-10%)	5	4.03	95	76.61	2	1.61	102	82.26	
Total	6	4.84	116	93.55	2	1.61			

*If p value > 0.05, this result means there was no significant relationship between the two groups.

Table 6. Distribution Profile of Answers to the Vitamin D Status Questionnaire Among Respondents

No.	Question	Answer	Frequency (n=124)	Percentage (%)
1.	What time do you usually get direct sunlight?	07.00-09.00	67	54.03
		10.00-11.00	32	25.80
		12.00-14.00	19	15.32
		15.00-17.00	6	4.83
2.	Do you use skin protection equipment (umbrella, hat, jacket, sunscreen cream, etc.) from direct sun exposure?	Yes	115	92.74
		No	9	7.25
3.	What skin protective equipment do you use (There can be more than one answer)	Umbrella	3	2.41
		Hat	77	62.09
		Jacket	69	55.64
		Sun block / sunscreen	7	5.64
		Other	5	4.03
4.	How often do you use skin protection equipment in question no. 3 ?	Every day	18	14.51
		Sometimes	69	55.64
		Seldom	28	22.58
		Never	9	7.25
5.	Do you usually wear closed clothes, such as long-sleeved shirts and trousers every day?	Yes	84	67.74
		No	40	32.25
6.	Which parts of the body do you want to protect from direct sunlight with the protective equipment you chose in question no. 3 ? (there can be more than one answer)	Face	68	54.83
		Hand	18	14.51
		Arm	23	18.54
		Foot	4	3.22
		Back & shoulders	51	41.12
		Whole body	16	12.90
		Never	9	7.25
7.	Do you use cosmetic products (facial moisturizer, body and <i>body cream</i>), powder etc. with SPF content?	Yes	12	9.68
		No	112	90.32
8.	Do the cosmetics you use contain UVA and UVB protection?	Yes	12	9.68
		No	112	90.32
9.	Have you consumed fish in the last week?	Yes	103	83.06
		No	21	16.94
10.	Have you consumed fish in the last week? (there can be more than one answer)	Love the taste	48	38.71
		Get health benefits	27	21.77
		Diet to reduce weight	6	4.83
		The price is cheaper/more affordable	16	12.90
		Coincidentally fish dishes were available to eat	49	39.51
11.	Have you consumed milk in the last week?	Yes	74	59.67
		No	50	40.32
12.	Have you consumed eggs in the last week?	Yes	117	94.35
		No	7	5.65
13.	Do you consume fish oil?	Yes	7	5.65
		No	117	94.35
14.	Do you take supplements?	Yes	29	23.39
		No	95	76.61
15.	Have you ever experienced this condition? (there can be more than one answer)	Muscle pain included lower back pain	75	60.48
		Pain in the hips, back and legs	63	50.81
		Muscle weakness	26	20.96
		Easily experiencing bad moods or depression	10	8.06
		Low immunity such as frequent colds in winter	33	26.61

The results of this research are comparable with previous research by Jamil *et al.* (2019). The results were that 44.89% had good knowledge of sun exposure and vitamin D intake, in the moderate category it was 29.25%, and in the poor category it was 25.85%. The lowest knowledge score was on the question 'vegetables are a food source of vitamin D' as much as 50.30%. So, the difference is that the percentage in the bad category in this study is higher than in the comparison study, while in the good category and the moderate category in this study it is lower than in the comparison study. The next difference lies in the research area, because each region has a different culture and habits, and the sample in this study is also different. The next results are compared with previous research by Lorensia *et al.* (2020b) is based on the sample studied, the comparison research sample was students related to obesity, while in this study the sample was male active smokers. The next difference lies in the research area, because each region has a different culture and habits.

The attitude of active smokers that has been obtained in this research is mostly in the medium category, namely with 26-37 correct questions amounting to (74%-51%), which is 116 out of 125 respondents and has a percentage of 92.80%. The second highest number was in the good category, namely with ≥ 38 correct questions of (100%-75%), which was 6 out of 125 respondents and had a percentage of 4.80%. In this study, it was said that the average attitude regarding vitamin D intake among active smokers was moderate because many of the respondents' attitudes lacked knowledge and did not know questions related to vitamin D, so that education could be provided from the relevant health service regarding vitamin D which was expected to be followed by holding outreach activities. can improve respondents' attitudes regarding vitamin D for the body. The results of

this research are compared with previous research by Jamil *et al.* (2019), the results were that 76.19% had a moderate attitude towards sun exposure and vitamin D intake, in the good category there were 23.80%, and there were no respondents in the bad category. The next difference lies in the research area, because each region has a different culture and habits, and the sample in this study is also different. The next results are compared with previous research by Lorensia *et al.* (2020b) is based on the sample studied, the comparison research sample was students related to obesity, while in this study the sample was male active smokers.

