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The Effect of Smoking Habit on Vitamin D Status of Adults in Indonesia

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Abstract

Smoking will reduce the metabolism of vitamin d in the body. Indonesia, as a tropical country that has a high level of sun exposure, is one with a high prevalence of smokers. Early identification of vitamin D status can be used as a preventive measure for risks associated with vitamin D deficiency. This study aimed to determine smoking behavior with vitamin D status. This research was conducted in April -November 2021. The research design was cross-sectional, using a purposive sampling method. Variables were smoker behavior, vitamin D status, and vitamin D deficiency. The differences between vitamin D status and smoker behavior in the smoker and non-smoker group used the chi-square test and the relationship used the contingency coefficient. This study involved 144 subjects, consisting of 73 non-smokers and 71 smokers. The groups at risk for vitamin D deficiency were 17 non-smokers (23.29%) and 31 smokers (43.66%). The smokers' group had a 2,553 times higher risk of vitamin D deficiency than non-smokers. There was a significant difference between smokers and non-smokers on 25(OH)D level vitamin D status. There was a significant relationship between vitamin D status in smokers and non-smokers. There was a weak relationship between smokers and non-smokers on vitamin D status.

Introduction

Tobacco smoking is one of the biggest health problems in the world. The 21st-century hazards reveal that smokers who start smoking early in adult life and do not quit lose a decade of life expectancy versus non-smokers (Jha, 2020). The prevalence of smoking in Indonesian society is 58% and 95% is dominated by men. Indonesia is the second-largest cigarette market in the world by retail volume and is one of the largest tobacco-consuming countries in the world (Kusumawardani *et al.*, 2018). Exposure to secondhand smoke is known to significantly increase the risk for the development of respiratory distress, which is characterized by markedly elevated baseline levels of proinflammatory cytokines (Azargoon *et al.*, 2022;that not only affects the users but also endangers the health of people inhaling the smoke (passive smoking/secondhand smoke Bhat *et al.*, 2018). Damage to the alveolar walls and loss of elasticity that occurs in respiratory disorders are caused by chronic inflammation and an imbalance of antioxidants (Hikichi *et al.*, 2019; Liguori *et al.*, 2018). Oxidative stress is increased in patients with respiratory distress. This oxidative stress causes a protease/antiprotease imbalance and is believed to be a contributing factor to the pathogenesis of respiratory disorders (Thimmulappa *et al.*, 2019; Marginean *et al.*, 2018).

Vitamin D deficiency or vitamin D deficiency can increase the incidence of respiratory diseases such as COPD or asthma which occupy the top 10 chronic diseases in Indonesia. This is because vitamin D deficiency causes a decrease in lung function (Ghosh *et al.*, 2020;but the relationship between vitamin

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D levels and COPD exacerbations remains controversial. In addition, the effect of vitamin D levels on imaging characteristics remains mostly unexplored. Using cross-sectional and longitudinal follow up data from the COPDGene Study, we assessed the association between vitamin D levels on respiratory symptoms, exacerbations, and imaging characteristics. We hypothesized that vitamin D deficiency will be associated with worse respiratory-related outcomes. Methods: Current and former smokers between ages 45-80 were enrolled the COPDGene Study. Subjects completed questionnaires, spirometry, six-minute walk test, and chest computed tomography scans. A subset of subjects had measurement of serum concentration of 25-hydroxyvitamin D (25(OH Wannamethee *et al.*, 2021). Low blood levels of vitamin D are associated with decreased lung function, increased inflammation, and infectious or neoplastic disease. The mechanism underlying the emergence of respiratory disease due to low vitamin D levels is unclear, but it is suspected that vitamin D affects the function of inflammatory and structural cells. Many studies have shown that vitamin D deficiency causes more susceptibility to respiratory diseases and requires a longer recovery time than patients with normal vitamin D (Vitamin D Council, 2017). Vitamin D supplementation can also reduce COPD worsening when it is given for a prolonged period (Khan *et al.*, 2017; Gupta & Ramadass, 2019).

