Determinant Factors of
Vitamin D Status
of Female Factory Workers
at Childbearing Age

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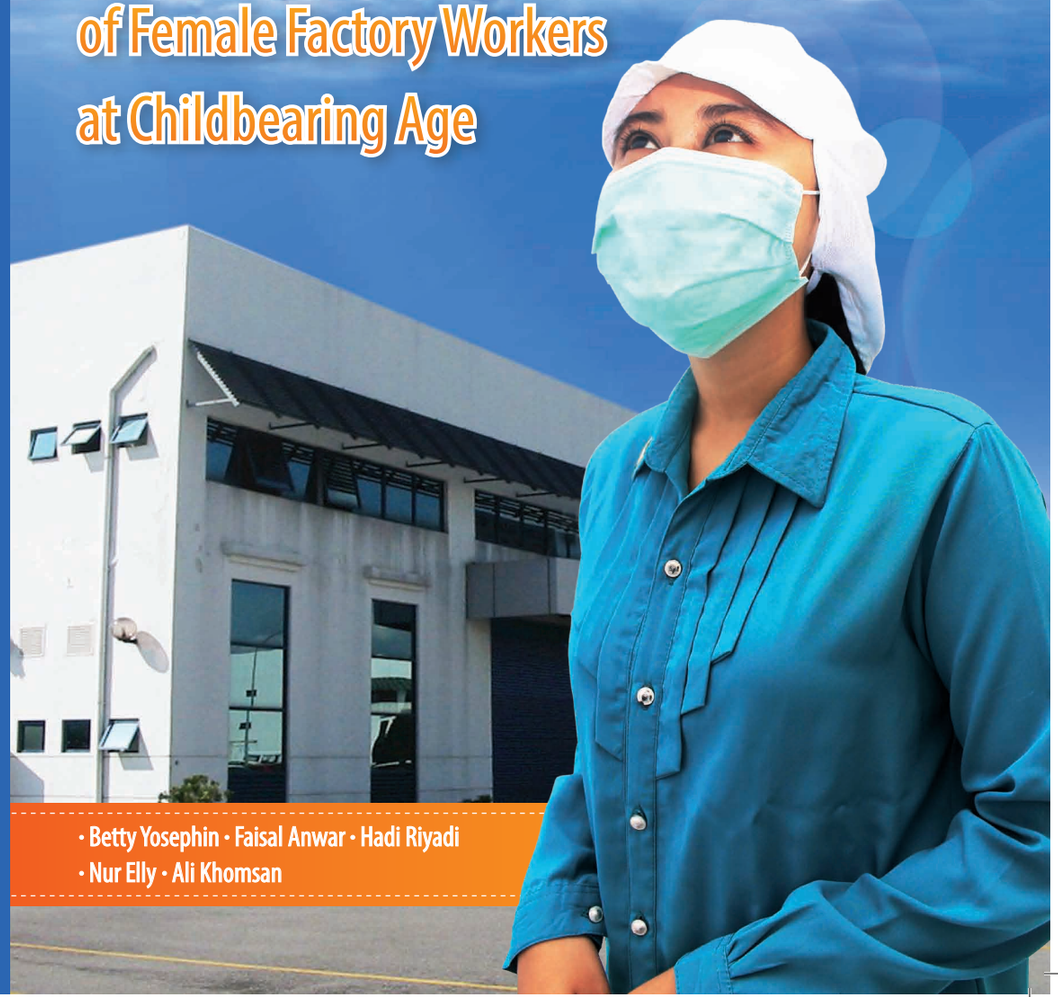

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Health Polytechnic of Bengkulu
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Summary

Female factory workers as a part of women of childbearing age need to get attention since they are susceptible to nutritional problems because of their physiological roles, giving birth and menstruation. Besides that, female factory workers, especially who work in garment industries are rarely exposed to sunlight. The workers work indoor so they are at risk of deficiency of vitamin D coming from sunlight. Research that has been done by Oemardi *et al*. (2007) on women who were 45-55 years old found the prevalence of vitamin D deficit was as many as 50%. The results of a study in Malaysia and Indonesia on women of childbearing age found the deficiency of this vitamin D in Indonesia was as many as 63% (Green *et al.* 2008). The objectives of this study were:

1. To identify the social economic characteristics of households of female factory workers.
2. To identify the contribution of female factory workers in household income.
3. To identify food habits and food consumption of female factory workers.
4. To measure intake of energy, protein, vitamin D and calcium of female factory workers and their nutritional status.
5. To identify sun exposure of female factory workers.
6. To analyze prevalence of deficiency vitamin D of female factory workers.
7. To analyze determinant factors of vitamin D status of female factory workers.

This study used a *cross sectional* design and was conducted at PT Gunung Salak (garment factory) in Sukabumi, West Java. The population of the samples in this study was women of childbearing age who were 18 to 40 years old. Of the total 171 female factory workers in the sample frame, as many as 155 samples were selected by a simple random sampling method. At the end 154 samples were analyzed.

The primary data was collected through interviews using a questionnaire, measurement, and analysis of blood biochemistry (serum 25(OH)D). Data of respondents' characteristics, habit of applying cosmetic/sun block, sun exposure, distance from home to factory, working duration, nutritional knowledge, physical activities including activities at home, sport, food habit, and health status were collected by questionnaire. Anthropometry data (weight and height) were collected by using a body weight scale (Omron Karada Scan Body Composition Monitor HBF-358-BW) and a body height measurement (microtoise). Vitamin D status analysis was performed by taking blood through the vein by laboratory analyst. The conclusions of this study were:

1. The female factory workers got an income of IDR1,110,000/capita/month. The ages of the subjects ranged ranged from 18 to 40 years. The subjects whose household members were <4 were 43.5% and those with 4-6 household members were 51.9%. In general, the last education was SD (44.8%), followed by SMP (35.7%) and SMA 18.2%. The majority of the subjects in this study was Sundanese (87.7%).
2. The female factory workers gave contribution to their household income as much as 62.1%. This shows a significant role of women as a pillar of household economy.
3. 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.
4. The subjects' average intakes of energy, protein, fat, calcium and vitamin D were 70%, 86%, 71%, 39%, and 5% of the RDA respectively. These intakes were still low to meet the daiy nutritional need. The nutritional status of the female factory workers showed that the prevalence of overweight and obesity was 33.7%.

5. Most of the subjects were not exposed to sunlight due to long working hours and working indoor, in addition to the subjects' application of cosmestic with high SPF (20-30 SPF). Besides that, the majority of the subjects wore veil everyday, and this reduced sunlight exposure.
6. Based on the result of serum 25(OH)D analysis it was found that the prevalence of being 'sufficient' was just 5.2%. The rest belonged to category deficient (47.4%) and insufficient (47.4%).
7. The factor which affected the prevalence of vitamin D defficiency was wearing veil. The women who wore veil had a risk of having vitamin D deficiency five times greater than the women who did not wear veil.

Based on the findings, the researchers recommended the following items:

1. Education on the importance of sunlight as the main source of vitamin D needs to be socialized either to the female factory workers or to the management of PT Gunung Salak. Because the source of vitamin D in food is very limited, it is suggested that they consume vitamin D supplements.
2. Outside their working hours (free days) the female factory workers are suggested to increase their physical activities outdoor to increase their sunlight exposure. Physical activities are also necessary to overcome obesity.
3. The government (the Manpower Department) as a manufacture controller is suggested to check the health and nutrition of the female factory workers to prevent nutrition deficiency and to improve their productivity.
4. It is necessary to conduct further studies on multiple intervention, namely, simultaneous provision of food supplements, food fortified with vitamin D, and nutritional education.

Acknowledgment

The research is made possible through a full financial aid from Neys-van Hoogstraten Foundation, The Netherlands. Therefore, the research team would like to express its deep gratitude for the support provided. We believe that such financial report to the research would bring great benefit to the understanding of the phenomenal problems of deficiency vitamin D of female factory workers at childbearing age. We hope the research would add an insight to such knowledge, which in turn would have an impact on the development of community health programs in preventing and solving the problems of deficiency vitamin D in Indonesian people.

To the Dean of **Health Polytechnic of Bengkulu and the** Chairman of Department of Community Nutrition, Bogor Agricultural University, the research team would also like to give its gratitude for granting us the opportunity to carry out the joint research with Neys-van Hoogstraten Foundation, The Netherlands. This research is a means of making cooperation with foreign agencies and enriching the dimension of research at Bogor Agricultural University.

The research team would also like to extend its thanks to the head management, staffs, and workers of PT Gunung Salak, Sukabumi, West Java who have allowed us to carry out the research in their factory. The team would like to give its highest appreciation to the research assistants: Catur Dwi Anggarawati SP and Puspita Dewi SGz, who showed extraordinary dedication during the research. Thank are further expressed to the enumerators (data collectors) who have worked with an extra ordinary patience in fields. They are Bogor Agricultural University (IPB) graduates who have applied the knowledge learned in the university.

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1
Introduction

1.1 Background

From the data of Central Bureau of Statistics (2003), the workers in Indonesia reached 100,316,007, where 64.63% of them were male workers and 35.37% female ones, and this increased in 2005, the number of the working-aged people in Indonesia reached 105,802,370, consisting of 63.97% of male workers and 36.03% of female workers. In 2009 approximately 116.5 millions of Indonesian people (69.0%) were projected to enter the working market, a number which is very "big", and it is expected that the number of the female workers also increases. This increase, besides viewed as a positive thing, meaning the increase of productive manpower, is also a challenge to be faced to improve the human resources. Furthermore, most of the workers are women of childbearing age, who come from middle and lower socio-economic groups, which are not free from health problems. The weak economic condition of the household makes the female factory workers get a difficulty to meet their needs of micronutrients.

