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Is vitamin D deficiency associated with using veil in female garment workers?

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ABSTRACT

Objective: To find out the determinant factors which are associated with the serum vitamin D status in the female garment workers.
Methods: This study was a cross sectional design with a total of 154 childbearing female garment workers aging from 18 to 40 who worked at garment factory in Sukabumi, Indonesia and fulfilled the inclusion criteria. Serum 25(OH)D was determined using a chemiluminescence immunoassay method. Ordinal logistic regression analysis was used to identify factors influencing serum vitamin D status.
Results: The results of this study showed that on average serum 25(OH)D of the workers was 31.6 nmol/L and only 5.2% of them had a sufficient status of vitamin D. There were no different proportion among body mass index, supplement consumption, energy, protein, calcium, and vitamin D adequacy level with the serum vitamin D status of the workers. The workers who wore veils had a higher proportion to have a deficient serum vitamin D compared to workers who did not use veils (P = 0.000). The women who wore veils had a higher risk of vitamin D deficiency than the women who did not wear any veil.
Conclusions: A need of vitamin D can be obtained from sunlight. Therefore it is suggested that the garment provide an opportunity for the garment workers to do exercise in the morning so that the workers can get sunlight prior to working.

1. Introduction

Female workers who work at formal sectors as laborers increase every year[1]. This increase is due to at least two factors. Firstly, it is due to industrial sectors, such as industries of cigarette, textile, convection, food, and drink, for some of which demand carefulness, meticulousness, and other characteristics of typical women. Secondly, it is due to the fact that female workers are considered more loyal and cheaper, so economically it is more beneficial for businessmen.

Female workers are a group of childbearing-aged women who require attention because this group is vulnerable to suffer nutritional problems. It is very closely connected to the fact that psychologically this group still has menstruation, to be pregnant, to deliver a baby, and to breastfeed. In addition, those women, especially who work at garment factory, are rarely exposed to any sunlight. It is because they work from morning to evening indoor, so these workers have a risk of suffering vitamin D deficiency.

Indonesia is a tropical country with rich of sunlight throughout the year. Indonesia lies at Indonesia lies at latitude of 6°00' N–11°08' S and longitude of 95°–145° E. Individuals who have a few minutes at mid-morning and mid-afternoon most days of the week at summer can maintain adequate levels of 25(OH)D[2]. According to Institute of Medicine 2011, serum 25(OH)D is categorized as: (i) risk of deficiency if serum 25(OH)D < 12 ng/mL (< 30 nmol/L); (ii) risk of inadequacy 12–19 ng/mL (30–49 nmol/L); (iii) sufficiency 20–50 ng/mL (50–125 nmol/L), and (iv) there may be reason for concern at level > 50 ng/mL (> 125 nmol/L) and there is no toxic levels of vitamin D from prolonged sun exposure[3]. However, a study in Indonesia and Malaysia showed that the average of serum 25(OH)D was 41.7 nmol/L and 44.5 nmol/L respectively[4,5].

The main role of vitamin D is to support calcium and phosphorous absorption. A systematic review and meta-analysis of prospective cohort studies showed that vitamin D deficiency

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may act as a risk factor for several chronic diseases such as cancer, diabetes mellitus, hypertension, and cardiovascular disease[6]. Several factors are thought to cause the high prevalence of vitamin D deficiency: (1) the low intake of food containing vitamin D; (2) there is a tendency of reducing high-fat food; (3) the use of sunscreen; (4) obesity; (5) the low consumption of vitamin D supplements; (6) the lack of sunlight exposure. Obese condition is connected with the lack of vitamin D in the body. Expression of human vitamin D receptor in mature mice adiposities leads to expression of vitamin D receptor in preadipocyte cell lines, thereby inhibited adiposity differentiation and increased adipose mass[7]. Meta-regression analysis indicated that every 10 kg mean weight loss there could be average increase of 6.0 nmol/L of 25(OH)D[8].

This study investigated various factors associated with ones' vitamin D status, considering that the information is still limitted, especially in West Java Province, where has considerable garment factories. The availability of the information on how big the problems of vitamin deficiency is, what the dominant factors affect the vitamin D status of the female factory workers can be a consideration to make preventive and promotive efforts among others prevention of non-communicable diseases.