Vitamin D Status Profile

The instrument for measuring vitamin D in this research uses a questionnaire consisting of 15 questions which are categorized into 4 categories, namely length of exposure to sunlight, consumption of foods containing vitamin D, consumption of fish oil and supplements, as well as signs and symptoms of vitamin D deficiency (Table 6).

The results of the frequency and percentage of vitamin D status in active smokers are in **Table 7** which states that in the group who were at risk of vitamin D deficiency, there were 68 people (54.80%) and those with no risk of vitamin D deficiency were 56 people (45.20%). Respondents who did not have a vitamin D deficiency obtained an average of 8.98 with a minimum value of 1 and a maximum value of 11. Meanwhile, for respondents who were at risk of vitamin D deficiency, the average was 13.40 with a minimum value of 12 and a maximum value of 17. Determining the vitamin D status of respondents was carried out based on looking at the median cut-off point value from the respondent data, where the categorization was done by looking at the median data from active

Table 7. Categories of Vitamin D Status among Respondents

Vitamin D status categories	Assess vitamin D status	Active smokers (n=124) n (%)	Total Knowledge			Total Attitude			Chi-square test (p value)
			High (75-100%)	Moderate (51-74%)	Less (10-50%)	High (75-100%)	Moderate (51-74%)	Less (10-50%)	
Has no risk of vitamin D deficiency	<12	56 (45.16)	1 (0.80)	5 (4.03)	50 (40.32)	3 (2.42)	52 (41.94)	1 (0.80)	0.173*
Has risk of vitamin D deficiency	≥ 12	68 (54.84)	2 (1.61)	14 (11.29)	52 (41.94)	3 (2.42)	64 (51.61)	1 (0.80)	
Total			3 (2.42)	19 (15.32)	102 (82.26)	6 (4.84)	116 (93.55)	2 (1.61)	

*If p value > 0.05 , this result means there was no significant relationship between the two groups.

smoker respondents as shown in the tables. The total question score was divided into 2 categories, namely having no risk of deficiency (total score <12) and having a risk of deficiency (total score ≥12).

The first question is about what time they usually get direct exposure to sunlight. The most answers were at 07.00-09.00 WIB as much as 54.03%. The best time to get sun exposure is from 10.00 WIB to 14.00 WIB. During these hours, UVB and UVA sunlight can stimulate human skin to produce vitamin D. If exposure to sunlight is less than 10.00 or more than 14.00, the body will not get enough vitamin D so that human skin synthesizes little vitamin D. The time of exposure is one of the important factors in the synthesis of vitamin D. Research was done on elderly women in Jakarta, Indonesia (6° south latitude), building upon prior studies. The participants were exposed to sunlight from 07:00 to 16:00 WIB, and a UV meter was utilized to measure the minimum erythral dose (MED) values on an hourly basis. The findings revealed that the peak UVB intensity was recorded between 11:00 and 13:00 WIB in the afternoon. The UVB radiation derived from sunlight plays a crucial role in facilitating the synthesis of vitamin D within the skin (Lorensia and Suryadinata, 2020).

The next question is about whether they use skin protection equipment (umbrella, hat, jacket, sunscreen cream, etc.) from direct exposure to sunlight. Active smoker respondents who answered "yes" used skin protective equipment as much as 92.74%. Meanwhile, the types of leather protective equipment that are most widely used are hats at 62.09% and jackets at 55.64%. Based on theory, it is stated that individuals who avoid sun exposure, including using sunscreen, hats and umbrellas, are at risk of vitamin D deficiency. Using skin protective equipment is not a problem, but it is better to let your face get sun exposure 3 times a week to get enough vitamin D. (Raymond-Lezman and Riskin, 2023).

Regarding the questions about wearing closed clothing, many respondents used closed clothing every day as much as 67.74%. Descriptions of the closed clothing used include jackets, trousers and long-sleeved shirts. People who tend to wear closed clothes are at risk of having low vitamin D status. Wearing short-sleeved clothes is better than long-sleeved clothes because it leaves enough face and arms to help vitamin D synthesis (Al-Yatama *et al.*, 2019). Prevention of vitamin D deficiency can be done

by allowing the body to be exposed to direct sunlight for 15-20 minutes with a minimum of 40% of the skin surface exposed to sunlight. Based on Holick's rules regarding exposure to sunlight for 25 minutes, 3 times a week at 09.00 in the morning can meet the body's vitamin D needs (Lorensia and Suryadinata, 2020).