Female factory workers as a part of women of childbearing age need to get attention since they are susceptible to nutritional problems because of their physiological roles, giving birth and menstruation. Besides that, female factory workers, especially who work in garment industries are rarely exposed to sunlight. This is connected with their working hours which start in the morning and end in the evening, and the workers work indoor so they are at risk of deficiency of vitamin D coming from sunlight (Looker *et al.* 2008).

Deficiency of vitamin D may cause inefficiency of calcium and phosphorus absorption so this increases parathyroid hormone (PTH). In addition, the most recent study showed that vitamin D deficiency increased the risk of insulin resistance, diabetes mellitus type 2, cell β disfunction, autoimmune

diseases, arthritis, multiple sclerosis, colon cancer, breast cancer, prostate cancer, and cardiovascular problems which were caused by hypertension, obesity, and lipid profile problems (Stroud *et al.* 2008).

Data on the prevalence of vitamin D deficiency in several countries are greatly varied. Vitamin D deficiency commonly occurs in Australia, Middle East, India, Africa and South America. Studies on the measurement of25(OH)D serum concentration among adult women of <50 years found the prevalence of vitamin D deficiency in several countries, that is, Vietnam 92.4%, Thailand 42–77%, Malaysia 48%, India 47%, 42% American women (Khor and Thuy 2011). A study conducted in Indonesia, for example, research that has been done by Oemardi *et al*. (2007) on women who were 45–55 years old found the prevalence of vitamin D deficit was as much as 50%. Setiati (2008) in her study involved 74 samples who were 60–75 years old found that the elderly who suffered from vitamin D deficiency were high enough, that is, 35.1%. The results of a study in Malaysia and Indonesia towards 504 of women of childbearing age, that is, 18–40 years old which was done in Kuala Lumpur and Jakarta found the average concentration of 25(OH)D serum was 48 nmol/L and the prevalence of vitamin D deficiency was 61%, while the deficiency of this vitamin in Indonesia was as much as 63% (Green *et al.* 2008).

The main cause of vitamin D deficiency is lack of sun exposure. Other factors are poor diet, obesity, sun blocking, and no vitamin D supplementation.

1.2 Objectives

1. To identify the social economic characteristics of households of female factory workers.
2. To identify the contribution of female factory workers in household income.
3. To identify food habits and food consumption of female factory workers.
4. To measure intake of energy, protein, vitamin D and calcium of female factory workers and their nutritional status.
5. To identify sun exposure of female factory workers.
6. To analyze prevalence of deficiency vitamin D of female factory workers.
7. To analyze determinant factors of vitamin D status of female factory workers.

2
Literature Review

2.1 Vitamin D

Vitamin D is of paramount importance to the forming of skeleton and mineral haemostatic, and also raising the absorption of calcium and phosphor. The lack of vitamin D may cause bone disorder named as ricketia among children and osteomalatia among adults. Besides that, the lack of vitamin D among adults may cause osteoporosis. The lack of vitamin D also disturbs the optimal function of immunity (Maggini *et al.* 2007). Some factors predicted to cause the high prevalence of the lack of vitamin D are: (1) The lack of consumption of food containing vitamin D like milk and fortified food, (2) the tendency of reducing fat-rich ingredients that causes the lack of vitamin D intake, (3) the use of sun block and (4) the lack of exposure to sunlight (Holick 2004).

The exposure of sunlight to skin is the best way to synthesize vitamin D from previtamin D under the skin. When somebody is exposed to ultraviolet, the skin transforms vitamin D into essential nutrition (Garrow *et al.* 1993). Ultraviolet B (UVB) ray with the magnitude of 290–315 nm, coming from the sun will be absorbed by the skin and then transform the 7–dehydrocholesterol in skin into previtamin D_3 and then will undergo a metabolism process in the liver until it turns into 25(OH)D and in kidney into 1.25 $(OH)_2D_3$ (Webb and Holick 1988).

The synthesis of D vitamin in the skin is influenced by some factors: level of melanine, age, the use of sun block, season, and latitude of a place. Melanine is very strong in absorbing the UVB radiation that the pigmentation of skin may reduce the synthesis of vitamin D. The skin pigmentation is considered as the body's natural sun block, therefore there is a decrease of vitamin D synthesis among people who often use sun block (Cannell *et al.* 2008). A person with white skin who is exposed to sunlight for long time during summer does

not suffer from vitamin D intoxication. This is because no matter how much pigments in the skin, the maximum amount of previtamin D that can be photosynthesised in the skin in a day is around 15% from the concentration of provitamin D_3 in the beginning. Exposure to sunlight will only later cause previtamin D_3 isomerising into two biologically inactive photoproducts, lumisterol and tachysterol (Webb and Holick 1988).

2.2 Function and Metabolism of Vitamin D

Vitamin D_3 comes from the result of synthesis in the skin that is diffused through the blood vessel by using α 2 *globulin vitamin D-binding protein* (DBP). This Cholecalciferol will be taken and carried by DBP. Around 60% of cholecalciferol bound to DBP will be carried to the organs especially liver and other organs like muscle and greasy tissue. While vitamin D_2 and vitamin D_3 coming from the food is absorbed in the form of micelles through passive diffusion and gets into the intestine. Only around 50% of the vitamin D intake is absorbed. While in the intestine, vitamin D_2 and D_3 bond themselves to kilo micron that later goes to the lymphatic system and carried to the circulation of blood vessels. Kilo micron carries about 40% of D_2 and D_3 in blood circulation. Some vitamin D_2 and D_3 is moved from kilo micron to the DBP to be carried to the extra hepatic network, kilo micron remnant will carry vitamin D_2 and D_3 to the liver (Gropper *et al*. 2009).

Cholecalciferol that reaches the liver will be metabolised by hydroxyls enzyme of liver to form an active metabolite. Hydroxylation of vitamin D_3 is done by the cytochrome enzyme P450 which are *25-hydroxylase, 1-hydroxylase, 24-hydroxylase. 25-hydroxylase* enzyme from liver will hydrolyse 25 *Cholecalciferol* carbon into calcidiol that really depends on the amount of vitamin D and its metabolite. *25-hydroxylase* works faster when the body is lacking in vitamin D. To change into an active form, vitamin D_2 and D_3 need two steps of hydroxylation, the first one is done in the liver by the hydroxyls enzyme of liver forming an active metabolite. Hydroxylation of vitamin D_2 and D_3 is done by 25-hydroxyls enzyme, resulting the 25(OH)D or the calcidiol circulated in biggest amount in the blood (Gallagher 2008; Gropper *et al*. 2009).

Calcidiol formed is the form of vitamin D that is circulated in biggest amount in the blood, but it is not biologically active, it needs splitting time about 10 days up to three weeks in the circulation. To be an active compound, calcidiol is carried to the kidney cortex to undergo the second stage of hydroxylation

done by α1-hydroxyls enzyme to form an active vitamin D that consists of 1.25 dehydroxite vitamin D or 1,25$(OH)_2D_3$ or mentioned as calcitriol. The concentration of calcitriol influences the activity of *1-hydroxylase,* the high level of calcitriol will slow interrupt the activity of *1-hydroxylase* that the concentration of *1-hydroxylase* is decreased. The work of *1-hydroxylase* of kidney that is lowered down will be substituted by the activity of 24-*hydroxylase* enzyme. This enzyme works in opposite to the function of *1-hydroxylase,* lowering the need for and forming calcitriol in the body to prevent excessiveness by forming metabolite. *24-hydroxylase* enzyme will hydroxylate the calcidiol and calcitriol into 24,25$(OH)_2D_3$ and 1,24,25 $(OH)_2D_3$. The form of metabolite 24,25$(OH)_2D_3$ will be released in the circulation network and bound to the DBP to be carried to the target network while 1,24,25 $(OH)_2D_3$can be carried to the kidney to be transformed into the compound that can be excreted (Gropper*et al.* 2009).

The variety of 25(OH)D concentration is influenced by season, with the higher concentration during summer and lower during winter or rainy season. During the winter or rainy season at the north latitude, sunlight has to travel a longer distance to go through the atmosphere and most UV are absorbed.

2.3 Sunlight Exposure

The variety of 25(OH)D concentration is influenced by season, with the higher concentration during summer and lower during winter or rainy season. During the winter of rainy season at the north latitude, sunlight has to travel a longer distance to go through the atmosphere and most UV are absorbed. Sunlight exposure is the best source of vitamin D and there is no case of vitamin D intoxication due to excessive exposure to sunlight because once previtamin D3 and vitamin D3 are formed, then they will absorb the UVB solar radiation and undergo the transformation into some biologically inactive photoproducts that will not cause vitamin D intoxication (Walker *et al.* 2003).

Indonesia that is rich in sunlight exposure for whole year is located at 6° of north latitude - 11°08' south latitude and 95°–141° east longitude. People living near equator who are exposed to sunlight without sunlight barrier have the 25 (OH)D concentration above 30 ng/mL. The use of chronic sun block may cause vitamin D deficiency. The use of sun block with SPF 8 reduces the production of vitamin D in the skin up to 93% and may rise to 99% with the use of sun block with SPF 15 (Holick 2003).