2. Materials and methods

2.1. Study population

Approval of the Institutional Review Board for the research has been approved by the Commission on Health Research Ethics Faculty of Public Health Diponegoro University, Semarang, No. 11/EC/FKM/2015. This study was a cross sectional design and was conducted at Gunung Salak Ltd. in Sukabumi, West Java from January to March 2015. The population of this research sample was childbearing-aged women aging from 18 to 40 years old who were worked at the Gunung Salak. While the samples of this study were childbearing women who exclusively fulfilled the criteria of healthy, married, not pregnant and not breastfeeding, not smoking, not drinking alcoholic drink, not being following a special diet, and willing to involve in this research by signing the inform consent. The sample frame was obtained from the Human Resources Department of Gunung Salak Ltd. Out of 171 female workers on the sample frame, 154 samples were selected through simple random sampling.

2.2. Data collection

Blood samples were collected in the morning (08:00–11:00 am) in a non-fasting state. Serum 25(OH)D was determined using a chemiluminescence immunoassay method and analyzed in an accredited laboratory. The serum 25(OH)D level was used to evaluate the vitamin D status.

Dietary intake was assessed using the 24-h dietary recall method and nutrient intake was determined using Indonesian food composition table. Supplement consumption was categorized into two groups that is yes and no. Sunlight exposure was determined by the use of cosmetics with sun proteetion factor (SPF), body part exposed to sunlight, the use of veil and duration of skin contact with sunlight.

Body weight was measured by a body weight scale (Omron Karada Scan Body Composition Monitor HBF-358). Height was measured using a microtoise staturmeter. Body mass index (BMI) was calculated according to the formula [(weight (kg)/height (m^2)].

2.3. Statistical analysis

Categorical data were expressed as frequency (*n*) and percentage (%) for serum vitamin D, nutritional status, supplement consumption, and exposure to sunlight. The vitamin D status was classified as deficient (< 30.0 nmol/L), insufficient (30.0–49.9 nmol/L), and sufficient (⩾ 50.0 nmol/L)[9]. BMI was classified as thin (< 18.5), normal (18.5–22.9), overweight (23.0–24.9), and obese (⩾ 25)[10].

Adequacy level of nutrition was calculated from consumption divided to Indonesian recommended dietary allowance (RDA)[11]. Adequacy levels of energy and protein were categorized as deficit (< 90%), normal (90%–110%), and over (> 110%)[12], meanwhile, adequacy levels of calcium and vitamin D were categorized as sufficient (⩾ 70%) and not sufficient (< 70%)[13].

Data were presented as mean ± SD for continuous data such as serum vitamin D, nutritional status, food consumption, nutritional adequacy, frequency and amount of supplement consumption. *Chi*-square test (χ^2-test) was performed to correlate between BMI, supplement consumption, the use of veil, and nutrient adequacy level with three groups of serum vitamin D. Ordinal logistic regression analysis was used to identify factors influencing serum vitamin D status. BMI, energy, protein, calcium, and vitamin D adequacy levels, supplement consumption, and the use of veil were independent variable in ordinal logistic regression model with serum vitamin D status as dependent variable. All statistical analyses were performed using SPSS Statistics V22.0 (International Business Machines Corporation, US).

3. Results

3.1. Serum vitamin D status

The parameter used for determining the status of vitamin D in this study was the level of 25(OH)D or calcidiol. The vitamin D status of female workers was categorized into: 1) Deficient, with the serum concentration of 25(OH)D under 30.0 nmol/L; 2) Insufficient, with serum concentration of 25(OH)D between 30.0 and 49.0 nmol/L; 3) Sufficient with the concentration of 25(OH)D above 50.0 nmol/L. The result showed that the level of 25(OH)D serum among the workers standed at 31.6 nmol/L and only 5.2% of the workers had sufficient status. Mostly the workers had deficient (47.4%) and insufficient (47.4%) serum vitamin D. The vitamin D status based on the level of 25(OH)D serum was listed in the Table 1.

Table 1

Serum vitamin D status of female garment workers. *n* (%).