Respiratory disease can be prevented by paying attention to vitamin D intake. Vitamin D contributes to preventing a person from experiencing respiratory disease. Vitamin D is most easily obtained from direct sunlight (Khan *et al.*, 2017; Gupta & Ramadass, 2019). In tropical countries in Asia, such as Indonesia, the need for sunlight should be sufficient, but in reality, it is estimated that the prevalence of vitamin D deficiency is quite high in their productive age (Lorensia, *et al.*, 2022; Suryadinata *et al.*, 2021). Modernization also brings changes in lifestyle and diet to be low in vitamin D. In addition, increasing pollution prevents sunlight from reaching the earth which results in blocking sun exposure on human skin (Manisalidis *et al.*, 2020; Dominguez *et al.*, 2021). Asian people's daily behavior can also be associated with vitamin D deficiency, where the assumption is that white people look more beautiful than dark-skinned people. So that most Asian people choose to protect their skin from sun exposure with sunscreen, which can prevent sun exposure to the skin (Lowe & Bhojani, 2017; Divakar *et al.*, 2019) where vitamin D deficiency is common despite the presence of sunlight all year round in most places. We examined the prevalence of vitamin D deficiency and its associated work-related factors among indoor workers using the data of 213 participants (aged ≥21 years. Modern lifestyles such as excessive eating patterns and limited physical activity will trigger obesity, which also causes low levels of vitamin D in the blood. Excess body weight that causes obesity can cause a decrease in the bioavailability of vitamin D from the skin and food because it accumulates in body fat (Migliaccio *et al.*, 2019;which is the biologically-inactive intermediate and represents the predominant circulating form. Different mechanisms have been hypothesized to explain the association between hypovitaminosis D and obesity, including lower dietary intake of vitamin D, lesser skin exposure to sunlight, due to less outdoor physical activity, decreased intestinal absorption, impaired hydroxylation in adipose tissue and 25(OH Khosravi *et al.*, 2018)fish oil supplements are produced commercially to complement low fish intake. It is not clear if both interventions have similar effects. The aim of this trial was to compare the anti-hyperlipidemic effect of omega3 fatty acid supplements with fresh fish. Method: A total of 106 patients with hyperlipidemia were randomized. One group received 2 g/day of omega-3 capsules for a period of 8 weeks and the other group received a mean of 250 g trout fish twice weekly (for dinner and lunch.

Vitamin D deficiency is due to several infectious diseases, with effects on breathing and lung function. Supplementation with vitamin D improves many lung conditions. There is an association between vitamin D and chronic disease (Zisi *et al.*, 2019;like cathelicidin, in response to both viral and bacterial stimuli. The aim of this review is to summarize the more recently published data with regard to potential associations of 25-hydroxyvitamin

D [25(OH Ganji *et al.*, 2020). The data show a significant association between vitamin D deficiency and decreased pulmonary function tests in a large outpatient population. Chronic lung diseases such as asthma and chronic obstructive pulmonary disease (COPD) are also genetically linked to vitamin D. Immune and genetic influences of vitamin D may influence the pathogenesis of chronic lung disease (Martineau *et al.*, 2019)antibiotics or both. Our secondary objectives are to evaluate the impact of Vitamin D supplementation on other effectiveness outcomes, including severe AECOPD, i.e. Those requiring emergency department (ED.