Carbone *et al.* (2008) conducted a survey among 50 adult male and female given a contact with artificial ultraviolet twice a week in twelve weeks. The result shows that there's an increase of 25 (OH) D serum and there is a negative correlation between the concentration of 25 (OH) D with the cholesterol HDL and LDL: HDL ratio.

2.3 Factors Influencing Vitamin D Deficiency

Vitamin D deficiency may happen in all population group with variety of risk factors. Some factors known to be influencing the case of vitamin D deficiency are: age, gender, melanin level (skin colour), the use of sun block, weather/ season (place of living), and duration and length of contact with sunlight (Fraser 1995; Norman 1998, 2008).

Number of vitamin D deficiency case reported from several studies stands at the range of 14–42% in general population. The newest data of 25 (OH) D serum measurement among adult females aged under the age of 50 are as follows: Thailand 42–77%, Malaysia 48%, India 47%, 42% American female (Khor and Thuy 2011). The research on the vitamin D deficiency prevalence in Indonesia is still rarely done as Indonesia is considered to be the country that is rich in sunlight for the whole year. The number of vitamin D deficiency case in Indonesia in the population of females aged 45–55 who are active and independent stands at the rate of 50%, 35.1 % among 74 subjects aged 60–75, and 63% among female aged 18–40 in Jakarta (Oemardi *et al*. 2007; Setiati *et al.* 2007; Green *et al.* 2008).

The main cause of vitamin D deficiency is the lack of contact with sunlight that makes the synthesis of vitamin D in skin decreased. Other than that, the body's need for vitamin D cannot be fulfilled to the fullest by the intake from food because the number of food containing vitamin D is very few and besides that, foods fortified with vitamin D is not enough yet to meet the body need (Holick and Chen 2008).

During the winter of rainy season at the north latitude, sunlight has to travel a longer distance to go through the atmosphere and most UV are absorbed. The distance that must be passed through by the UVB through the atmosphere is the function of solar zenith corner and depends on the position of latitude, season, intensity, and duration of sunlight exposure. Latitude position has an important influence toward the skin ability to produce previtamin D_3 (Webb and Holick 1988).

People with bright skin who are exposed to sunlight for long duration during the summer will not suffer from vitamin D intoxication. This is because no matter how much pigments in the skin, the maximum amount of previtamin D3 that can be photosynthesised in the skin is only 15% of the concentration of provitamin D3 in the beginning. Exposure to sunlight will then only cause vitamin D3 isomerised into two inactive photoproducts, lumisterol and tachysterol. Webb and Holick (1988) recommend the elderly with bright skin to expose their faces, arms, and hands to the sunlight twice up to three times a week within the a quarter of the time needed to reach 1 MED to fulfil the need for adequate vitamin D. Minimal Erythemal Dose is the lowest dosage on the skin area with certain magnitude that triggers slow pink erythema (Holick 2003).

Lifestyle, like the use of sun block, clothes, and local culture and obesity may influence the synthesis of vitamin D. Sun block like p-aminobenzoat acid slow down the absorption of sunlight spectrum that is useful for synthesising the vitamin D in the skin (UVB). The average value of 25(OH)D serum is lower among the user of chronic sun block compared to the control subjects (Lips *et al.* 2001). Besides that, clothes also gives protection from the sunlight spectrum. The research done by Robson and Diffey (1990) shows that clothes made of polyester provides lower level of protection from radiation, while cotton and jeans will provide more protection from the sunlight. Matsuoka *et al.* (1992) found that clothes may disturb the forming of vitamin D3. Moslems women with burqa have the risk of suffering from vitamin D deficiency 2.5 times higher than European women (Tsiaras and Weinstock 2011).

Obesity also influences the case of vitamin D deficiency due to the decrease of bioavailability of vitamin D3 in the skin and the existence of deposition of fat in the body. Obesity is related to the vitamin D deficiency. This is because vitamin D is trapped in fat and cannot easily go out. As the result, someone with obesity needs at least twice more vitamin D than the individuals without obesity to keep the vitamin D status normal with the level of 25 (OH) D between 30–60 ng/mL (Wortsman *et al.* 2000). In countries with four seasons, the number of vitamin D deficiency case is very much influenced by the season and skin colour. But in general, age stands as the factor that is quite dominant in influencing the case of vitamin D deficiency.

2.4 Vitamin D Supplementation among Females of Chilbearing Age

Various multivitamins containing plain vitamin D3 (standard vitamin D) which are the supplement of nutrition are now available in the market. Besides that, now there has been vitamin D3 that has been hydroxilised in form of calcitriol and alfacalcidol. Calcitriol is an active vitamin D3 (that has been completely hydroxilised) that can directly linked to the vitamin D receptor in the intestines that can raise the calcium absorption in the intestines. Alfa calcidol is an active synthetic analogue of vitamin D that has been hydroxilised, that physiologically will happen in kidneys only after the hydroxylation process in the liver. After orally consumed and absorbed in the intestine, 1α-OHD will be hydroxilised in the liver.

The research of Chiu *et al*. (2004) found that vitamin D is positively correlated with the sensitivity of insulin, supplying vitamin D will increase the insulin sensitivity up to 60%, more beneficial than the use of triglitazone or metformin (respectively increasing insulin sensitivity up to 54% and 13%). Besides that, this research also concludes that vitamin D can reduce the concentration of free fat acid, therefore it can improve the vitamin D sensitivity. Gedik and Akalin (1986) also got the fact that there is an increase of insulin secretion after vitamin D supplementation.

3

Conceptual Framework

Vitamin D deficiency define as a condition when 25(OH)D less than 20 ng/mL (50 nmol/L) (Ross*et al*. 2011). People who live in tropical climate and exposed to the sun should have 25(OH)D level above 30 ng/mL, however vitamin D deficiency could occur when most of the skin surface is covered and protected from sun exposure. Garment factory labour is one of the productive groups who are prone to vitamin D deficiency. This group is working indoor with clothing covered all of the body and face, often using a sunblock, and has behavior of avoiding the sun.

Study by Kauffman (2009) showed that the 25(OH)D level of people live near the equator exposed to the sun without using sunblock is above 50 nmol/L. In contrast, Green *et al*. (2008) discovered mean 25(OH)D serum level is 48 nmol/L and the prevalence of vitamin D deficiency is 63%.

Factors considered as the cause for high vitamin D deficiency are: (1) low intake of food contained vitamin D, (2) tendency of avoiding high fat food, (3) usage of sunblock, (4) obesity, (5) low consumption of vitamin D supplement, and (6) low sun exposure.

Obesity is associated to vitamin D deficiency because vitamin D is trapped in fat thus difficult to metabolize. As the result, obese individu need at least two times more vitamin D compared to non-obese individuals to maintain 25(OH)D serum level between 30 to 60 ng/mL (Wortsman *et al*. 2000). Usage of SPF8 (Sun Protector Factor) sunblock may cause vitamin D deficiency as its lower vitamin D production in skin to 93% and it will increase into 99% with the usage of SPF15 sunblock.

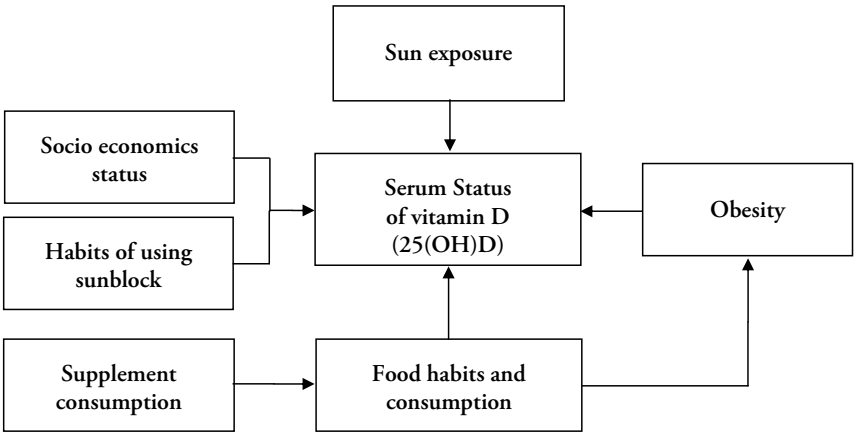

Figure 1 Conceptual framework

4
Method

4.1 Research Design, Location and Time

This study used a *cross sectional* design and was conducted at PT Gunung Salak (garment factory) in Sukabumi, West Java. The study was scheduled for 12 months, consisting of preparation (site survey, clearance, and training enumerators), data collection, data processing and analysis, report writing, and dissemination of the research results.

4.2 Sampling

Sample population was female workers at child bearing age (18-40 years old) who works in garment factory, Sukabumi, West Java. Meanwhile, sample was female garment factory workers who met the inclusion criteria of healthy, married, not pregnant nor being lactating, not being smoker nor alcohol drinker, not being in a special diet, and be able to participate in the research project by signing an informed consent. The sampling frame was obtained from the Human Resource Development (HRD) of PT Gunung Salak Garment Factory. Out of 171 female factory workers 155 of them were chosen by simple random sampling. It exceeded the total sample of 150 which had been planned by researchers. The extra sample was needed to anticipate the incompleteness of data during interview, measurement, or blood collection. There was one female factory worker who was not able to be measured by BIA (for anthropometric measurement) because of obesity. Therefore, the total sample became 154 female factory workers.

4.3 Data Collection

The data collection was conducted by enumerators accompanied by the research team as supervisors. All interviews and measurements (anthropometric nutritional status and anemia status, and health status) were conducted in factory.