Serum vitamin D status	Number of workers
Deficient (< 30.0 nmol/L)	73 (47.4)
Insufficient (30.0–49.9 nmol/L)	73 (47.4)
Sufficient (50.0 nmol/L)	8 (5.2)
Total	154 (100.0)
Mean ± SD	31.6 ± 10.6

3.2. Supplement consumption habit

The distribution of respondents who accustomed to consuming supplements can be seen in Table 2. The type of supplement consumed were vitamin C, vitamin D, vitamin E, iron, multivitamin and mineral, herbal, and traditional herbal drink. Most workers did not consume supplements. Those who consumed supplements were only about 37.0% and the rest 63.0% did not consume supplements.

Table 2

Supplement consumption habit of female garment workers. *n* (%).

Supplement consumption habit		Number of workers
Consuming supplement	Yes	57 (37.0)
	No	97 (63.0)
Type of supplements	Vitamin C	14 (24.6)
	Vitamin D	8 (14.0)
	Vitamin E	7 (12.3)
	Fe	4 (7.0)
	Multivitamin and mineral	12 (21.0)
	Herbal/traditional herbal drink	7 (12.3)
	Others	5 (8.8)
Frequency of consumption (times/week)		3.5 ± 3.8
Amount of supplement consumed (tablet/consumption)		1.1 ± 0.3

Out of 57 workers who consumed supplements, 24.6% subjects consumed vitamin C and 21.0% subjects consumed multivitamin and mineral. Vitamin D supplement was only consumed by 14.0% subjects, and the rest consumed vitamin E (7.0%), Fe (12.3%), and herbs (12.3%). The frequency of supplement consumption was about 3.5 times a week with the amount of 1.12 tablets per consumption. There was no correlation between supplement consumption habits and serum vitamin D status ($P = 0.675$) (Table 3).

Table 3

Correlation of serum vitamin D status with BMI, supplement consumption, the use of veil, and the adequacy level of nutrition. *n* (%).

Variable		Deficient ($n = 73$)	Insufficient ($n = 73$)	Sufficient ($n = 8$)	P
BMI	Thin (< 18.5)	4 (80.0)	1 (20.0)	0 (0.0)	0.803
	Normal (18.5–22.9)	28 (43.1)	33 (50.8)	4 (6.1)	
	Overweight (23.0–24.9)	15 (46.9)	15 (46.9)	2 (6.2)	
	Obese (⩾ 25)	26 (50.0)	24 (46.2)	2 (3.8)	
Supplement consumption	Yes	26 (45.6)	29 (50.8)	2 (3.5)	0.675
	No	47 (48.4)	44 (45.4)	6 (6.2)	
The use of veil daily	Yes	56 (59.6)	33 (35.1)	5 (5.3)	0.000
	No	17 (28.3)	40 (66.7)	3 (5.0)	
Energy adequacy level (%)	Deficit (< 90)	60 (47.6)	60 (47.6)	6 (4.8)	0.387
	Normal (90–110)	5 (33.3)	8 (53.4)	2 (13.3)	
	Over (> 110)	8 (61.5)	5 (38.5)	0 (0.0)	
Protein adequacy level (%)	Deficit (< 90)	43 (44.3)	48 (49.5)	6 (6.2)	0.480
	Normal (90–110)	16 (61.5)	10 (38.5)	0 (0.0)	
	Over (> 110)	14 (45.2)	15 (48.4)	2 (6.4)	
Calcium adequacy level (%)	Sufficient (⩾ 70)	8 (53.3)	6 (40.0)	1 (6.7)	0.825
	Not sufficient (< 70)	65 (46.8)	67 (48.2)	7 (5.0)	
Vitamin D adequacy level (%)	Sufficient (⩾ 70)	0 (0.0)	1 (100.0)	0 (0.0)	0.572
	Not sufficient (< 70)	73 (47.7)	72 (47.1)	8 (5.2)	

3.3. Sunlight exposure

Less than 10% of the workers applied cosmetics containing SPF but its SPF content was very high (> 20). The average length of sunlight exposure was 18.4 min and the parts of their body which were frequently exposed to sunlight were their face, hands, and feet. In their daily life, more than half (61.0%) of these workers wore bright-colored veil (35.1%). The sunlight exposure was shown in Table 4. Proportion of workers who wore veil was higher to suffer deficient serum vitamin D than those who did not wear veil ($P = 0.000$) (Table 3). The veil covered a part of face and within a long period of time it will reduce sunlight exposure.