Early identification of vitamin D status can be used as a preventive measure for risks associated with vitamin D deficiency (Aji *et al.*, 2019;pregnancy profiles, dietary intake, and maternal anthropometry measurements Pilz *et al.*, 2019). Indicators used to determine vitamin D status include blood tests, intake of foods containing vitamin D (Aji *et al.*, 2019;pregnancy profiles, dietary intake, and maternal anthropometry measurements Pilz *et al.*, 2019; Lorensia *et al.*, 2020a), and questionnaires (Larson-meyer *et al.*, 2019;winter (n = 49 Bolek-Berquist *et al.*, 2009). Evaluation of vitamin D status using a questionnaire is easier and more economical to do than a 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;pregnancy profiles, dietary intake, and maternal anthropometry measurements Bolek-Berquist *et al.*, 2009; Annweiler *et al.*, 2017)without resorting to a blood test, older adults with low vitamin D concentrations. Our objective was to determine whether a self-administered VDSP was concordant with the VDSP administered by a physician, and to examine the concordance of every single item of the VDSP. Methods: A total of 349 older in- and outpatients (mean, 83.2±7.2years; 59% female. Questionnaires can be used to identify patients at high or low risk of vitamin D deficiency (Bolek-Berquist *et al.*, 2009). Smoking habits as a risk factor for vitamin D deficiency (Yang *et al.*, 2021; Nwosu & Kum-Nji, 2018)263 subjects of ages 3 to 17 years. Subjects were categorized into two groups based on their age: children, if <10 years; and youth if 10 to 17 years. Descriptive and multiple logistic regression analyses were conducted to determine the effect of serum cotinine-verified tobacco smoke exposure on vitamin D status after controlling for key sociodemographic confounders. Vitamin D deficiency was defined as 25(OH need prevention efforts as early as possible considering the dangers of vitamin D deficiency and low physical activity as causes of obesity that affect the development of chronic diseases and decreased quality of life (Kim *et al.*, 2018; Oh *et al.*, 2017). This study aimed to determine smoking behavior with vitamin D status.

Method

The design of this study was cross-sectional. The research location was in the southern part of the city of Surabaya, Rungkut district, East Java, Indonesia, and was carried out from April to November 2021. Ethical test No. 001-QL/KE/IV/2021 at the Universitas Surabaya.The independent variable in this study was a group of smoker and non-smoker respondents. The dependent variables in this study were vitamin D status and vitamin D deficiency. Vitamin D status can be defined as the presence of vitamin D in a certain amount in the body which is 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 >8, and negative (-) if the total answer score was ≤8. Vitamin D deficiency is a health problem related to vitamin D status. A smoker is a person who has smoked at least 100 cigarettes during his life and is currently smoking at least 1 cigarette per day or has smoked in the last 30 days. A non-smoker is a person who has never smoked in his life or has smoked but less than 100 cigarettes in his life.

The population used in this study were all young adults with student status who live in the southern city of Surabaya. The sample used in this study were those who met the criteria, which were male, 18-25 years old and did not have certain diseases such as cardiovascular disorders such as angina, renal and hepatic disorders. (such as cirrhosis of the liver), and have no motor problems. The sampling technique used was the purposive sampling method in which the sampling process was based on previously known characteristics or characteristics of the population and the consideration of the researcher. The national prevalence of obese adults was 15.4%, and the prevalence of the obese adult population in the city of Surabaya was 27.3% (Kementerian Kesehatan Republik Indonesia, 2018). To calculate the sample size in this study, the formula for the number of samples was used to estimate the proportion. The P value (proportion of the desired variable) used was 27.3% which was obtained from the basic health research data of East Java province in 2013 regarding the prevalence of adult obese people with a value of Zα=1.96 because α=0.05 with a value of d=10%. Then the study sample size (n) at least for each group in this study was 76 people.

