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FOOD SOURCES OF VITAMIN D AND ITS DEFICIENCY IN WORKER WOMEN

Betty Yosephin¹, Faisal Anwar², Hadi Riyadi², Ali Khomsan², Nur Elly¹

¹*Nutrition Department of Health Polytechnique, the Indonesian Ministry of Health Bengkulu, Bengkulu, 38224, Indonesia*

²*Department of Community Nutrition, the Faculty of Human Ecology, Bogor Agricultural University, Bogor, 16680, Indonesia*

Corresponding author's email: patricknmom@yahoo.co.id

The main source of vitamin D comes from sunlight. The high vitamin D deficiency is strongly associated with low sun exposure. The sources of vitamin D in food was limited. This study is to identify food sources and food habits of female factory workers. This study used a cross sectional design and was conducted at PT Gunung Salak (garment factory) in Sukabumi, Indonesia. Sample population was female workers at child bearing age (18-40 years old) who works in garment factory, 154 women. The data collected in this study was primary type. The primary data was collected through interviews using a questionnaire and analysis of blood biochemistry (serum 25(OH)D). Vitamin D status analysis was performed by taking blood through the vein by laboratory analyst. Data of repondents' characteristics (name, date of birth, ethnic group, and education), food sources and food habits were collected by questionnaire. The finding obtained the respondents' average consumption of chicken eggs was 20.1 times per month with an average weight per consumption as much as 56.3 g. Chicken eggs were a food stuff which was consumed most frequently by the respondents. The kinds of fruits and vegetables containing vitamin D were very few and rarely consumed by the respondents. However, the respondents' fruit consumption was high enough for each consumption. The kinds of fruits which were most frequently consumed by the respondents were oranges, bananas, and papayas. The vegetable which was consumed most frequently was spinach. Spinach was consumed for 6.0 per month with the average weight of 55.6 g for each consumption.

Keywords: Food Sources, Worker Women, Vitamin D

1. INTRODUCTION

Worker women are a part of women of childbearing age who need to get attention because those women are rarely exposed to sunlight. This is connected with their working hours which start in the morning and end in the evening, and they work indoor so they are likely to be at risk of vitamin D deficiency coming from sunlight.

Vitamin D is solulable in the fat which consists of steroid molecular structures. Vitamin D is not merely as vitamin because it can be synthesized by the body with the help of sunlight exposure. Naturally vitamin D is found in fish oil, egg, margarine, liver, some fish such: mackerel, salmon, sardine, and tuna. Now there are many kinds of foods which contain fortified vitamin D, particularly milk products, biscuits, and cereals. Vegetable foods generally contain low vitamin D (Kauffman 2009). The more frequently one consumes foods containing high vitamin D, the more his/her requirement of vitamin D is likely to be fulfilled.

Several factors that are predicted to lead to high deficiency of vitamin D are; (1) low intake of food containing vitamin D such as milk and fortified food, (2) the tendency of reducing food high in fat, which is in turn resulting in low intake of vitamin D, (3) the use of sunscreen, and (4) lack of sunlight exposure (Holick 2004). The decrease in the role of vitamin D is characterized by defective bone mineralization process in children, in which severe vitamin D deficits may lead to the defective formation of the skeleton (rickets). Disruption of bone mineralization in the adult can cause hypocalcaemia and eventually leads to osteomalacia (Lips et al. 2001).

Vitamin D either vitamin D2 or vitamin D3 is rarely found in food. The main sources of natural vitamin D are fatty fish, such as salmon, mackerel or tuna, mushrooms and also egg yolks. Vitamin D can also be obtained from food fortified with vitamin D, such as cereal products, bakery products, baby food, milk, butter, cheese and margarine (Holick 2007).

The purpose of this study is to identify food sources and food habits of female factory workers, and examined the prospective correlation between the nutrient adequacy level and vitamin D status.

2. RESEARCH METHODOLOGY

This study used a *cross sectional* design and was conducted at PT Gunung Salak (garment factory) in Sukabumi, Indonesia. Sample population was female workers at child bearing age (18-40 years old) who works in garment factory, 154 worker women. The data collected in this study was primary type. The primary data was collected through interviews using a questionnaire and analysis of blood biochemistry (serum 25(OH)D). Serum 25(OH)D was determined using a chemiluminescent immunoassay (CLIA) method. Vitamin D status analysis was performed by taking blood through the vein by laboratory analyst. 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 chemiluminescent immunoassay method and analyzed in an accredited laboratory. The serum 25(OH)D level was used to evaluate the vitamin D status. The vitamin D status was classified as deficient (<30 nmol/L), and not deficient (\geq 30 nmol/L).