Table 4

Sunlight exposure of female garment workers. *n* (%).

Variables			Number of workers
The use of cosmetics with SPF outdoor	Yes		15 (9.7)
		SPF 20	1 (0.6)
		SPF 21	9 (5.8)
		SPF 30	5 (3.3)
	No		139 (90.3)
Body part exposed to sunlight	Face		153 (99.4)
	Hands		135 (87.7)
	Feet		89 (57.8)
	AT (min/day)		18.4 ± 21.4
The use of veil daily	Yes		94 (61.0)
		Dark veil	40 (25.9)
		Bright veil	54 (35.1)
	No		60 (39.0)

AT: Average time of contact with sunlight.

3.4. Nutritional status of female garment workers

The nutritional status of workers was measured by BMI. The nutritional status of workers was shown in Table 5. Less than half (42.2%) of the workers had a normal BMI. Few workers (3.3%) were classified as thin. Among them, there were also some workers who were classified as overweight (20.8%) and obese (33.8%). The average BMI was (23.8 ± 3.7). Table 3 showed that high prevalence of low serum vitamin D suffered by all BMI categories. *Chi*-square test showed that there was no correlation between the nutritional status and vitamin D status. There was a tendency that serum vitamin D status was low for all nutritional status.

Table 5

BMI and nutrition adequacy level of female garment workers. *n* (%).

Variable		Number of workers
BMI	Thin (< 18.5)	5 (3.2)
	Normal (18.5–22.9)	65 (42.2)
	Overweight (23.0–24.9)	32 (20.8)
	Obese (⩾ 25)	52 (33.8)
	Mean ± SD	23.8 ± 3.7
Energy adequacy level (%)	Deficit (< 90)	126 (81.8)
	Normal (90–110)	15 (9.7)
	Over (> 110)	13 (8.5)
	Mean ± SD	70.1 ± 24.7
Protein adequacy level (%)	Deficit (< 90)	97 (63.0)
	Normal (90–110)	26 (16.9)
	Over (> 110)	31 (20.1)
	Mean ± SD	86.2 ± 34.8
Calcium adequacy level (%)	Sufficient (⩾ 70)	15 (9.7)
	Not sufficient (< 70)	139 (90.3)
	Mean ± SD	38.5 ± 22.7
Vitamin D adequacy level (%)	Sufficient (⩾ 70)	1 (0.6)
	Not sufficient (< 70)	153 (99.4)
	Mean ± SD	5.4 ± 10.8

3.5. Energy and nutrition intakes

Energy and nutrient intakes were shown in Table 5. Energy intake only met 70.1% of the RDA. Most of the workers (81.8%) had energy intake less than 90% of the RDA. The low energy intake in the long term will result in the decrease of muscle mass and reproduction. The average protein adequacy level of female workers met 86.2% of RDA. More than half (63.0%) of the workers had less than 90% RDA of protein intake. This low protein intake was possibly related to the expensiveness of the price of protein rich foods. Almost all the workers had a low adequacy levels of calcium and vitamin D and cannot fulfill the 70% RDA. The low intake of food source of calcium and vitamin D was the main reason why the adequacy level was very low (Table 3).

3.6. Determinant factors of vitamin D status

To evaluate the main determinant of serum vitamin D status, we analyzed BMI, sunlight exposure (the use of veil, and average time of contact with sunlight), supplement consumption, and nutrient adequacy level (energy, protein, calcium and vitamin D) of the workers using ordinal logistic regression (Table 6). The results of the ordinal regression showed that BMI, supplement consumption, and nutrient adequacy level were not the determinant factors of serum vitamin D status. The use of veil was the only factor that determine the serum of vitamin D status ($P = 0.001$).