Measuring instruments used in the study were the vitamin D status questionnaire to identify vitamin D status. Measurement of weight and height using a digital weight scale and a microtoise stature meter for height. The questionnaire was namely vitamin D status questionnaire (Bolek-Berquist *et al.*, 2009; Cairncross *et al.*, 2017). Assessment of respondents related to vitamin D status was carried out using a questionnaire consisting of 17 questions. The questionnaire assessed attitudes towards sun exposure including the time and duration of the subject's exposure to sunlight, how to dress, and the use of skin protection such as hats, jackets, and sunscreen. Conducted a trial or pilot study where data collection was preceded by testing 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. External validation was done by testing the questionnaire on the subject then the results were analyzed using the SPSS version 24.0 computer program. The questionnaire was said to be valid if the value of r_{count}>0.361. The questionnaire was reliable if the Chronbach alpha value was> 0.60. Comparative analysis of the risk of vitamin D deficiency based on vitamin D status in the smoker and non-smoker group of respondents using the prevalence odds ratio. Meanwhile, differences in vitamin D status and smoker behavior in the smoker and non-smoker respondent groups used the chi-square test. Then proceed to test the relationship between vitamin D status and smoker behaviour in the group of smoker and non-smoker respondents using a contingency coefficient.

Result and Discussion

Data collection was carried out from April to November 2021 by filling out a questionnaire. During the search process, 158 people were found, and only 144 were respondents, consisting of 73 non-smokers and 71 smokers. A validation test was done by comparing the values of r_{count} and r_{table} on each question item. If the r_{count} correlation between the scores of each item and the total score was greater than r_{table} (0.361) then the item was valid, with a significance level of 5% with a sample of 30 people (Table 1). In addition, the measurement scale was said to be reliable if it had a Cronbach's alpha value of 0.6. The value in the study was 0.812.

Table 2 shows that the characteristics of the research respondents consist of age and body mass index (BMI). Most of the non-smoker group (n:73) were 20 years old (27.40%) with an average age of 21.03 years. Most of the smoker group (n:71) were 17 years old (23.94%) with an average age of 22.00 years. Based on the difference test between groups, it showed that the age factor was a difference between smoker and non-smoker groups. The severity of smoking based on the Brinkman index showed that all respondents (100%) from the smokers group were light smokers. Table 3 shows the profile of respondents' answers to vitamin D status from the questionnaire.

Table 4 showed that most of the respondents were in a non-smoker condition and were not at risk of deficiency as many as 56 people (76.71%). The groups at risk for vitamin D deficiency were 17 non-smokers (23.29%) and 31 smokers (43.66%). Odd ratio (OR) test with a P value of 2,553, meaning that the smokers group had a 2.553 times risk of vitamin D deficiency than non-smokers. Chi-square test with a P value of 0.010 (P<0.05), meaning that there were differences in vitamin D status

Table 1. The Results of the Validity Test of the Vitamin D Status Questionnaire

No.	Question	rcount
1	How long per day are exposed to direct sunlight?	0.415
2	Do you use skin protection equipment from direct sun exposure?	0.432
3	Do you often wear closed clothes such as wearing long sleeves and long pants every day?	0.517
4	Which body parts should be protected from direct sun exposure with protective equipment?	0.536
5	How often to use sunscreen cream when exposed to direct sunlight?	0.650
6	Do you use sunscreen repeatedly in a day?	0.662
7	Do you use cosmetic products with SPF content?	0.507
8	Have you eaten fish in the past week?	0.560
9	How often did you eat fish in the past week?	0.723
10	Have you consumed milk in the past week?	0.368
11	How often have you consumed milk in the past week?	0.461
12	Have you eaten eggs in the past week?	0.605
13	How often have you eaten eggs in the past week?	0.432
14	What are the most processed eggs consumed in the past week?	0.530
15	Do you take fish oil?	0.419
16	Do you take supplements?	0.454
17	Do you often experience condition symptoms due to vitamin D deficiency?	0.409

Source: Primary Data, 2021

Table 2. Characteristics of Respondents

Characteristics of Respondents		Group				P-value
		Non-smoker (n: 73)		Smoker (n: 71)		
		Frequency	Percentage (%)	Frequency	Percentage (%)	
Age (years)	18	7	9.59	3	4.23	0.027*
	19	10	13.70	3	4.23	
	20	7	9.59	9	12.68	
	21	20	27.40	10	14.08	
	22	15	20.55	15	21.13	
	23	9	12.33	17	23.94	
	24	3	4.11	10	14.08	
	25	2	2.74	4	5.63	
BMI (kg/m2)	Kurus (<18.5)	14	19.18	10	14.08	0.412
	Normal (18.5-22.9)	59	80.82	61	85.92	

Source: Primary Data, 2021

BMI: Body mass index

*P value<0.05, it meant that there was a difference between smoker and non-smoker groups

Table 3. Profile of Respondents' Answers Regarding Vitamin D Status.