Dietary intake was assessed using the 24-h dietary recall method and nutrient intake determined using Indonesian food composition table. Supplement consumption was categorized into two groups that are yes and no. Data of respondents' characteristics (name, date of birth, ethnic group, and education), food sources and food habits were collected by questionnaire. Consumption of energy, protein, fat, vitamin D and calcium were gathered by FFQ and Food Recall and then categorized below Nutrition Adequacy Level (NAL) and above Nutrition Adequacy Level (NAL).

3. RESULTS AND DISCUSSION

3.1. Frequency of Food Consumption

Frequency of consumption of meat and vegetable which is containing high vitamin D can be seen in Table 1. The respondents' average consumption of chicken eggs was 20.1 times per month with an average weight per consumption as much as 56.3 g. Chicken eggs were a food stuff which was consumed most frequently by the respondents. The high consumption of chicken eggs was due to their price which was not so expensive and affordable for the respondents as well as their easy access. The consumption of beef sausage was on average 4.2 kcal in a month, with the weight of

10.6 g per serving. *Kembung* fish (a kind of sea fish) was consumed on average 2.5 times per month with an average weight of 20.2 g per consumption.

Milk was consumed 2.1 times per month with an average consumption as much as 18.1 g per serving. While the consumption frequencies tuna and cat fish were 1.6 and 1.3 times per month respectively with an average consumption of 16.8 g and 10.2 g respectively. The frequency of beef consumption was on average 1.4 times per month with an average weight of 12.5 g for each consumption.

Table 1. The frequency of consumption animal and vegetable foods containing vitamin D

Foods	Frequency (times/per month)		Weight (g/consumption)	
	Mean	SD	Mean	SD
Animal Foods				
Chicken egg	20.1	16.1	56.3	11.6
Beef sausage	4.2	8.9	10.6	15.7
<i>Kembung</i> fish	2.5	5.1	20.2	25.7
Milk	2.1	6.8	18.1	56.6
Tuna	1.6	3.6	16.8	22.7
Cat fish	1.3	7.5	10.2	22.5
Beef	1.4	5.1	12.5	16.5
Ice cream	1.4	3.4	25.6	38.3
Yoghurt	1.1	4.8	13.4	49.5
Cheese	1.1	5.6	5.9	29.9
Beef Liver	0.9	3.7	4.7	13.0
Sardines	0.7	1.9	5.4	11.3
Shrimp	0.6	1.7	9.2	20.9
<i>Puyuh</i> egg	0.3	1.4	6.0	24.7
Skim milk	0.3	1.6	0.9	3.9
Butter	0.1	1.4	0.1	1.1
Vegetable food				
Margarine	3.0	7.9	3.9	6.2
Soybean milk	0.3	1.2	17.1	56.8

Ice cream, yoghurt, and cheese were consumed 1.4 and 1.1 times on average for each month with an average weight of 25.6 g, 13.4 g, and 5.9 g respectively per consumption. Even though ice cream was not consumed very frequently, the weight of its consumption was high enough. The consumption frequencies of beef liver and sardines were 0.9 and 0.7 times per month with an average of 4.7 and 5.4 g per consumption respectively. On average shrimp was consumed for 0.6 time per month with an average weight of 9.2 g per consumption.

Animal food materials which are rarely consumed by the respondents were quail egg, skim milk, and butter. The average consumption frequency of quail eggs was 0.3 time per month with the average weight of 6.0 g for each consumption. Skim milk was also consumed 0.3 time per month on average but with the weight of 0.9 g for each consumption. On the other hand, butter was consumed 0.11 per month with the weight of 0.1 g for each consumption.

Vegetable food stuffs containing vitamin D which were frequently consumed were margarine and soybean milk. The average consumption of margarine was 3.0 times per month with the average weight of 3.9 g for each consumption. While soybean milk was consumed 0.3 time per month with the weight of 17.1 g for each consumption. Even though soybean milk was very rarely consumed, its amount for each consumption was significant, that is, 17 g.

Table 2 Consumption frequency of vegetables and fruits containing vitamin D

Foods	Frequency (time/per month)		Weight (g/each consumption)	
	Mean	SD	Mean	SD
Fruits				
Orange	14.6	15.0	80.0	42.7
Banana	8.0	17.9	50.9	50.4
Papaya	6.1	11.3	66.8	71.3
Guava	1.7	9.1	22.7	46.1
Orange juice	0.6	2.8	22.3	68.7
Vegetables				
Spinach	6.0	8.6	55.6	60.6
<i>Kangkung</i> (water spinach)	4.3	6.0	32.3	36.4
Bean	4.3	7.6	29.7	27.4
Mushroom	4.1	9.3	36.2	39.9
Running bean	3.0	5.3	28.1	34.0
Broccoli	1.3	3.9	8.6	18.2