Regarding the questions about the part of the body to be protected, the most common answer from respondents regarding the part of the body that is protected was the face at 54.83%, followed by the back and shoulders at 41.12%. This result is because in everyday life the average respondent wears skin protective equipment such as hats and jackets. According to previous research from Chalcraft *et al.* (2020), exposing the face and arms to sunlight can increase vitamin D synthesis in the skin. Questions about using cosmetic products containing Sun Protection Factor (SPF). Respondents who used cosmetic products with SPF content were 9.68%. Cosmetic products containing SPF 8 can reduce previtamin D3 by 93% while SPF 15 is 99%. Regular use of sunblock can significantly reduce vitamin D production in the skin. Using good sunscreen is giving 15 minutes without using sunscreen on the face and arms every day, which is enough to maintain vitamin D (Lorensia and Suryadinata, 2020). The use of SPF sunscreens is a means of protecting the skin from UVB rays. When the SPF value increases, protection from UVB rays also increases. Although the use of sunblock will have a risk of low vitamin D status, infrequent use will have little impact on reducing vitamin D synthesis in the skin (Raymond-Lezman and Riskin, 2023).

Regarding the question about whether in the last week, they consumed fish, many respondents had consumed fish in the last week as many as 83.06%. Fish is the main source for obtaining vitamin D. The average daily intake of vitamin D obtained from fish is 7.10 g (284 IU), around 70% of the recommended amount of vitamin D consumption, namely (400 IU) and fish provides a contribution of 90.7% of total vitamin D intake, so frequent fish intake can be recommended in an effort to prevent vitamin D deficiency. Several types of fish that contain vitamin D are fatty fish such as tuna, salmon, eel, mackerel, sardines, and cod. Apart from those, there are also tilapia, catfish, tilapia, snapper, gourami, mullet, salted fish, and shrimp (Lorensia and Suryadinata, 2020). The amount of vitamin D in fish does not change if the fish is grilled, but the frying process with cooking oil can reduce the amount of vitamin D in fish by

50% due to the fat-soluble nature of vitamin D. Fish consumption among Indonesians is very varied, and many Indonesians are more likely to consume meat, chicken, tempeh and tofu (Sridonpai *et al.*, 2022).

Respondents who drank milk were 59.67%. The type of milk that is good for consumption is fortified milk. In Indonesia, fortified milk is usually available in ready-to-drink liquid packaged milk. However, drinking milk alone is not enough to be a source of vitamin D, because each glass of fortified milk contains 100 IU of vitamin D. Fortification is a process of adding one or more certain micronutrients (vitamins, and minerals) to improve the nutritional status of people's health. The protein contained in milk has a positive relationship with bone mass and bone density (Lorensia and Suryadinata, 2020).

Respondents who consumed eggs were 94.35%. Eggs are a source of protein that is rich in vitamin D. The vitamin D content in egg yolks is 279 IU per 67 grams. Eggs contain several ingredients, in the form of zinc, selenium, retinol and tocopherol. One of the biggest benefits of eggs is that they are antioxidants which can protect a person from degenerative diseases including cardiovascular disease. Apart from fried and boiled, many Indonesians also consume eggs processed with STMJ (milk, eggs (raw), honey and ginger) (Lorensia and Suryadinata, 2020).

Consumption of vitamin D supplements among respondents was only 23.29%. If vitamin D intake is insufficient and exposure to sunlight is insufficient, prevention of vitamin D deficiency can be done by consuming vitamin D supplements in the active form of 400-600 IU/day for ages 19-50 years. Meanwhile, if the laboratory test results confirm that you have a vitamin D deficiency or therapy is needed to increase serum 25(OH)D to above 30ng/mL, then you need to consume 1500 IU-2000 IU/day of vitamin D (Contreras-Bolívar *et al.*, 2021). Providing vitamin D supplements is also justified for individuals who are not at risk of vitamin D deficiency but have inadequate nutritional intake and sun exposure. In severe vitamin D deficiency (<10ng/ml), it is recommended to prescribe a loading dose of 50,000 IU of oral vitamin D for 8 weeks (Lorensia and Suryadinata, 2020).