No	Question	Answers		Group			
				Non-smoker (n: 73)		Smoker (n: 71)	
				Freq	Percentage (%)	Freq	Percentage (%)
1	How long per day are you exposed to direct sunlight?	<5 minutes	07.00-09.00	0	0.00	0	0.00
			10.00-11.00	0	0.00	0	0.00
			12.00-14.00	1	1.37	2	2.82
			15.00-17.00	0	0.00	0	0.00
		5-10 minutes	07.00-09.00	5	6.85	6	8.45
			10.00-11.00	2	2.74	6	8.45
			12.00-14.00	0	0.00	2	2.82
			15.00-17.00	0	0.00	1	1.41

No	Question		Answers	Group: Non-smoker (n: 73) Freq	Non-smoker Percentage (%)	Smoker (n: 71) Freq	Smoker Percentage (%)
		10-15 minutes	07.00-09.00	17	23.29	7	9.86
			10.00-11.00	5	6.85	4	5.63
			12.00-14.00	3	4.11	4	5.63
			15.00-17.00	1	1.37	0	0.00
		15-30 minutes	07.00-09.00	14	19.18	17	23.94
			10.00-11.00	12	16.44	12	16.90
			12.00-14.00	10	13.70	7	9.86
			15.00-17.00	3	4.11	3	4.23
2	What time do you usually get direct sunlight?		Yes	62	84.93	69	97.18
			No	11	15.07	2	2.82
	What skin protection equipment is used? (*)		Umbrella	0	0.00	0	0.00
			Hat	14	19.18	26	36.62
			Jacket	57	78.08	57	80.28
			Sunblock	17	23.29	23	32.39
	When do you use the protective equipment?		When leaving the house	24	32.88	28	39.44
			Midday	17	23.29	10	14.08
			Driving	21	28.77	31	43.66
			Never	11	15.07	2	2,82
	How often do you use the protective equipment?		Every day	32	43.84	31	43.66
			Sometimes (4-6x per week)	22	30.14	31	43.66
			Rarely (1-3x per week)	8	10.96	7	9.86
			Never	11	15.07	2	2.82
3	Do you usually wear closed clothes such as long-sleeved shirts and trousers every day?		Yes	24	32.88	35	49.29
			No	49	67.12	36	50.70
4	Which body part would you like to protect from direct sunlight with the protective equipment of your choice in question no. 2? (*)		Face	25	34.25	41	57.75
			Arm	53	72.61	59	83.09
			Foot	59	80.82	61	85.92
			Back and Shoulders	38	52.05	36	50.70
			Never	13	17.81	4	5.63
5	How often do you use sunscreen cream when exposed to direct sunlight?		Always or almost every day (>3 times a week)	5	6.85	3	4.23
			Sometimes (≤3 times a week)	6	8.22	8	11.27
			Rarely (2 times a month)	6	8.22	12	16.90
			Never	56	76.71	48	67.61
6	Do you use sunscreen repeatedly in a day?		Yes	2	2.74	5	7.04
			No	71	97.26	66	92.96
	If "yes", how many hours do you use sunscreen in a day?		Every hour	0	0	0	0
			Every 2 hours	0	0	3	4.23
			Every 4 hours	2	2.74	2	2.82
			Never	71	97.26	66	92.96
7	Do you use cosmetic products (face moisturizer, hand and body cream, powder, etc.), with SPF content?		Yes	17	23.29	23	32.39
			No	56	76.71	48	67.61
	Do the cosmetics you use contain protection from UVA and UVB?		Yes	14	19.18	14	19.72
			No	1	1.37	6	8.45
			Don't know	2	2.74	3	4.23