The kinds of fruits and vegetables containing vitamin D were very few and rarely consumed by the respondents. The kinds of fruits which were most frequently consumed by the respondents were oranges, bananas, and papayas. Oranges were consumed for 14.6 times per month with the average weight of 80.0 g for each consumption. While bananas were consumed for 8.0 times per month with the average weight of 50.9 g. Papayas were consumed for 6.1 times per month with the average weight of 66.8 g for each consumption. Guavas and orange juice were very rarely consumed. Guavas were consumed 1.7 times per month with the weight of 22.7 g. Orange juice was consumed 0.6 time per month with the weight of 22.3 g for each consumption.

The vegetable which was consumed most frequently was spinach. Spinach was consumed for 6.0 per month with the average weight of 55.6 g for each consumption. *Kangkung* on average was consumed for 4.3 times per month with the average weight of 32.3 g for each consumption. Whereas, beans were consumed 4.3 times per month with the weight of 20.7 g. Mushrooms were consumed for 4.1 times per month with the average weight of 36.3 g for each consumption. Running beans were consumed for 3.0 times per month with the average weight of 28.1 g. While broccoli was very rarely consumed, that is, only 1.3 per month with the average weight of 8.6 g per each consumption. Even though the vegetable consumption was high enough, the vitamin D content in the vegetables was not so high.

Table 3 Distribution of the worker women by nutrient adequacy level

Nutrient Adequacy Level	N	%
Energy		
Adequate ($\geq 100\%$)	16	10.4
Lack ($< 100\%$)	138	89.6
Protein		
Adequate ($\geq 100\%$)	47	30.5
Lack ($< 100\%$)	107	69.5
Fat		
Adequate (ages 19-29 $\leq 30\%$; 30-49 $\leq 25\%$)	100	64.9
Excessive (ages 19-29 $> 30\%$; 30-49 $> 25\%$)	54	35.1
Calcium		
Adequate ($\geq 100\%$)	4	2.6
Lack ($< 100\%$)	150	97.4
Vitamin D		

Adequate ($\geq 100\%$)	0	0.0
Lack ($< 100\%$)	154	100.0

The parameter used for determining the status of vitamin D in this study is the level of 25(OH)D or calcidiol. The vitamin D status of female workers is categorized into: 1) deficient, with the serum concentration of 25(OH)D under 30 nmol/L; 2) not deficient, with serum concentration of 25(OH)D above 30 nmol/L. The result shows that the level of 25(OH)D serum among the workers stands at 31.6 nmol/L. The vitamin D status based on the level of 25(OH)D serum is listed in the Table 4.

Table 4 Serum vitamin D status of worker women

Serum Vitamin D Status	N	%
Deficient (< 30 nmol/L)	73	47.4
Not deficient (≥ 30 nmol/L)	81	52.6
Total	154	100.0
$\bar{x} \pm SD$	31.6 \pm 10.6	

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 fish oil, egg, butter, liver, and fish like mackerel salmon, and tuna. Nowadays there have been foods with fortified vitamin D especially milk, biscuit, and cereal. Food from plants generally contains less vitamin D (Kauffman JM. 2009). The more often someone consumes food rich in vitamin D the better his/her need for vitamin D is fulfilled.

The prevalence of vitamin D deficiency in women of childbearing age (WCBA) in various countries in Europe, America, and Asia (Malaysia, Singapore, Thailand, Vietnam, India, Japan and Hong Kong) are varied from 42% to 90%. Until now, the study on the prevalence of vitamin D deficiency is rarely conducted, moreover on WCBA workers. Among several studies that had been conducted, for example Oemardi *et al.* (2007) found that the prevalence of vitamin D deficiency in women aged 45-55 years was 50%, while Setiati's study (2008) that involved 74 research subjects of women aged 60-75 years found that a deficiency of vitamin D was quite high at 35.1%. Recent study in Indonesia in 504 WCBA aged 18-40 years obtained an average concentration of serum 25(OH)D at 48 nmol/L with deficiency prevalence of 63% (Green *et al.* 2008).