The data collected in this study was primary type. The primary data was collected through interviews using a questionnaire, measurement, and analysis of blood biochemistry (serum 25(OH)D). Data of repondents' characteristics (name, date of birth, ethnic group, and education), habit of applying cosmetic/ sunblock, sun exposure, distance from home to factory, working duration, nutritional knowledge, physical activities including activities at home, sport (length, kinds and frequency), food habit, and health status (illness history and habit of supplement consumption) were collected by questionnaire.

Anthropometry data (weight and height) were collected by using a body weight scale (Omron Karada Scan Body Composition Monitor HBF-358-BW) and a body height measurement (microtoise). Vitamin D status analysis was performed by taking blood through the vein by laboratory analyst. The data collection activities went on smoothly without any significant obstacles, and were supported by the factory's management staffs. The items of data that had been collected is listed in Table 1.

Table 1 Methods of measurement and data collection

Variables	Instruments	Methods	Measurement results
• Economic	Questionnaire	Interview	Income per month Income contribution in HH
• Working hours	Questionnaire	Interview	Hours per day Days per week
• Distance	Questionnaire	Interview	Home-work distance Length of transport to work
• Age	Questionnaire	Interview	Years
• Education	Questionnaire	Interview	Elementary School Graduate Junior High School Graduate Senior High School Graduate Non-degree/ degree undergraduate

Table 1 Methods of measurement and data collection (cont.)

Variables	Instruments	Methods	Measurement results
• Nutritional knowledge	Questionnaire	Interview	Lack:<60% right Moderate: 60%–80% right Good: > 80% right
• Consumption of energy, protein, fat, vitamin D and calcium	Form of Food Recall Form of FFQ	Interview	<Nutrition Adequacy Level (NAL) > Nutrition Adequacy Level (NAL)
• Nutritional Status (BMI)	A body weight scale,Seca, and a body height measurement, microtoise	Weighing respondents' BW by Seca, and measuring BH by microtoise	Thin:<18.5 Normal: 18.5–25 Overweight : 25–27 Obesity:>27
• Serum 25(OH)D	Laboratory analysis	Taking blood through the vein, and having the blood analyzed at laboratory	Deficiency: <30 nmol/L Insuficiency: 30–49.9nmol/L Suficiency: ≥ 50 nmol/L
• Habits of using sunblock	Questionnaire	Interview	Frequency of using sunblock Sun Protector Factor (SPF) content in the cosmetics
• Supplement consumption	Questionnaire	Interview	Frequency of supplement consumption Vitamin D content in the supplement
• Sun exposure	Questionnaire	Interview	Duration of sun exposure per day

4.4 Data Analysis and Management

Data analyses were performed after data collection, coding, entry, editing, and cleaning. The Microsoft Excel 2010 and Statistical Packages for the Social Sciences were used to analyze parametric and nonparametric data.

The descriptive analyses were performed by calculating mean, standard deviation, and proportion estimation. The inferencia analyses used the regression models to determine factors affecting vitamin D status.

5
Socioeconomic Characteristics

5.1 Social Demography Characteristics

In the last two decades, it is predicted that the number of female workers taken into the industrial sector as labours has an increase of 4.3% every year (Tjaja 2000). According to Sayogjo (1989) in Tjaja (2000), that increase happens, at least, because of two factors. First, the industrial sectors like cigarette, textile, convection, and food and beverage industries are demanding meticulousness, perseverance and other characteristics which are generally the typical of female. Second, female workers are seen to be more obedient and cheaper that makes them more economically profitable for businessmen.

In this research, the respondents are females working in garment industry PT Gunung Salak, Sukabumi, West Java. The result of the research shows that the respondents are of the age range between 18 to 40 years old with the average age of 29.5 ±5.3 years. That age range belongs to the productive category for working. The research result of Hayutama (2013) states that age has a significant influence toward female working opportunity. It can be said that the older a female gets, the lower chance to work she has.

Household size is an important factor that determines the prosperity of the household and it has become the measuring tool to predict the level of household poverty. The smaller the size of the household is, the smaller allowance for the household spending that the household has bigger chance to be more prosperous (Lewin and Maurin 2005). Based on the result of the research, 43.5% of the respondents belong to small household, 51.9% belong to the medium household, and the rest 4.5% belong to the big household. In general, the average number of their household members is 3.8±1.6 persons.

Education is one of the important elements in determining the field of work to get into because there are some fields available only for those with certain levels of education (Fadah and Istatuk 2004). To work as a factory labour, there is no need to have a high level of education, expertise, or certain skills. This can be seen from the respondents' level of education that almost half of them graduated from primary or elementary school (44.8%), although some of them are graduated from junior high school (35.7%), senior high school (18.2%), even diploma (1.3%). With the average level of respondents that stands at 8.4±2.5 years, it can be said that their level of education is quite low.

The data of marital status shows that 79.9% of the respondents are married and the rest 20.1% are widowed. This shows that majority of the respondents are dominated by married women who have family that they have responsibility toward the family to help fulfilling the needs by working as a factory labour.

The development of industry has become a magnet that pulls the female factory workers. The majority of female factory workers who become the respondents in the research are Sundanese (87.7%) and Javanese (7.8%). The rest are Javanese-Sundanese, Batakese, Betawinese, Padangese, and Palembangese.

In this research, the respondents came from several working units. The largest proportion of the respondents worked in the sewing unit (54.5%), followed by finishing (11.0%), administration (6.5%) and cutting (6.5%). While the rest were spread from operator, quality control, helper, polybag, warehouse, etc.

Table 2 Socio-demographic characteristics of the female factory workers' households

Socio-demographic characteristics	n	%
Age (year)		
18–29	77	50.0
30–40	77	50.0
Mean±SD		29.5±5.3
Household Size		
Small (<4 people)	67	43.5
Medium (4–6 people)	80	51.9
Big (>6 people)	7	4.5
Mean±SD (people)		3.8±1.6

Table 2 Socio-demographic characteristics of the female factory workers' households (cont.)

Socio-demographic characteristics	n	%
Level of Education		
SD (Elementary School)	69	44.8
SMP (Junior High School)	55	35.7
SMA (Senior High School)	28	18.2
Diploma	2	1.3
Mean±SD (year)		8.4±2.5
Marital Status		
Married	123	79.9
Widow	31	20.1
Ethnic Group		
Sundanese	135	87.7
Javanese	12	7.8
Javanese-Sundanese	3	1.9
Batakese	1	0.6
Betawinese	1	0.6
Padangese	1	0.6
Palembangese	1	0.6
Working Unit		
Sewing	84	54.5
Finishing	17	11.0
Administration	10	6.5
Cutting	10	6.5
Operator	8	5.2
Quality Control	7	4.5
Helper	6	3.9
Polybag	4	2.6
Warehouse	2	1.3
Others*	6	3.9

* ironing, *kontik* (counting the results of sewing), land operator, folding, production, and stock.

5.2 Economy Charateristics

Household income is the total of family earnings from various sources: husband's income, wife's income, gift, loan and side business profit per month (Nurani *et al.* 2009). In this research, it can be inferred that there is a big contribution from the respondents' incomes toward household income with the average contribution of IDR 2,010,000/month or 62.1% from the total family income. The average family income is IDR 3,640,000/month with the income per capita of IDR 1,110,000/month.

Table 3 Contribution of the female factory workers in household income

Economic Characteristics	Mean	SD
Income		
Respondent (IDR/month)	2,010,000	444,581
Household (IDR/month)	3,640,000	1,696,060
Per capita income (IDR/cap/moth)	1,110,000	717,308
Expenditure (IDR/cap/month)		
Food	299,000	171,717
Non food	512,000	306,300
Total	811,000	413,875
Proportion (%)		
Mother income to household income	62.1	20.0
Food expenditure to total expenditure	38.4	13.1
Non-food expenditure to total expenditure	61.6	13.1

In general, the household income is allocated for various needs like food, daily needs, social activities, children's school needs, and other needs. The household expenditures in this research are grouped into two, food and non-food expenditure. The proportion of expenditure for non-food compared to whole expenditure may become the indicator of citizens' prosperity. According to the law of Engel, the bigger the proportion of non-food expenditure, the higher the level of prosperity. Based on Table 3, the average expenditure per capita per month is IDR 299,000 for food (38.4%) and IDR 512,000 for non-food (61.6%). Therefore, based on the law of Engel, it can be concluded that most household in this research are prosperous.

Vitamin D deficiency may happen in all population groups with variety of risk factors. Some factors known to be influencing the number of vitamin D deficiency case are: age, gender, melanin level (skin colour), the use of sun block, weather/season (place of living, duration and time of exposure to sunlight (Norman 1998; Fraser 1995).

The distribution of respondents based on social economy characteristics can be seen on Table 4. Age factor is known to be quite influential to the case of vitamin D deficiency. The distribution of respondents based on social economy characteristics can be seen on Table 3. The case of deficiency among those aged 18–29 years old appears to be 53.2%, while among those aged 30–40 is 41.6%. In the age of 18-29, there is no significant difference in the percentage of respondents who suffer from deficiency (53.2%) and those who do not (46.8%). The same as in the age of 30–40, there is no significant difference between the percentage of respondents who suffer from deficiency (41.6%) and those who do not (58.4%).

Respondents' household size does not influence the vitamin D status. 47.8% of respondents with small household suffer from vitamin D deficiency, and 52.2% do not. 47.5% respondents with medium household suffer from deficiency and 52.5% do not. While 42.9% of respondents with big household suffer from deficiency and 57.1% do not.