No	Question	Answers	Group			
			Non-smoker (n: 73)		Smoker (n: 71)	
			Freq	Percentage (%)	Freq	Percentage (%)
8	Have you consumed fish in the past week?	Yes	59	80.82	64	90.14
		No	14	19.18	7	9.86
	What type of fish have you consumed the most in the past week?	Fish that contain vitamin D	54	73.97	54	76.06
		Fish that do not contain vitamin D	11	15.07	10	14.08
	How processed fish do you consume? (*)	Fry	43	58.90	45	63.38
		Grill	11	15.07	9	12.68
		Sauté	5	6.85	3	4.23
		Steam	2	2.74	2	2.82
		Can	4	5.48	4	5.63
		Sushi/raw	2	2.74	1	1.41
	Where did you get the fish from? (*)	Food stall	34	46.58	36	50.70
		Homemade/ Cook yourself	31	42.47	28	39.44
	What is your goal in consuming fish? (*)	Love the taste	21	28.77	27	38.03
		Benefit for Health	27	36.99	31	43.66
		Diet to lose weight	2	2.74	4	5.63
		The price is low. More affordable	11	15.07	15	21.13
		Incidentally fish dishes available to eat	23	31.51	26	36.62
		Don't eat fish	8	19.18	7	9.86
9	How often have you eaten fish in the past week? (*)	1-3 times per week	51	69.86	49	69.01
		4-6 times per week	7	9.59	5	7.04
		>6 times per week	1	1.37	1	1.41
		Never	14	19.18	16	22.54
10	Have you consumed milk in the past week?	Milk contains vitamin D	60	82.19	53	74.65
		Milk does not contain vitamin D	3	4.11	3	4.23
		Don't consume milk	10	13.70	16	22.54
	What kind of milk have you consumed in the last week? (*)	Cow's milk	12	16.44	14	19.72
		Soy milk	9	12.33	7	9.86
		Canned milk liquid/powder	16	21.92	23	32.39
		Milk box liquid or powder	38	52.05	23	32.39
11	How often have you consumed milk in the past week?	1-3 times per week	32	43.84	36	50.70
		4-6 times per week	19	26.03	9	12.68
		>6 times per week	9	12.33	8	11.27
		Never	10	13.69	15	21.13

No	Question	Answers	Group			
			Non-smoker (n: 73)		Smoker (n: 71)	
			Freq	Percentage (%)	Freq	Percentage (%)
12	Have you eaten eggs in the past week?	Yes	71	97.26	68	95.77
		No	2	2.74	3	4.23
	Which part of the egg do you eat?	egg whites	4	5.48	3	4.23
		egg yolk	3	4.11	2	2.82
		all	64	87.67	63	88.73
13	How often have you eaten eggs in the past week?	1-3 times per week	43	58.90	43	60.56
		4-6 times per week	21	28.77	20	28.17
		>6 times per week	7	9.59	5	7.04
		Never	2	2.74	3	4.23
14	What kind of processed egg have you consumed the most in the past week? (*)	Fry	63	86.30	61	85.92
		Boiled	31	42.47	30	42.25
		Traditional herbs	3	4.11	9	12.68
15	Do you take fish oil?	Yes	6	8.22	5	7.04
		No	65	89.04	68	95.78
16	Do you take vitamin D supplements?	Yes	2	2.74	0	0.00
		No	71	97.26	71	100
17	Do you often experience this condition? (*)	Muscle pain including lower back pain	18	24.66	19	26.76
		Pain in the pelvis. Back and legs	17	23.29	12	16.90
		Muscle weakness	5	6.85	6	8.45
		It's easy to have a bad mood or depression	8	10.96	19	26.76
		Low immunity like frequent colds in winter	22	30.14	26	36.62
		Never	20	27.40	15	21.13

Source: Primary Data, 2021

in smokers and non-smokers. Spearman's test with a P value of 0.009 (P<0.05) and r=0216, meaning that there was a significant relationship between vitamin D status in smokers and non-smokers. Even though the relationship was weak.