Cross Tabulation of Knowledge-Attitudes and Vitamin D status

Based on Table 7, the results of the chi-square test are used to see the relationship between total knowledge and total attitudes with

vitamin D status. The results of the cross tabulation between total knowledge and vitamin D status in the chi-square test were obtained asymp values. The sig is 0.173 (>0.05) which proves that there was no significant relationship between knowledge related vitamin D and vitamin D status. The results of the cross tabulation between total attitude and vitamin D status in the chi-square test were obtained asymp values. The sig is 0.960 (>0.05) which proves that there was no significant relationship between attitude related vitamin D and vitamin D status. The results of the chi-square test are considered invalid because the expected frequency is less than 5 or cannot be more than 20% on categories.

The measurement of vitamin D status uses a questionnaire that assesses the respondent's lifestyle in the form of food intake containing vitamin D and exposure to sunlight. The results of the research showed that 68 (54.80%) respondents were at risk of vitamin D deficiency and 56 (45.20%) respondents were at no risk of vitamin D deficiency. This research is in accordance with that conducted by Nwosu and Nji (2018) in the United States of America which stated that exposure to cigarette smoke was a determining factor in the incidence of vitamin D deficiency after controlling for age, race, gender, BMI, education and socioeconomic status.

Cigarettes affect vitamin D metabolism through changes in gene expression and influence nutritional intake of vitamin D (Yang *et al.*, 2021). Cigarette smoke containing nicotine will enter 25% of the blood circulation and brain in approximately 15 seconds. Then, nicotine will be received by nicotinic receptors which will trigger the release of hormones and neurotransmitters, some of which are leptin, which triggers a decrease in appetite (Calarco *et al.*, 2020). Modification of taste in smokers also causes smokers to prefer certain foods. Smokers more often consume instant foods, high in sugar, meat and alcohol. As many as 20-50% of smokers experience deficiencies in calcium folate, magnesium, vitamins A, D and K and more than 50% experience deficiencies in fiber, potassium and vitamin E (Ma and Lee, 2023). There are several factors that can influence a decrease in vitamin D status, including:

1. Reduced synthesis of vitamin D may result from various factors, such as having darker skin, the application of sunscreen, wearing covered clothing, and engaging in activities in shaded areas or indoors. Skin pigmentation is a significant element influencing the body's natural production

of vitamin D. The darker a person's skin color, the longer it takes to form vitamin D compared to individuals with lighter skin. How someone dresses is also a factor in vitamin D synthesis. There are significant differences in vitamin D synthesis between UVB exposure in all parts of the body compared to only the face, hands and arms (Webb *et al.*, 2018).

2. Medical conditions are associated with vitamin D deficiency, including chronic kidney disorders, obesity, use of anticonvulsant drugs, fat malabsorption, and pregnancy. Patients with stage 4 and 5 chronic kidney disease who require dialysis have a risk of reducing the ability to synthesize 1,25-dihydroxyvitamin D. Furthermore, obesity is a factor in vitamin D deficiency (Christodoulou *et al.*, 2021). Each increase in BMI is associated with a decrease in vitamin D in the body by 1.25%. This pattern is because vitamin D is a fat-soluble vitamin. Therefore, it can be stored in adipose tissue thereby reducing vitamin D levels in the blood. A number of studies have proven that obese people tend to be more at risk because obese people have a larger body mass and accumulate fat, so that a lot of vitamin D is dissolved and stored in adipose tissue, resulting in less vitamin D being synthesized and released into the systemic circulation than in other people with non-obese subjects (Karampela *et al.*, 2021; Lorensia and Suryadinata, 2020).

CONCLUSIONS

Most respondents had a low level of knowledge regarding vitamin D and a moderate level of attitude regarding vitamin D. Most respondents also had a risk level of vitamin D deficiency status. The study found no substantial correlation between knowledge and attitudes concerning vitamin D, nor was there a significant relationship between knowledge and attitudes regarding vitamin D and vitamin D deficiency.

ACKNOWLEDGEMENTS

This research was funded by Institute of Research and Community Service by Universitas Surabaya.

CONFLICT OF INTEREST

The authors declare no conflict of interest.