Table 6

Factors influencing the vitamin D status among female garment workers

Variable		Estimate	Sig.	95% Confidence interval	
				Lower bound	Upper bound
Threshold	Deficient (< 30.0 nmol/L)	0.374	0.871	–4.148	4.896
	Insufficient (30.0–49.9 nmol/L)	3.697	0.112	–0.864	8.258
	AT (min/day)	0.008	0.287	–0.007	0.024
BMI	Thin (< 18.5)	–0.536	0.656	–2.891	1.819
	Normal (18.5–22.9)	0.414	0.347	–0.448	1.276
	Overweight (23.0–24.9)	0.524	0.312	–0.491	1.539
	Obese (≥ 25)	0.000	.	.	.
	No supplement consumption	–0.165	0.640	–0.857	0.527
	The use of veil daily	1.228	0.001	0.519	1.936
Energy adequacy level (%)	Deficit (< 90)	0.198	0.770	–1.133	1.529
	Normal (90–110)	1.502	0.070	–0.121	3.125
	Over (> 110)	0.000	.	.	.
Protein adequacy level (%)	Deficit (< 90)	0.055	0.906	–0.856	0.966
	Normal (90–110)	–0.569	0.331	–1.715	0.577
	Over (> 110)	0.000	.	.	.
Calcium adequacy level (%)	Sufficient (≥ 70)	0.471	0.450	–0.750	1.691
	Not sufficient (< 70)	0.000	.	.	.
Vitamin D adequacy level (%)	Sufficient (≥ 70)	–1.036	0.628	0.631	–5.264
	Not sufficient (< 70)	0.000	.	.	.

Sig.: Significant. AT: Average time of contact with sunlight. Dot (.) : This parameter is redundant.

4. Discussion

Indonesia is a tropical country with two seasons, therefore it has full exposure of sunlight all year long. Compared to the research of Yosephin *et al.* and Moy and Bulgiba, the result of this research showed a lower concentration of serum 25(OH)D (only 31.6 nmol/L)[4,5]. This study showed that the prevalence of vitamin D deficiency (< 30 nmol/L) was high (47.4%) among female garment workers. They work for 8.4 h a day in a week (5 days). The problem of vitamin D deficiency happens not only in subtropical countries with four seasons, but also in tropical countries. This result was in line with the systematic review done by Palacios and Gonzalez (2014) who showed that vitamin D deficiency has become a health problem of the society taking the range of all ages, even in countries with enough sunlight along the year like in Middle East, especially among women[14].

Vitamin D is not a natural vitamin, because vitamin D can be formed in the body with the help of sunlight. Naturally, vitamin D is found in cod liver oil, salmon, mackerel, tuna, and egg yolk. Nowadays foods are fortified with vitamin D especially in milk, biscuit, margarine, cheese, and cereal. Food from plants generally contains less vitamin D[15]. The requirement of vitamin D will be fulfilled through sunlight exposure and consumption of vitamin D food source.

Various multivitamins contain plain vitamin D3 (standard vitamin D) are considered as a nutritious supplement and now many of it are available in the market. Besides that, hydroxylated vitamin D3 in form of calcitriol and alfacalcidol are also available now. Calcitriol is an active vitamin D3 (that has undergone complete hydroxylation) that can directly work with vitamin D receptor and increase the absorption of calcium in the guts.

The lack of vitamin D causes muscle weakness, increasing risk of fracture[6] and chronic diseases[15]. The deficiency of vitamin D happens in all age groups[14]. Some factors known to be influencing the number of vitamin D deficiency are: age, gender, BMI, melanine level (skin colour), the use of sun block cream, weather/season (place of living), and length of sun exposure period[16]. Less than 10% of female workers use cosmetics containing sun block, but the level of SPF in that cosmetic is high (above 20). The higher the SPF level, the more prevention of sunlight spectrum absorption that is useful for synthesizing vitamin D in skin (UVB) occurs. A study of 20 people long-term sunscreen users in US by Matsuoka *et al.* in 1988 found that sunscreen users have lower level of 25(OH)D serum than those who do not[17]. The use of sunscreen may cause vitamin D deficiency. The sunscreen will block the sunlight so the production of vitamin D under the skin decreases. The higher SPF applied to the skin, the lower the vitamin D will be produced. The use of sunscreen with SPF 15 will reduce the vitamin D production in the skin up to 50% and SPF 30 up to 97.5%[18].