The prevalence of smoking in Indonesia is quite high among men than women. Generally, in Indonesia, smoking is done by men, while smoking among women in Indonesia is less socially acceptable. As a result of the negative view and great pressure from society on female smokers have caused the desire to quit smoking in women is greater than in men (Ayuningtyas *et al.*, 2021). So that respondents in this study will be more open in providing information

Table 4. Risk Analysis of Vitamin D Deficiency on Smokers and Non-Smokers.

Vitamin D status category	Non-smoker (n: 73)		Smoker (n: 71)		TOTAL
	Freq.	Percentage (%)	Freq.	Percentage (%)	
No risk of deficiency (≤8)	56	76.71	40	56.34	96
Have a risk of deficiency (>8)	17	23.29	31	43.66	48

Source: Primary Data, 2021

about smoking status.

Respondents tend to be young, so no one has comorbidities, such as liver and kidney disease. Comorbidities can affect vitamin D status. In the liver, vitamin D will be hydroxylated by 25-hydroxylation to 25(OH) D or calcidiol so that in patients with liver disorders, calcidiol levels were low due to disturbances in its synthesis. Liver disease will also interfere with the absorption of vitamin D because liver damage will also affect the production of bile acids which function to convert non-polar forms of vitamin D into water soluble so that it can be absorbed by the intestinal wall. In addition, the liver is an organ for protein synthesis or vitamin D binding protein (DBP) which is the main carrier for 25(OH)D and 1,25(OH)2D into the circulation, DBP will also facilitate 1,25(OH)2D to enter the circulation, target cells and bind to receptors (Wannamethee *et al.*, 2021; Henríquez & Romero, 2020). The availability of vitamin D in the body was influenced by kidney function because 25(OH)D will undergo hydroxylation by 1 -hydroxylase to the active form 1,25-dihydroxyvitamin D (calcitriol). So that chronic kidney disorders associated with structural and functional abnormalities of the kidneys can affect the decrease in the active form of 1,25(OH)2-D (Wannamethee *et al.*, 2021; Vitamin D Council, 2017; Henríquez & Romero, 2020).

Body mass index also affects vitamin D status. Based on the source of vitamin D, which includes fat-soluble vitamins, it can come from food intake and synthesis through the skin, then it will be stored in adipose tissue which will be released and undergo metabolism when the production of vitamin D in circulation is reduced. Weight gain causes vitamin D to be trapped in fat and unable to get out into circulation. Individuals with a BMI who are obese and overweight have a risk of decreased bioavailability of vitamin D in the body, so they have a risk of vitamin D deficiency twice as large as individuals with a normal BMI and underweight (Orces, 2019). Obese individuals need to consume larger amounts of vitamin D than non-obese individuals to get enough vitamin D.

Measurement of vitamin D status was based on the value of the total score of each respondent's response to smokers and non-smokers. Each answer number that included the deficiency criteria will be given a score of 1 and money including the non-deficiency criteria will be given a score of 0. The category for the conclusion was through a total score based on the median cut-off point criteria, the answer to the total score of the questionnaire was 8 categorized as not having a deficiency risk while having a deficiency risk if the total score was >8 (Bolek-Berquist *et al.*, 2009; Cairncross *et al.*, 2017). Although a high intake of dietary nutrients can cause weight gain, proper and healthy nutritional intake can increase vitamin D levels in the blood. Intake of calcium and vitamin D can have an effect on body weight, but this still requires further research and will depend on a person's healthy lifestyle (Vranic, 2019).