REFERENCES

- Al-Yatama, F.I., AlOtaibi, F., Al-Bader, M.D., Al-Shoumer, K.A. 2019. The effect of clothing on vitamin D status, bone turnover markers, and bone mineral density in young Kuwaiti females. *Int J Endocrinol*, 2019, 6794837. doi: [10.1155/2019/6794837](https://doi.org/10.1155/2019/6794837)
- Amrein, K., Scherkl, M., Hoffmann, M., Neuwersch-Sommeregger, S., Köstenberger, M., Tmava-Berisha, A., Martucci, G., Pilz, S., Malle, O. 2020. Vitamin D deficiency 2.0: an update on the current status worldwide. *Eur J Clin Nutr*, 74(11), 1498–513. doi: [10.1038/s41430-020-0558-y](https://doi.org/10.1038/s41430-020-0558-y)
- Bernard, A., Ku, J.M., Vlahos, R., Miller, A.A. 2019. Cigarette smoke extract exacerbates hyperpermeability of cerebral endothelial cells after oxygen glucose deprivation and reoxygenation. *Sci Rep*, 9(1), 15573. doi: [10.1038/s41598-019-51728-2](https://doi.org/10.1038/s41598-019-51728-2)
- Calarco, C.A., Picciotto, M.R. 2020. Nicotinic acetylcholine receptor signaling in the hypothalamus: Mechanisms related to nicotine's effects on food intake. *Nicotine Tob Res*, 22(2), 152–63. doi: [10.1093/ntr/ntz010](https://doi.org/10.1093/ntr/ntz010)
- Chalcraft, J.R., Cardinal, L.M., Wechsler, P.J., Hollis, B.W., Gerow, K.G., Alexander, B.M., Keith, J.F., Larson-Meyer, D.E. 2020. Vitamin D synthesis following a single bout of sun exposure in older and younger men and women. *Nutrients*, 12(8), 2237. doi: [10.3390/nu12082237](https://doi.org/10.3390/nu12082237)
- Christodoulou, M., Aspray, T.J., Schoenmakers, I. 2021. Vitamin D supplementation for patients with chronic kidney disease: A systematic review and meta-analyses of trials investigating the response to supplementation and an overview of guidelines. *Calcif Tissue Int*, 109(2), 157–78. doi: [10.1007/s00223-021-00844-1](https://doi.org/10.1007/s00223-021-00844-1)
- Contreras-Bolívar, V., García-Fontana, B., García-Fontana, C., Muñoz-Torres, M. 2021. Mechanisms involved in the relationship between vitamin D and insulin resistance: Impact on clinical practice. *Nutrients*, 13(10), 3491. doi: [10.3390/nu13103491](https://doi.org/10.3390/nu13103491)
- Haam, J.H., Kim, B.T., Kim, E.M., Kwon, H., Kang, J.H., Park, J.H., Kim, K.K., Rhee, S.Y., Kim, Y.H., Lee, K.Y. 2023. Diagnosis of obesity: 2022 update of clinical practice guidelines for obesity by the Korean Society for the Study of Obesity. *J Obes Metab Syndr*, 32(2), 121–9. doi: [10.7570/jomes23031](https://doi.org/10.7570/jomes23031)