Table 4 The relationship between socio-economic factors with vitamin D status

Variable	Non Deficiency (n=81)	Deficiency (n=73)	Total (n=154)	p-value
Age (years)				
18–29	36 (46.8)	41 (53.2)	77 (100.0)	0.146
30–40	45 (58.4)	32 (41.6)	77 (100.0)	
Household Size (persons)				
Small (<4)	35 (52.2)	32 (47.8)	67 (100.0)	0.970
Medium (4–6)	42 (52.5)	38 (47.5)	80 (100.0)	
Big (>6)	4 (57.1)	3 (42.9)	7 (100.0)	
Education Level				
SD (elementary)	39 (56.5)	30 (43.5)	69 (100.0)	0.426
SMP (junior high school)	28 (50.9)	27 (49.1)	55 (100.0)	
SMA (senior high school)	14 (50.0)	14 (50.0)	28 (100.0)	
Diploma	0 (0.0)	2 (100.0)	2 (100.0)	

Table 4 The relationship between socio-economic factors with vitamin D status (cont.)

Variable	Non Deficiency (n=81)	Deficiency (n=73)	Total (n=154)	p-value
Nutrition Knowledge Score				
Good (>8)	8 (57.1)	6 (42.9)	14 (100.0)	0.903
Average (6-8)	43 (51.2)	41 (48.8)	84 (100.0)	
Low (<6)	30 (53.6)	26 (46.4)	56 (100.0)	

The level of education among respondents is various, ranging from elementary, junior high school, senior high school, and diploma. Education level does not significantly influence the case of vitamin D deficiency. 43.5% of respondents with primary education level suffer from deficiency, and 56.6% do not. 49.1% of respondents with junior high school level of education suffer from deficiency and 50.9% do not. 50.0% of respondents with senior high school level of education suffer from deficiency, and 50.0% do not.

The main cause of vitamin D deficiency is exposure to sunlight that causes the vitamin D synthesis in the skin decreased. Besides that, the body needs for vitamin D cannot all be fulfilled from food consumption, because the number of food containing vitamin D is very few. A good nutrition and health knowledge supports the selection of food containing vitamin D and exposure to sunlight that is expected to reduce the case of vitamin D deficiency.

The distribution of respondents suffering from vitamin D deficiency based on the level of nutrition knowledge can be seen on Table 4. Respondents' nutrition knowledge level shows no significant influence toward the case of vitamin D deficiency. Respondents with high level of nutrition knowledge can choose the food rich in vitamin D that can reduce the case of vitamin D deficiency. 42.09% of respondents with good nutrition knowledge score suffer from deficiency, and 57.1% do not. Meanwhile, 48.8% of respondent with average level of nutrition knowledge suffer from deficiency and 51.2% do not; 46.4% of respondents with high level of nutrition knowledge suffer from deficiency and 53.6% do not.

5.3 Nutrition Knowledge

Nutrition knowledge is one of the many factors with a role to shape someone's dietary habit; other factors are social economy, culture, and ecology. Nutrition knowledge somebody gets might come from mass media, either printed or electronic, and also from other sources (health officers or nutrition cadre).

Most (54.5%) of the female factory workers of childbearing age have average score of nutritional knowledge (scored 60-80) and very few (9.1%) of them have good nutrition knowledge (see Table 5). The average score of nutritional knowledge is 61 (categorised into average).

Table 5 Distribution of female factory workers based on nutrition knowledge score

Nutritional Knowledge	n	%
Good (score >80)	14	9.1
Average (score 60–80)	84	54.5
Low (score <60)	56	36.4
Score (mean±SD)	61±18	

With the level of formal education up to high school level, the respondents can gain nutritional knowledge while they were at school through the school subjects like biology or physical and health education. It is very important to give sufficient nutritional knowledge base to anyone that everyone can implement the balanced nutrition. Socialisation of balanced nutrition and its implementation on society level may create a healthy nation, far from diseases caused by malnutrition or over nutrition.

Creating a society with nutritional awareness is very important because nutrition can be one of the determining factors of human resources quality. With good nutritional knowledge, someone can do the food choice that is higher in quality as long as there is no economical problem. The problem in the developing country like Indonesia is the high number of social economy problems in the society due to the low level of education and income, therefore the nutritional knowledge alone cannot guarantee the improvement of nutritional habit.

Table 6 shows 10 nutritional knowledge questionnaire items given to female factory workers who become the respondents of this research. Item 1 that tells that egg is a source of protein was answered correctly by 82.5% of respondents. Egg is a popular food in the society; the price is relatively affordable (compared to other food from animal) and it is easy to cook it to make a side dish. Egg

contains cholesterol which is needed for producing vitamin D and gastric juice protecting the nerve cells and producing various hormones (Ministry of Agriculture and Ministry of Health of Indonesia 2010).

Item 2 that states that calcium is a nutritious substance needed by the body and cheese is one of the foods as the source of calcium was answered correctly by 55.2% of respondents. Cheese, despite the relatively large amount available in the market, is not a popular food, especially for the middle-low class society. Because of that, it can be understood that the understanding on cheese as the source of calcium is relatively low. Cheese is commonly eaten with plain bread. Due to its expensive price, its role is often substituted by margarine due to its lower price.

Table 6 Distribution of female factory workers who answered correctly the nutritional knowledge questions (n=154)

No	Statement	n	%
1	Egg is a source of protein	127	82.5
2	Calcium is a nutritious substance the body needs. Cheese is one of the good sources of calcium.	85	55.2
3	Vitamin D deficiency may result in bone problems.	74	48.1
4	The body that is lacking in food which are source of calcium will have bone problems.	91	59.1
5	Obesity can be caused by excessive consumption of greasy food.	149	96.8
6	Doing sports regularly and controlling food consumption (diet) is a way to overcome obesity.	143	92.9
7	Food as source of vitamin D are mostly among milk, fish, and egg	82	53.2
8	Sunlight is the best source of vitamin D	83	53.9
9	To get sufficient sunlight for the body, it is better to get it in the morning	13	8.4
10	Besides its benefit for bone, vitamin D is also useful for helping calcium absorption	85	55.2

Vitamin D together with calcium and protein are nutritious substances related to the case of osteoporosis (Sahota 2000). On the other hand, according to the research of Papadimitropoulos *at al.* (2002) supplementation of combined calcium and vitamin D may reduce the loss of bone mass and reduce the vertebral fracture accidents, femur fracture and other non-vertebral. Item

3 states that the lack of vitamin D may cause bone problems. Only 48.1% of respondents answered this item correctly. This low level of understanding shows that the function of vitamin D so far is not well known by the society. The next item given was when body is lacking in food containing calcium, then it will cause problems to the bone health. 59.1% of respondents answered that item correctly. Calcium as one of the most important minerals for bone formation has been well known by the respondents. The milk advertisement on electronic media generally emphasizes the importance of calcium for bone.

As many as 96.8% of the respondents have answered correctly the item that states that obesity may be caused by the excessive consumption of greasy food. This awareness is expected to be able to improve the respondents' dietary habits that they will not consume too much of greasy food. Many Indonesians are accustomed to consuming fries in forms of side dish or snack in daily life. The concern that now appears in Indonesia is that the society is considered to be too much in consuming fat, sugar, and salt. Meanwhile, the excessive consumption of greasy food may increase the size of belly and body weight (Drapeau *et al.* 2004). Basically, the better someone's nutrition knowledge, the more possible the balanced nutrition intake to happen.

The item about the importance of doing sports regularly and controlling food consumption (diet) are ways to overcome obesity was answered correctly by 92.9% of respondents. According to Jakicic and Otto (2005), physical activity may control the body weight in long term, therefore habit intervention is needed to increase the physical activity, one of which is doing sports for 30 minutes per day to gain control over body weight. Now obesity is an increasingly easy to find phenomenon in Indonesia. The understanding of the respondents on how to overcome obesity has already been really good that it is expected that they can implement the healthy lifestyle (especially doing sports) to reach the ideal body weight.

Vitamin is an organic compound in tiny amount but important to control the process of metabolism. Vitamin D is quite unique because it is naturally formed in the skin from the inactive precursor 7-dehydrocholeterol through the reaction that is helped by the presence of solar UV (Valentina 2014). Vitamin D is a fat liquid vitamin. Commonly, food as the source of vitamin D comes from fish, egg, cheese, margarine, cereal butter, yoghurt, and milk (Bowden *et al.* 2008). Item on foods as the source of vitamin D has just been understood by half (53.2%) of the respondents; this is an indication that there are still quite many respondents who have not known the source of vitamin

D. The knowledge that sunlight is the best source of vitamin D is also known only by 53.9% of respondents. Among the society, vitamin D may be less popular than vitamin A. Elimination of problems of the lack of vitamin A has become the national nutrition program involving *Posyandu* (Integrated Service Post) as the main agent to distribute high dosage of vitamin A capsules to the society.

To get sufficient sunlight from the body, it is better for someone to get it in the morning. The most appropriate time to give sunlight exposure is around 09.00 in the morning (Setiati *et al.* 2007). Only 8.4% of the respondents who answered that question correctly. The availability of sunlight in tropical country like Indonesia is plentiful, but if one has to go to work in the morning when the sun is not fully shining, then the potential vitamin D will not be obtained.