a) Fish. Respondents of smokers who consumed fish in the last week were 55 smokers (78.88%) and 59 non-smokers (80.82%). Meanwhile, the number of respondents who smoked fish containing vitamin D in the past week were 54 smokers (76.06%) and 54 non-smokers (73.97%). Fish that contain vitamin D are fatty fish such as tuna, salmon, eel, mackerel, sardines, tuna, tilapia, mackerel, catfish, tilapia, snapper, carp, and shrimp. The greatest content of vitamin D was found in fresh/raw fish. But cooking did not significantly affect the decrease in vitamin D content in food, cooking, or baking in an oven at 172°C or 200°C induces a decrease in vitamin D3 <10% (Ložnjak & Jakobsen, 2018). The answer to the frequency of eating fish in the last week was 1-3 times, 49 people (69.01%) were smokers and 47 people (64.38%) were non-smokers.
b) Milk. Of respondents who consumed milk containing vitamin D, 53 people (74.65%) were smokers, and 60 non-smokers (82.19%). Generally, milk that contains vitamin D is soy milk, cow's milk, and goat's milk (Collard & McCormick, 2021). The vitamin D content in raw milk is 0.57 IU/ml lower than 0.80 IU/ml fortified milk. In the making process of pasteurized dairy products in high milk, no loss of vitamin D content was found, while the stability

of vitamin D3 remained stable during the appropriate storage life for each product (Mandrioli et al., 2020).

c) Egg. The highest consumption of eggs was 68 smokers (95.77%) and 71 non-smokers (97.26%). Eggs had a high content of vitamin D, which was found in all types of egg yolks. The average weight of egg yolk in duck eggs was greater than that of chicken eggs (18 grams), where the weight of duck egg yolk is about 23-28 grams. In addition, duck egg yolk has 6 times more vitamin D, 2 times vitamin A, and 2 times more cholesterol than chicken eggs (Kuang et al., 2018).

Previous research by Lorensia *et al*. (2022), on 143 student respondents in Surabaya. The results showed that there was a significant difference in physical activity (p=0.047) and vitamin D status (p<0.05) between the non-obese 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. Meanwhile, in different subjects with a lower socio-economic tendency, namely construction workers, it shows that most of the respondents also have heavy physical activity (48.73%). Meanwhile, regarding lung health, as many as 50% of people do not have lung function disorders, and some have mild (37.34%) and severe (12.66%). Builders are at risk for vitamin D deficiency and impaired lung function, despite having a strenuous level of physical activity (Lorensia *et al*., 2020[b]). Another study that supports the results of this study by Suryadinata *et al*. (2021), There was a relationship between the level of knowledge (p=0.000) and attitude (p=0.000) toward sun exposure levels related to vitamin D and lung function. There was a relationship between the level of knowledge to attitude on sun exposure levels related to vitamin D (p=0.000). Therefore, knowledge and attitudes on sun exposure related to vitamin D were important concerns to maintain healthy lung function.

One of the most common symptoms of vitamin D deficiency is fatigue. Symptoms of easy weakness are not specific symptoms of vitamin D deficiency and need to be assessed from vitamin D levels in the blood. Identification of genetic variations that arise as a consequence of diet as selective pressure helps identify alleles of genes that affect nutrient utilization. Understanding the molecular mechanisms underlying gene-nutrient interactions and their modifications with genetic variation is expected to lead to dietary recommendations and nutritional interventions that optimize individual health (Indraswari *et al*., 2018).

Conclusion

There was a significant difference between smokers and non-smokers on vitamin D status. There was a weak relationship between smokers and non-smokers on vitamin D status. Early identification of vitamin D status can be used as a preventative measure for risks associated with vitamin D deficiency. Assessment of vitamin D status includes living habits. However, many factors can influence vitamin D status, such as variations in sun exposure due to latitude, season, time of day, atmospheric components, clothing, use of sunscreen, and skin pigmentation, as well as age, obesity, and the onset of several chronic diseases. Therefore, it is necessary to develop further research by observing each factor that influences in more detail than vitamin D levels.

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