Table 5 Correlation between the nutrient adequacy level and vitamin D status

Nutrient Adequacy Level (%)	Not-deficient (n=81)	Deficient (n=73)	Total (n=154)	P
Energy				
Adequate ($\geq 100\%$)	8 (50.0)	8 (50.0)	16 (100.0)	0.826
Lack ($< 100\%$)	73 (52.9)	65 (47.1)	138 (100.0)	
Protein				
Adequate ($\geq 100\%$)	23 (48.9)	24 (51.1)	47 (100.0)	0.546
Lack ($< 100\%$)	58 (54.2)	49 (45.8)	107 (100.0)	
Fat				
Adequate	52 (52.0)	48 (48.0)	100 (100.0)	0.840
Excessive	29 (53.7)	25 (46.3)	54 (100.0)	
Calcium				
Adequate ($\geq 100\%$)	3 (75.0)	1 (25.0)	4 (100.0)	0.363
Lack ($< 100\%$)	78 (52.0)	72 (48.0)	150 (100.0)	
Vitamin D				

Adequate ($\geq 100\%$)	0 (0.0)	0 (0.0)	0 (100.0)
Lack ($< 100\%$)	81 (52.6)	73 (47.4)	154 (100.0)

3.2. Habit of Supplement Consumption

A health supplement is a product for people’s health which contains one or more substances which are nutrients and medicines. Supplements which are nutrients are vitamin, mineral, and amino acid, whereas supplements which are medicines are generally taken from plant essence or animal tissues.

Individuals are at risk of vitamin D insufficiency (< 30 mmol/L of serum 25(OH)D), when the sunlight exposure they receive is limited, have dark complexion, their skins are protected from the sun by the glass, wear long dress, use sunscreen or have low intake of vitamin D from their diets. Prevention of this deficiency at the age of 19-50 years is conducted by taking vitamin D supplement at least 600 IU/day in order to prevent bone and muscle disorders. However, to increase serum 25(OH)D more than 30 ng/mL it is recommended to take 1500 to 2000 IU/day of vitamin D supplement (Holick *et al.* 2011).

Many multivitamins contain plain vitamin D₃ (vitamin D which is standard), which are nutrient supplements, and now they are available at many markets. In addition, now vitamin D₃ which has been hydroxylized in forms of calcitriol and alfacalcidol. Calcitriol is active vitamin D₃ (having passed complete hydroxylized) which can directly function by being bound with the receiver of vitamin D in the intestine so it is able to increase the calcium absorption in the intestine .

Table 6 Habit of supplement consumption

Habit of supplement consumption	N	%
Supplement Consumption		
Yes	57	37.0
No	97	63.0
Kinds 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	21.1
Herb/Tonic/Medicinal Plants	7	12.3
Others	5	8.8
Consumption frequency (times/week)	3.5 \pm 3.8	
Number of supplements consumed (tablet /consumption time)	1.1 \pm 0.3	

The distribution of the respondents who usually consumed supplements can be observed in Table 6. The kinds of supplements which were consumed by the respondents were vitamin C, vitamin D, vitamin E, iron mineral, multivitamin and mineral, herbs, and jamu (processed medicinal herbs). Most of the respondents did not consume supplements The respondents who were used to consuming supplement were 37.0% and the rest (63.0%) did not consume.

Table 7 Correlation between supplement consumption and vitamin D status

Supplement Consumption	Not deficient (n=81)	Deficient (n=73)	Total (n=154)	P
Yes	31 (54.4)	26 (45.6)	57 (100.0)	0.733
No	50 (51.5)	47 (48.5)	97 (100.0)	

Of those who were used to consuming supplements, most consumed supplements in form of vitamin, that is, vitamin C (24.5%). Another supplement which was consumed was vitamin D, that is, 14.0%. While the kinds of supplements which were consumed relatively high were multivitamin and mineral. The respondents which consumed supplement multivitamin and mineral were 21.1%. Some (12.3%) of the rest consumed vitamin E, 7.0% Fe, and 12.3% consumed herbs. The frequency of supplement consumption was 3.5 times per week with 1.12 tablets per consumption time.

The 18-to-40 year-old female factory workers who consumed supplements were 57. The majority of the female factory workers consumed supplements containing vitamin C, vitamin E and drinks to boost stamina while the habit of consuming supplements containing vitamin D (CDR) was done only by 8 female factory workers (Tabel 7). The result of this study concluded that the female factory workers who consumed supplements were 54.4% had their vitamin D belong to category not deficient but there was no correlation between the habit of consuming supplements and their vitamin D status (p value = 0.733).

4. CONCLUSION

Animal-sourced foods as a vitamin D source which were frequently consumed by the subjects were egg, sausage, and *kembung* fish, whereas vegetable-sourced food as a vitamin D source which was frequently consumed was margarine, eventhough the amount consumed was still relatively low. Fruit as vitamin D source which was frequently consumed was orange with an average consumption of three times/week and the amount consumed was 80.0 g/serving. The consumption of spinach as a source of vitamin D was only 1 to 2 times per week with an average consumption amount of 56 g/eating time. There were only 14% of the subjects who were used to consuming a vitamin D supplement and 21% consuming multivitamin and mineral.

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