Besides its use for bone health, vitamin D is also useful for helping the calcium absorption; 55.2% of the respondents answered this nutrition item correctly. Still half of the respondents did not understand the role of vitamin D together with calcium in the body. The vitamin D endocrine system influences calcium and phosphorus metabolism by affecting the target organs: intestine, bone and kidney. The active metabolite, 1,25$(OH)_2$vitaminD3 (calcitriol) facilitates active calcium absorption in the intestine by stimulating the synthesis of calcium binding protein (calbindin) (Illich and Kerstetter 2000). Vitamin D obtained from the diet and sunlight exposure will then be dehydroxilised into 25 hydroxyvitamin D in the liver that later turns into 1.25$(OH)_2$D in the kidney. This active metabolite 1.25 $(OH)_2$D stimulates the calcium absorption from intestines and is also important for keeping the bones normal (Nurchasanah 2006).

The questionnaires items related to the nutritional knowledge given to the respondents in this research were mostly not answered correctly. Therefore, the effort on nutritional illumination to the respondents becomes very important. This can be done by the officers of the health department in cooperation with the managements of garment companies in the research area in Kabupaten Sukabumi.

6
Food Habits

6.1 Frequency of Food Consumption

Vitamin D is a vitamin which is solulable in the fat which consists of steroid molecular structures. Vitamin D is not merely as vitamin because vitamin D 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 as 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 vitamin D need is likely to be fulfilled.

The consumption frequency of animal and vegetable foods containing high vitamin D can be seen in Table 7. 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 for 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.

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 icecream was not consumed very frequently, the weight of its consumption was higher. 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 7 Consumption frequency of animal and vegetable foods containing vitaminD

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
Kembung 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
Icecream	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

Table 7 Consumption frequency of animal and vegetable foods containing vitaminD (cont.)

Foods	Frequency (times/per month)		Weight (g/consumption)	
	Mean	SD	Mean	SD
Sardines	0.7	1.9	5.4	11.3
Shrimp	0.6	1.7	9.2	20.9
Puyuh 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

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. 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 wwas 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 pe month with the average weight of 28.1 g. While brocolli was very rarely consumed, that is, only 1.3 pe 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 8 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
Kangkung (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
Brocolli	1.3	3.9	8.6	18.2

6.2 Energy and Nutrient intakes

Energy and nutrient intakes are displayed in Table 9. The energy intake of the female factory workers was as much as 1681 kcal. The energy intake was just to meet about 70% of the recommended dietary adequacy (RDA). That energy intake belonged to a low category, even in Table 9 is observed that 90% of the female factory workers' intake was below RDA. The energy intake which is always low will result in their decreasing muscular mass and may result in a negatif effect to their reproductive condition.

Table 9 The average consumption, adequacy and nutrient adequacy level of the female factory workers

Nutrients	Consumption		Adequacy		Adequacy Level (%)	
	Mean	SD	Mean	SD	Mean	SD
Energy (kcal)	1681	498	2486	510	70.1	24.7
Protein (g)	46.8	16.4	55.8	8.8	86.2	34.8
Fat (g)	47.4	22.7	67.6	7.5	70.6	33.6
Calcium (mg)	404	239	1051	50	38.5	22.7
Vitamin D (IU)	32.3	64.7	600.0	0.0	5.4	10.8

The protein intake of the female factory workers was 46.8 g on average or just fulfilled appoximately 86% of the RDA. Therefore, two-thirds of the female factory workers had their protein intake below the RDA (Table 10). This low protein intake might be connected with the relatively expensive food containing protein while the female factory workers usually tried to limit their expenditures.

Table 10 Distribution of the female factory workers by nutrient adequacy level

Nutrient Adequacy Level	n	%
Energy		
Adequate (≥100%)	16	10.4
Lack (<100%)	138	89.6
Protein		
Adequate (≥100%)	47	30.5
Lack (<100%)	107	69.5
Fat		
Adequate (ages 19–29 ≤30%; 30–49 ≤25%)	100	64.9
Excessive (ages 19–29 >30%; 30–49 >25%)	54	35.1
Calcium		
Adequate (≥100%)	4	2.6
Lack (<100%)	150	97.4
Vitamin D		
Adequate (≥100%)	0	0.0
Lack (<100%)	154	100.0

The fat intake of the female factory workers was also low, that is, only 47.4 g. That fat intake only fulfills 70% of the RDA. In Table 10 all of the fat intakes belonged to the adequate category, even there were female factory workers whose fat intake was more than adequate if it is based on the energy contribution which comes from fat. Adequate fat intake will guarantee the fulfillment of essential fat acid need which is very important for the body.

The calcium intake of the female factory workers was very low, that is, just 404 mg. That calcium intake only meets about one-third of the RDA. In Table 10 is seen that 100% of the female factory workers had their calcium intake below the RDA. The continually low calcium intake will result in osteoporosis.

Their vitamin D intake was also low, that is, only 32 IU or only fulfilling 5% of the female factory workers' vitamin D need. In Table 10 is observed that 100% of the female factory workers had their vitamin D intake lower than the RDA. This low vitamin D intake is suspected because the female factory workers rarely consumed animal foods. The low vitamin D intake will worsen the emergence of osteoporosis among the female factory workers in the future.

In Table 11 are presented the results of chi square test to see the correlation between energy intake and nutrients, and vitamin D status. From the results of the tests is not found the correlation between energy intakes and nutrients, and vitamin D status. The fact that there was no correlation is suspected because energy intake and nutrients intakes are generally low.

Table 11 Correlation between the nutrient adequacy level and vitamin D status [n (%)]

Nutrient Adequacy Level (%)	Not-deficient (n=81)	Deficient (n=73)	Total (n=154)	p
Energy				
Adequate (≥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 (≥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 (≥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 (≥100%)	0 (0.0)	0 (0.0)	0 (100.0)	-*
Lack (<100%)	81 (52.6)	73 (47.4)	154 (100.0)	

* Undetected since for Vitamin D all of the respondents belonged to category 'lack' so a chi square test could not be performed.

6.3 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 generraly taken from plant essesnce or animal tissues.

Many multivitamins contain plain vitamin D_3 (vitamin D which is standard), which are nutrient supplements, and now they are available at many markets. In addition, now vitamin D_3 which has been hydroxilized in forms of calcitriol and alfacalcidol. Calcitriol is active vitamin D_3 (having passed complete hydrocilized) 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.

The distribution of the respondents who usually consumed supplements can be observed in Table 12. 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.

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.

Table 12 Habit of supplement consumption

Habit of supplement consumption	n	%
Sopplement Consumption		
Yes	57	37.0
No	97	63.0
Kinds of supplements		

Table 12 Habit of supplement consumption (cont.)

Habit of supplement consumption	n	%
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 ± 3.8	
Number of supplements consumed (tablet /consumption time)	1.1 ± 0.3	

In a due course the supplement use in a form of high-dosaged multivitamin is intended to overcome inflamation and to improve the body immunity. High-dosaged vitamin C isused to improve eye health, increase colagen content, and to speed up a wound recovery. Whereas, vitamin D is used to increase the bone intensity.

All minerals and most of vitamins cannot be produced by the human body so they must be obtained from outside the body, that is, food, especially fruits, vegetables, and animal foods. Therefore, to fulfill the need for vitamin and mineral it is necessary to consume balanced and diverse foods. In a certain condition, where vitamin and mineral coming from foods are unable to meet the body need, the supplements can be used as an alternative.

Table 13 Correlation between supplement consumption and vitamin D status [n (%)]

Supplement Consumption	Indeficient (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)	

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. The result of this study concluded that the female factory workers who consumed supplements

were 54.4% had their vitamin D belong to category indeficient but there was no correlation between the habit of consuming supplements and their vitamin D status (p value = 0.733).

7
Physical Activity and Exercise Habits

7.1 Physical Activity

Constant physical activities will maintain the physical health including the bone. In general the female factory workers who worked in the garment industry possessed light physical activities (37%) and moderate ones (62%) (Tabel 14). There were just 0.6% of the female factory workers whose physical activities belonged to heavy ones. The female factory workers' activities were generally sitting and standing, so there was no much movement done. The low physical activities will worsen the female factory workers' health.

Table 14 The physical activities of the female factory workers

Physical Activities	n	%
Light (≤1.69)	57	37.0
Moderate (1.70–1.99)	96	62.3
Heavy (≥2.00)	1	0.6
Mean±SD		1.72 ± 0.09

If calculated, the average value of their physical activities was 1.72 or belonged to the moderate category according to the criteria proposed by FAO/WHO/UNU (2001). In Table 15 are presented the correlation between physical activities and vitamin D status. In the tables it is observed that there was no correlation physical activities with vitamin D status (p=0.366). The fact that there is no correlation is suspected that the female factory workers were centred in light and moderate physical activities.

Table 15 Correlation between physical activities and vitamin D status [n (%)]

Physical Activities	Indeficient (n=81)	Deficient (n=73)	Total (n=154)	p
Heavy (PAL ≥ 2.00)	0 (0.0)	1 (100.0)	1 (100.0)	0.366
Moderate (PAL=1.70–1.99)	48 (50.0)	48 (50.0)	96 (100.0)	
Light (PAL≤1.69)	33 (57.9)	24 (42.1)	57 (100.0)	

PAL = Physical Activity Level

7.2 Exercise Habits

Female factory workers have to increase their physical activities ouside their daily work to be healthier, for example by doing exercise. However, the female factory workers who did exercises were very few (See Table 16). More than two-thirds of the female factory workers were not used to doing exercises. Kinds of sports which were usually performed by the female factory workers were gymnastics,walking, jogging, and skipping. Those exercises were just done about once a week (Table 17). The female factory workers only did exercises on Sunday.