- Hackshaw, A., Morris, J.K., Boniface, S., Tang, J.L., Milenković, D. 2018. Low cigarette consumption and risk of coronary heart disease and stroke: Meta-analysis of 141 cohort studies in 55 study reports. *BMJ*, 360, j5855. <https://doi.org/10.1136/bmj.j5855>
- Haq, I.U., Liu, Y., Liu, M., Xu, H., Wang, H., Liu, C., Zeb, F., Jiang, P., Wu, X., Tian, Y., Li, M., Li, Q., Fu, J., Shen, C., Feng, Q. 2019. Association of smoking-related Knowledge, Attitude, and Practices (KAP) with nutritional status and diet quality: A cross-sectional study in China. *Biomed Res Int*, 2019, 5897478. doi: [10.1155/2019/5897478](https://doi.org/10.1155/2019/5897478)
- Herath, P., Wimalasekera, S., Amarasekara, T., Fernando, M., Turale, S. 2022. Effect of cigarette smoking on smoking biomarkers, blood pressure and blood lipid levels among Sri Lankan male smokers. *Postgrad Med J*, 98(1165), 848–54. doi: [10.1136/postgradmedj-2021-141016](https://doi.org/10.1136/postgradmedj-2021-141016)
- Holipah, H., Sulistomo, H.W., Maharani, A. 2020. Tobacco smoking and risk of all-cause mortality in Indonesia. *PLoS ONE*, 15(12), e0242558. doi: [10.1371/journal.pone.0242558](https://doi.org/10.1371/journal.pone.0242558)
- Hrabovsky, S.M., Midya, V., Lester, C., Veldheer, S., Yingst, J.M., Allen, S.I., Krebs, N.M., Liao, J., Reinhart, L., Modesto, J., Evins, A.E., Richie, J.P., Muscat, J.E., Horn, K., Foulds, J. 2019. Effect of cigarette rod length on smokers switching to SPECTRUM cigarettes. *Am J Health Behav*, 43(2), 380–92. doi: [10.5993/AJHB.43.2.14](https://doi.org/10.5993/AJHB.43.2.14)
- Itkonen, S.T., Skaffari, E., Saaristo, P., Saarnio, E.M., Erkkola, M., Jakobsen, J., Cashman, K.D., Lamberg-Allardt, C. 2016. Effects of vitamin D2-fortified bread v. supplementation with vitamin D2 or D3 on serum 25-hydroxyvitamin D metabolites: an 8-week randomised-controlled trial in young adult Finnish women. *Br J Nutr*, 115(7), 1232–9. doi: [10.1017/S0007114516000192](https://doi.org/10.1017/S0007114516000192)
- Jamil, N.A., Shahudin, N.N., Abdul-Aziz, N.S., Qi, C.J., Aminuddin, W.A.A.W., Ludin, A.F.M., Chin, K.Y., Abd-Manaf, Z., Mat-Daud, N. 2019. Knowledge, Attitude and Practice related to vitamin D and its relationship with vitamin D status among Malay female office workers. *Int J Environ Res Public Health*, 16(23), 4735. doi: [10.3390/ijerph16234735](https://doi.org/10.3390/ijerph16234735)
- Karampela, I., Sakelliou, A., Vallianou, N., Christodoulatos, G.S., Magkos, F., Dalamaga, M. 2021. Vitamin D and obesity: Current evidence and controversies. *Curr Obes Rep*, 10(2), 162–80. doi: [10.1007/s13679-021-00433-1](https://doi.org/10.1007/s13679-021-00433-1)
- Khammissa, R.A.G., Fourie, J., Motswaledi, M.H., Ballyram, R., Lemmer, J., Feller, L. 2018. The biological activities of vitamin D and its receptor in relation to calcium and bone homeostasis, cancer, immune and cardiovascular systems, skin biology, and oral health. *Biomed Res Int*, 2018, 9276380. doi: [10.1155/2018/9276380](https://doi.org/10.1155/2018/9276380)
- Kuwabara, A., Tsugawa, N., Mizuno, K., Ogasawara, H., Watanabe, Y., Tanaka, K. 2019. A simple questionnaire for the prediction of vitamin D deficiency in Japanese adults (Vitamin D Deficiency questionnaire for Japanese: VDDQ-J). *J Bone Miner Metab*, 37(5), 854–63. doi: [10.1007/s00774-018-0984-2](https://doi.org/10.1007/s00774-018-0984-2)
- Lee, H., Kim, K.N., Lim, Y.H., Hong, Y.C. 2015. Interaction of vitamin D and smoking on inflammatory markers in the urban elderly. *J Prev Med Public Health*, 48(5), 249–56. <https://doi.org/10.3961/jpmph.15.042>
- Lorensia, A., Suryadinata, R.V., Inu, I.A. 2022. Comparison of vitamin D status and physical activity related to obesity among tertiary education students. *Journal of Applied Pharmaceutical Science*, 12(4), 108–18. doi: [10.7324/JAPS.2022.120412](https://doi.org/10.7324/JAPS.2022.120412)
- Lorensia, A., Suryadinata, R.V., Rahmawati, R.K., Septiani, R. 2024. The effect of smoking habit on vitamin D status in adults in Indonesia. *KEMAS*, 19(3), 410–21. <https://doi.org/10.15294/kemas.v19i3.46823>
- Lorensia, A., Suryadinata, R.V., Chandra, N.L.M.R. 2020a. Profil status vitamin D, aktivitas fisik dan kesehatan paru pada Tukang Bangunan. *CoMPHI Journal: Community Medicine and Public Health of Indonesia Journal*, 1(2), 117–24. <https://doi.org/10.37148/comphijournal.v1i2.19>
- Lorensia, A., Suryadinata, R.V. 2020. Mengenal Peran Vitamin D untuk Sistem Pernafasan. Fakultas Farmasi Universitas Surabaya, Surabaya.
- Lorensia, A., Suryadinata, R.V., Amir, G.A. 2019. Relation between vitamin D level and knowledge and attitude towards sunlight exposure among asthma outpatients in Surabaya [Hubungan Kadar Vitamin D