The result of the interview showed the average duration of subjects contact with sunlight is around 18.4 min and the face, hand, and feet are most often body parts that contact with sunlight. This contact happens before 07:00 am and after 16:00 am. Skin is the first body defence mechanism toward the harmful external factors. When skin is exposed to the sunlight wave length of 290–315 nm, the provitamin D3 (7-dehydrocholesterol) on the epidermis layer of skin forms a previtamin D3 and then forms vitamin D3 through the process of thermal isomerizations hours after the contact[17]. The inappropriate timing of contact with sunlight is in the morning and afternoon. Some results of studies showed that the intensity of sunlight is low at 07:00 in the morning, but raising through the following hours until 10:00 am. The intensity of the sun's ultraviolet between 10 am–4 pm is the strongest[19].

Most female workers (61%) wear veils with bright colour (35.1%) (Table 4). The veil and clothes made of cotton they wore have a good sunlight absorption. Synthesis of vitamin D is attenuated by clothing, sunscreen, and influenced by melanin content of skins. Cotton and linen are less effective at blocking radiation than wool, silk, nylon, and polyester. Black wool reduced irradiance by 98.6% while white cotton reduced 47.7%[17].

Human can fulfill the need for vitamin D from sunlight and food. Vitamin D is synthesized in human skin (epidermis) from 7-dehydrocholesterol following exposure to UVB radiation with wavelength 290–320 nm. Only a few food sources naturally contain vitamin D, such as fish, liver oil, and egg yolk. Therefore, some foods are fortified with vitamin D[3]. The low contribution from the consumption of food containing vitamin D in this research caused the absence of relation between the level of vitamin D sufficiency with vitamin D serum ($P > 0.05$).

The use of veil is a variable that significantly influences the vitamin D status. Women wearing veil have higher risk of suffering vitamin D deficiency than women with no veil. This happens because the whole skin surface is covered by the clothes that the contact with sunlight is prevented. Studies in Egypt also showed the same result[20]. Wearing veil is not the direct cause of vitamin D deficiency because the subjects' habit of working indoor for 8 hours causing the lack of contact with sunlight. This causes the workers having rarely exposed to the radiation of UVB from the sunlight as UVB is shortly available before afternoon. The UVB is needed to synthesize the vitamin D in the skin layers. Skin has the great capacity to form vitamin D. Besides that, very few food naturally contain vitamin D. Time used for producing sufficient vitamin D in the skin depends on the variation in sun exposure, duration of contact, clothing, sunscreen, and skin pigmentation[17].

The contact with sunlight 5–10 min on the arm and feet or on arm, feet, and face 2 up to 3 times per week (until the skin goes a bit red), increases the consumption of the agent of vitamin D source, and supplement with vitamin D is a way that can be done to fulfil the need for vitamin D. Melanine pigment is a natural sun block, therefore, to form the same amount of vitamin D3, someone with more melanine pigment (darker skin) has to have more contact with the sunlight than people with brighter skin[17]. Sunlight exposure to skin for 10–15 min shortly before afternoon is equal to the supply of oral vitamin D with the amount of 15000 (375 µg). On the other hand, exposure of sunlight on hands, face, and hand (15% of whole body skin surface) is equal to 1000 IU of vitamin D[21]. Sufficiency of vitamin D among fertile females in Indonesia based on RDA 2013 is about 600 IU or 15 µg. As the forming of vitamin D in the skin layers is depending on the power of UVB radiation, duration of contact with sunlight and amount of skin pigment. The duration of contact with sunlight for woman with veil and brown skin must be increased 2–3 times (30–45 min) compared to those without veil or having brighter skin.

The distance from home to workplace and the use of veil are significant variables that influence the vitamin D status. It is suggested that Gunung Salak Ltd. provides a chance for the workers to have aerobic activity in the morning in order to help them get contact with sunlight before they start working. Besides that, further research must be done on the field of the influence of giving vitamin D supplement to the workers on the improvement of vitamin D status among them.

Conflict of interest statement

We declare that we have no conflict of interest.

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