The female factory workers' activities for doing exercises have to be increased by holding a routine exercise which is managed by the factory, for example 2 to 3 times a week, and at the end this will increase the female factory workers' productivity. The female factory workers who do routine exercises will be fitter.

Table 16 Habits of doing exercises among the female factory workers

Habits of doing exercises	n	%
Gymnastics		
Yes	23	14.9
No	131	85.1
Walking		
Yes	43	27.9
No	111	72.1
Jogging/Running		
Yes	25	16.2
No	129	83.8
Skipping		
Yes	3	1.9
No	151	98.1

Table 17 Frequency and length of doing exercises among the female factory workers

Habits of doing exercises	Frequency (times/weeks)	Length (minutes/per time)
Gymnastics (n=23)	0.9±0.6	50.4±25.6
Walking (n=43)	1.5±1.6	36.4±31.8
Jogging/running (n=25)	1.0±1.3	41.6±28.2
Skipping (n=3)	0.8±0.4	20.0±8.7

In Table 18 is presented the correlation between the female factory workers' habits of doing exercises and their vitamin D status. The result of statistical test showed that there was no association between the habit of doing exercises and vitamin D status. The fact that there was no correlation is suspected because the proportion of the female factory workers who did exercises was still very few and the frequency of doing exercises was also very low.

Table 18 Correlation between habits of doing exercises and vitamin D status [n (%)]

Habit of doing exercises	Indeficient (n=81)	Deficient (n=73)	Total (n=154)	p
Gymnastics				
Yes	8 (34.8)	15 (65.2)	23 (100.0)	0.064
No	73 (55.7)	58 (44.3)	131 (100.0)	
Walking				
Yes	20 (46.5)	23 (53.5)	43 (100.0)	0.347
No	61 (55.0)	50 (45.0)	111 (100.0)	
Jogging/Running				
Yes	10 (40.0)	15 (60.0)	25 (100.0)	0.168
No	71 (55.0)	58 (45.0)	129 (100.0)	
Skipping				
Yes	1 (33.3)	2 (66.7)	3 (100.0)	0.500
No	80 (53.0)	71 (47.0)	151 100.0)	

8
Sun Exposure

Table 19 shows that on average the working length of the female factory workers at the garment of PT Gunung Salak was 4.2 years with 5 working days per week and with 8.4 working hours per day. Most of the female factory workers used motorcycle to work (58.4%) with the average distance from their home to their working place of 5 km (Table 19 and 20). Besides using motorcycle as a means of transportation, approximately 24% of the female factory workers walked to and fro between their home to their working place. Whereas, the time needed to reach the working place from their home was about18 to 22 menutes.

Table 19 Working length and distance from home to the working place

Economic Characteristics	Mean	SD
Working length (year)	4.2	2.2
Number of working days (day/week)	5.0	0.2
Length of working time (hour/day)	8.4	0.5
Distance from home to the working place (km)	5.0	4.2
Length of time to reach the working place (minute)	18.0	11.6
Length of time to reach home from the working place (minute)	21.8	15.0

Table 20 Means of transportation mostly used to the working place

Economic Characteristics	n	%
Going to work		
On foot	37	24
Motorbike	90	58.4
Public transportation	27	17.5
Going back from work		
On foot	38	24.7
Motorbike	85	55.2
Public transportation	31	20.1

Viewed from glove wearing among the female factory workers of chilbearing age who rode motorbike to work everyday, most of them (87 people) did not wear gloves but there were only 22 people (14.3%) who did not wear any jacket when riding motorbike. The use of gloves and jackets may inhibit the sunlight penetration into the body.

Table 21 Glove and jacket usage among female factory workers riding motorbike

Wearing	n	%
Gloves		
Yes	3	1.9
No	87	56.5
Jacket		
Yes	68	44.2
No	22	14.3

Vitamin D deficiency can occur among all population groups with their various kinds of risk factors. Some factors which are known to affect the number of vitamin D deficiency prevalences, among others, are age, sex, melamine level (skin colour), sunblock usage, weather/season (living area), as well as the length and time of sunlight exposure (Fraser 1995; Norman 1998, 2008). There were only 10% of the female factory workers who applied cosmetics containing Sun Protector Factor (SPF) but its SPF content was very high (20 or over). The higher the SPF content is, the greater it will inhibit the absorption of sunlight spectrum which is is useful to the vitamin D synthesis in the skin (UVB). The sunblock applied by the subjects made their 25(OH) D serum lower than the 25(OH)D serum of the subjects who did not apply any sunblock (Lips *et al.* 2001).

Table 22 Distribution of respondent based on sunlight exposure

Sunlight exposure	n	%
Applying cosmetics containing sunblock		
Yes	15	9.7
No	139	90.3
SPF content of the cosmetics		
20	1	6.7
21	9	60.0
30	5	33.3

Table 22 Distribution of respondent based on sunlight exposure (cont.)

Sunlight exposure	n	%
Respondents' opinion that the sunlight exposure gives a bad impact for the health		
Yes	35	22.7
No	119	77.3
Parts of the body frequently exposed to the sunlight		
Face	153	99.4
Hands	135	87.7
Feet	89	57.8
The average length of sunlight exposure (minute/day)		18.4±21.4
Wearing a veil everyday:		
Yes	94	61.0
No	60	39.0
Veil colour worn daily:		
Dark	40	26
Bright	54	35.1
Clothe materials which is worn daily:		
Supporting the sunlight absorption[1]	131	85.1
Not supporting the sunlight absorption[2]	23	14.9

[1]Clothe materials which easily absorb sun exposure (catoon, shirt)

[2]Clothe materials which hardly absorb sun exposure (jeans, polyester, *sifon*, *spandex,* etc)

The interview result showed that there were 22.7% of the female factory workers who stated that sunlight exposure gave bad effects to the health. The average length of sunlight exposure for the subjects was around 18.4 minutes and the parts of their body which were frequently exposed to the sunlight were their face, hands, and feet. However, that sunlight exposure occurred before 7 a.m. and after 4 p.m.. Skin is the first shield of the body in the mechanism of fighting against external factors. The skin responses to the ultraviolet (UV) radiation are erythema, increase in the vitamin D synthesis, increase in the citokin production and in the melanogenesis process (Soter 1990).

In their daily life the majority of these female factory workers (61%) wore bright-coloured veils (35.1%). Whereas, the material of their clothes worn daily was a clothing fabric which supported the sunlight absorption, that is, cotton and elastic materials. Matsuoka *et al.* (1992) states that clothes may inhibit the formation of vitamin D_3.

When the skin is exposed to the sunlight with the 290–315 nm wave length, pro-vitamin D3 (7–dehydrocholesterol) in the epidermis skin layer which then forms pre-vitamin D_3 and then forms vitamin D_3 through an isomerisasi termal process for hours after the sunlight exposure (Holick 2004). The female factory workers who walked from their house to work or vice versa did not have a better vitamin D status (p value > 0.05). This is because the sunlight exposure in the morning and in the evening is not right. Some research results showed that the sunlight intensity was low at 7 a.m, increased in the next hours up to 11 a.m. After 11 a.m. the intensity was relatively stable and high up to 14 p.m., the intensity decreased and at 4 p.m. reached a similar intensity as it was at 7 a.m. (Setiati 2008; Yosephin 2014).

The factors which make the sunlight difficult to penetrate into the body are jackets and gloves worn when ones ride vehicle, wear a hat, and apply cosmetics containing SPF. In this study most of the female factory workers who did not wear gloves and jackets when riding motorcycle tended to have a better vitamin D status that the female factory workers who wore gloves and jacket (p values=0.092 and 0.087). This is possible because the times for going to and coming back from work are still in the morning or not too late evening so the sunlight exposure is low or little.

The finding of this study showed that the female factory workers who did not apply any sunblock when outdoor had their vitamin D status belong to category deficiency (p value=0.628). This is possible because their working hours is started in the morning and their working activities are indoor for a long time. Even though the female factory workers who work in the garment factory do not apply any sunblock and live in a country which has abundant sunlight, they could still suffer vitamin D deficiency because they did not have any outdoor activities (Islam *et al.* 2010). The sunlight exposure is the best vitamin D source and there is no case of vitamin D intoxication due to excessive sunlight exposure (Webb and Holick 1988). Individuals who lived close to the equator which were exposed to the sunlight without applying something like sunblock had their 25(OH)D concentration above 75 nmol/L (Kauffman 2009). Furthermore, the female factory workers whose perception was that the sunlight did not give any bad impacts to the health tended to have their vitamin D status belong to category indeficiency (p value = 0.354). This is possible since the female factory workers who held this perception tended not to avoid the sunlight, did not apply any *sunblock* but their opportunity to sunbath was limited (they worked indoor for a long time) (Holick 2007).