- terhadap Tingkat Pengetahuan dan Sikap Mengenai Paparan Sinar Matahari pada Pasien Asma Rawat Jalan di Surabaya]. *Global Medical & Health Communication*, 7(3), 162–9. <https://doi.org/10.29313/gmhc.v7i3.3094>
- Lorensia, A., Raharjo, D.N., Gandawari, N. 2020b. Pengaruh pengetahuan-sikap mengenai vitamin D terkait obesitas pada mahasiswa. *Jurnal Ilmiah Ibnu Sina*, 5(1), 72–86. <https://doi.org/10.36387/jiis.v5i1.388>
- Lorensia, A., Suryadinata, R.V., Suryandi, T. 2020c. Knowledge-attitude about toward sunlight exposure and lung function in construction workers. *FARMASAINS*, 5(2), 77–84. doi: [10.22219/farmasains.v5i2.13927](https://doi.org/10.22219/farmasains.v5i2.13927)
- Lorensia, A., Mahmudah, R.L., Naim, M., Raharjo, D.N. 2023. Effect of education on knowledge and attitude level related to vitamin D in pharmacy students. *J. Trop. Pharm. Chem*, 7(2), 123–32. <https://doi.org/10.30872/j.trop.pharm.c.hem.v7i2.163>
- Lorensia, A., Suryadinata, R.V., Amir, G.A., Saputra, R. 2024. Relationship of the knowledge-attitudes of sun exposure and physical activity in asthma and non-asthma. *Community Medicine and Public Health of Indonesia Journal*, 4(3), 257–69. <https://doi.org/10.37148/comphijournal.v4i3.198>
- Ma, J., Lee, Y.K. 2023. Examining the association between cigarette smoking quantity and subjective salt taste preference and salt-related eating behavior. *Korean J Fam Med*, 44(6), 335–41. doi: [10.4082/kjfm.23.0027](https://doi.org/10.4082/kjfm.23.0027)
- Mousavi, S.E., Amini, H., Heydarpour, P., Amini-Chermahini, F., Godderis, L. 2019. Air pollution, environmental chemicals, and smoking may trigger vitamin D deficiency: Evidence and potential mechanisms. *Environ Int*, 122, 67–90. doi: [10.1016/j.envint.2018.11.052](https://doi.org/10.1016/j.envint.2018.11.052)
- Nagelhout, E.S., Lensink, R., Zhu, A., Parsons, B.G., Haaland, B., Hashibe, M., Grossman, D., VanDerslice, J., Gren, L.H., Jensen, J.D., Wu, Y.P. 2021. Higher ultraviolet radiation exposure among rural-dwelling versus urban-dwelling adults and children: Implications for skin cancer prevention. *J Community Health*, 46(1), 147–55. doi: [10.1007/s10900-020-00860-6](https://doi.org/10.1007/s10900-020-00860-6)
- Nwosu, B.U., Kum-Nji, P. 2018. Tobacco smoke exposure is an independent predictor of Vitamin D deficiency in US children. *PLoS ONE*, 13(10), 1–12. <https://doi.org/10.1371/journal.pone.0205342>
- Pleasant, R.A., Rivera, M.P., Tilley, S.L., Bhatt, S.P. 2020. Both duration and pack-years of tobacco smoking should be used for clinical practice and Research. *Ann Am Thorac Soc*, 17(7), 804–6. doi: [10.1513/AnnalsATS.202002-133VP](https://doi.org/10.1513/AnnalsATS.202002-133VP)
- Raymond-Lezman, J.R., Riskin, S.I. 2023. Benefits and risks of sun exposure to maintain adequate vitamin D levels. *Cureus*, 15(5), e38578. doi: [10.7759/cureus.38578](https://doi.org/10.7759/cureus.38578)
- Rebelos, E., Tentolouris, N., Jude, E. 2023. The role of vitamin D in health and disease: A narrative review on the mechanisms linking vitamin D with disease and the effects of supplementation. *Drugs*, 83(8), 665–85. doi: [10.1007/s40265-023-01875-8](https://doi.org/10.1007/s40265-023-01875-8)
- Rounds, S., Lu, Q. 2018. Cigarette smoke alters lung vascular permeability and endothelial barrier function (2017 Grover Conference Series). *Pulm Circ*, 8(3), 2045894018794000. doi: [10.1177/2045894018794000](https://doi.org/10.1177/2045894018794000)
- Santana, K.V.S., Oliver, S.L., Mendes, M.M., Lanham-New, S., Charlton, K.E., Ribeiro H. Association between vitamin D status and lifestyle factors in Brazilian women: Implications of sun exposure levels, diet, and health. *EClinicalMedicine*, 47, 101400. doi: [10.1016/j.eclinm.2022.101400](https://doi.org/10.1016/j.eclinm.2022.101400)
- Sözen, T., Özışık, L., Başaran, N.Ç. 2016. An overview and management of osteoporosis. *Eur J Rheumatol*, 4(1), 46–56. doi: [10.5152/eurjrheum.2016.048](https://doi.org/10.5152/eurjrheum.2016.048)
- Sridonpai, P., Judprasong, K., Tirakompong, N., Saetang, P., Puwastien, P., Rojroongwasinkul, N., Ongphiphadhanakul, B. 2022. Effects of different cooking methods on the vitamin D content of commonly consumed fish in Thailand. *Foods*, 11(6), 819. <https://doi.org/10.3390/foods11060819>
- Supriyanto, D.A., Damayanti, T. 2023. Correlation of smoking habit and level of nicotine dependence in university students. *Respir Sci*, 3(2), 94–102. <https://doi.org/10.36497/respirsci/v3i2.54>
- Suryadinata, R.V., Lorensia, A., Tangkilisan, E.C. 2019. Effect of physical activity and vitamin D status on geriatrics obesity.

- Global Medical & Health Communication (GMHC)*, 7(1), 1–6.
- Trofor, A.C., Papadakis, S., Lotrean, L.M., Radu-Loghin, C., Eremia, M., Mihaltan, F., Driezen, P., Kyriakos, C.N., Mons, U., Demjén, T., Nogueira, S.O., Fernández, E., Tountas, Y., Przewoźniak, K., McNeill, A., Fong, G.T., Vardavas, C.I.; EUREST-PLUS consortium. 2019. Knowledge of the health risks of smoking and impact of cigarette warning labels among tobacco users in six European countries: Findings from the EUREST-PLUS ITC Europe Surveys. *Tob Induc Dis*, 16, A10. doi: [10.18332/tid/99542](https://doi.org/10.18332/tid/99542)
- United States Public Health Service Office of the Surgeon General; National Center for Chronic Disease Prevention and Health Promotion (US) Office on Smoking and Health. 2020. Smoking Cessation: A Report of the Surgeon General [Internet]. Washington (DC): US Department of Health and Human Services; 2020. Chapter 2, Patterns of Smoking Cessation Among U.S. Adults, Young Adults, and Youth. Available from: <https://www.ncbi.nlm.nih.gov/books/NBK555598/>.
- Uzrail, A.H., Assab, M.A., Alkalbani, R., Al-Kofahi, R., Kadhim, A. 2021. Knowledge, Attitude and Practice (KAP) towards vitamin D deficiency in the Jordanian adult population: A cross-sectional study. *Research Journal of Medical Science*, 15(3), 62–71. doi: [10.36478/rjmsci.2021.62.71](https://doi.org/10.36478/rjmsci.2021.62.71)
- Voulgaridou, G., Papadopoulou, S.K., Detopoulou, P., Tsoumana, D., Giaginis, C., Kondyli, F.S., Lymperaki, E., Pritsa, A. 2023. Vitamin D and calcium in osteoporosis, and the role of bone turnover markers: A narrative review of recent data from RCTs. *Diseases*, 11(1), 29. doi: [10.3390/diseases11010029](https://doi.org/10.3390/diseases11010029)
- Webb, A.R., Kazantzidis, A., Kift, R.C., Farrar, M.D., Wilkinson, J., Rhodes, L.E. 2018. Colour counts: Sunlight and skin type as drivers of vitamin D deficiency at UK latitudes. *Nutrients*, 10(4), 457. <https://doi.org/10.3390/nu10040457>
- Yang, L., Zhao, H., Liu, K., Wang, Y., Liu, Q., Sun, T., Chen, S., Ren L. 2021. Smoking behavior and circulating vitamin D levels in adults: A meta-analysis. *Food Sci Nutr*, 9(10), 5820–32. doi: [10.1002/fsn3.2488](https://doi.org/10.1002/fsn3.2488)