Table 23 Correlation between the sunlight exposure and vitamin D status [n (%)]

Variables	Indeficient (n=81)	Deficient (n=73)	Total (n=154)	p
Means of transportation to work				
On foot	19 (51.4)	18 (48.6)	37 (100.0)	0.862
Vehicle	62 (53.0)	55 (47.0)	117 (100.0)	
Means of transportation to home				
On foot	20 (52.6)	18 (47.4)	38 (100.0)	0.996
Vehicle	61 (52.6)	55 (47.4)	116 (100.0)	
Wearing gloves when riding motorbike				
No	43 (49.4)	44 (50.6)	87 (100.0)	0.092
Yes	0 (0.0)	3 (100.0)	3 (100.0)	
Wearing a jacket when riding motorbike				
No	14 (63.6)	8 (36.4)	22 (100.0)	0.087
Yes	29 (42.6)	39 (57.4)	68 (100.0)	
Applying sunblock when outdoor				
Never	74 (53.2)	65 (46.8)	139 (100.0)	0.628
Always	7 (46.7)	8 (53.3)	15 (100.0)	
Holding perception that the sunlight exposure gives bad impacts to the health				
No	65 (54.6)	54 (45.4)	119 (100.0)	0.354
Yes	16 (45.7)	19 (54.3)	35 (100.0)	
Their face is often exposed to the sunlight				
Yes	80 (52.3)	73 (47.7)	153 (100.0)	0.341
No	1 (100.0)	0 (0.0)	1 (100.0)	
Their hands are often exposed to the sunlight				
Yes	72 (53.3)	63 (46.7)	135 (100.0)	0.626
No	9 (47.4)	10 (52.6)	19 (100.0)	

Table 23 Correlation between the sunlight exposure and vitamin D status [n (%)] (cont.)

Variables	Indeficient (n=81)	Deficient (n=73)	Total (n=154)	p
Feet are often exposed to the sunlight				
Yes	48 (53.9)	41 (46.1)	89 (100.0)	0.698
No	33 (50.8)	32 (49.2)	65 (100.0)	
Wearing veil				
No	43 (71.7)	17 (28.3)	60 (100.0)	0.000
Yes	38 (40.4)	56 (59.6)	94 (100.0)	
Colours of veils which are frequently used				
Dark	15 (37.5)	25 (62.5)	40 (100.0)	0.619
Bright	23 (42.6)	31 (57.4)	54 (100.0)	
Clothe materials which is often worn				
Support the sunlight absorption	69 (52.7)	62 (47.3)	131 (100.0)	0.965
Do not support the sunlight exposure	12 (52.2)	11 (47.8)	23 (100.0)	

The main cause of vitamin D deficiency was a lack of sunlight exposure so the vitamin D synthesis in the skin decreased. The female factory workers in this study started to work from 7.30 a.m. for about 8 hours everyday. This condition seemed to affect the prevalence of vitamin D deficiency. The sunlight exposure which penetrated into their face, hands, and feet did not significantly correlate with their vitamin D status because the exposure time was relatively still inadequate and did not cause erythema.

Erythema is a vascular response to ultraviolet light (UV), in forms of increasing bloodflow in the skin which has been exposed to the sunlight. Immediate erythema is a bright red colour in the skin which happens soon after the skin is exposed to the sunlight, appearing in 30 minutes after there is no more exposure. Delayed erythema appears later within 2 to 6 hours, the peak is within 12 to 16 hours, and it disappears within several days (Walker *et al.* 2003).

Another factor which causes vitamin D deficiency of female factory workers is the clothes they wear; even though it functions as a screen to the sunlight spectrum. A study which was conducted by Robson and Diffey (1990) showed that clothes made of polyester protected the body from the sunlight so it was difficult to penetrate into the skin. The result of this study showed that the female factory workers which worn fabric which supported the sunlight penetration was not significantly associated with their vitamin D status (p value=0.965). The reason is that even though the female factory workers worn the clothes that supported the sunlight penetration (made of cotton), they did activities indoor from the morning until evening. Therefore, this did not give any positive impact to their vitamin D status (Matsuoka *et al.* 1992).

The result of this study showed that there was a correlation between veil wearing and vitamin D status (p value = 0.000). The veil covered a part of the face and it was worn within a long period, and acccordingly it was difficult for the skin to be exposed to the sunliht. Matsuoka *et al.* (1992) found out that the clothes could disturb vitamin D_3 formation. A study by Tsiaras and Weinstock (2011) concluded that the moslem women who worn a burqa (a veil) had a risk of vitamin D deficiency 2.5 times compared to the European women.

9
Health and Nutritional Status

9.1 Health Status

Based on Table 24 it can be explained that of 154 samples of the female factory workers of chilbearing age, just very few (0.6%) had a history of diabetes mellitus, 0.6% heart disease, 0.6% liver disease, 1.3% kidney disease, and 4.5% lung disease/respiratory-tract disease, and also 9.7% had hypertension history.

Table 24 History of the female factory workers' diseases

Diseases	n	%
Diabetes Mellitus		
Yes	1	0.6
No	153	99.4
Heart		
Yes	1	0.6
No	153	99.4
Lungs/repiratory tract deseases		
Yes	7	4.5
No	147	95.5
Kidney		
Yes	2	1.3
No	152	98.7
Liver		
Yes	1	0.6
No	153	99.4
Hypertension		
Yes	15	9.7
No	139	90.3

Table 24 History of the female factory workers' diseases (cont.)

Eventhough in this study there were just few female factory workers of childbearing age who had hypertension history, based on the result of a basic research health in 2007 showed that mortality and morbidity increased due to a sharp increase in hypertension and cardiovascular diseases. The mortality caused by non-communicable diseases which were dominated by hypertension among 24-to-45-year-old people was 24.45% and by cardiovascular disease 15.4%. The hypertension prevalence in Indonesia according to *Riskesdas* 2013 was 26.5%. The prevalence of DM, hyperthiroid and hypertension among the women tended to be higher compared to the men, and in the urban areas it also tended to be higher. In addition, the prevalence of hepatitis in 2013 was 1.2%, twice time higher than in 2007 (MoH 2013).

Most of the recent studies show that vitamin D deficiency can increase the risk of cardiovascular disease which is caused by hypertension (Pilz *et al.* 2012). Vitamin D deficiency is connected with osteoporosis and is suspected to increase the risk of cancer CVD (Hilger *et al.* 2014).

Based on the result of a study Muldowney *et al.* (2011) stated that there was an interaction between s25, iPTH and the cardio-metabolic risk factor which was caused by the increasing prevalence of the low vitamin D and obesity among adults so this needed a random control on the study of vitamin D among the people who were overweight. Most of the recent studies also show that vitamin D deficiency increases the risks of insuline resistence, diabetes mellitus type 2, autoimmune diseases, arthritis, multiplesclerosis, colon cancer, breast cancer, prostate cancer, and cardiovascular problems which were due to hypertension, obesity and problems of lipid profile (Stroud *et al.* 2008).

In this study the writers only present the description of disease history of the childbearing-aged female factory workers but do not correlate between the variable of disease history and vitamin D status, so it cannot be explained whether there is a correlation or not and how big the correlation is. Besides that, this study is a cross sectional one so it must be careful in explaining the cause and effect correlation.

9.2 Nutritional Status

Nutrtional status of the female factory workers was viewed from their body mass index (BMI). The nutritional status of the female factory workers is presented in Table 25. A few of the female factory workers (3.2%) still

belonged to category thin. However, there were also female factory workers who were overweight (BMI 25–27) and obese (BMI >27). The prevalence of the female factory workers who were overweight was 18.8 percent, while the prevalence the female factory workers who were obese was 14.9 percent. If it is viewed from their average BMI, 23.8, in general the female factory workers belonged to category normal.

Table 25 Nutritional status of the female factory workers

Nutritional Status	n	%
Thin (BMI<18.5)	5	3.2
Normal (BMI 18.5–25)	97	63.0
Overweight (BMI 25–27)	29	18.8
Obese (BMI >27)	23	14.9
Total	154	100.0
Mean±SD		23.8 ± 3.7

The parameter which was used to determine vitamin D status in this study was the level of serum 25 (OH)D or calcidiol. The concentration of calcidiol in the blood is 100 times greater. That is because more than 99% of 1.25 OH D (calcitriol) is bound with DBP and albumin and also has very short, that is, 4-6 hours; therefore, to assess one's vitamin D status measurement of the calcidion concentration is used (Gropper and Smith 2012). Besides that, the use of calcidiol as the parameter for the assessment of vitamen D status is because the metabolism of enzime 25 hydroxilase cannot be affected so the cakcidiol level is an adequate indicator for the level of vitamin D which comes from a synthesis in the skin and daily intakes, the calcidiol concentration is connected with many clinical manifestations of diseases.

The vitamin D status of the female factory workers in this study is categorized into 'deficient' if their serum 25(OH)D concentration is below 30 nmol/L, 'insufficient' if their serum 25(OH)D concentration is between 30 to 49.9 nmol/L, and 'sufficient' if their serum 25(OH)D concentration is above 50 nmol/L. The result of this study showed that the average serum 25(OH)D concentration of the female factory workers was 31.6 nmol/L, and there were only 5.2% of the female factory workers who had their vitamin D status sufficient. The status of the vitamin D based on serum 25(OH)D concentration is displayed in Table 26.

Table 26 Status of vitamin D among the female factory workers

Vitamin D Status	n	%
Deficient (<30 nmol/L)	73	47.4
Insufficient (30–49.9 nmol/L)	73	47.4
Sufficient (≥50 nmol/L)	8	5.2
Total	154	100.0
Mean±SD		31.6 ± 10.6

Indonesia belongs to a tropical country which has two seasons and accordingly it is rich of sunlight along the year. If compared to a study conducted by Green *et al.* (2008) in Jakarta, who reported that the concentration of serum 25(OH)D was 48 nmol/L (19.2 ng/mL), the finding in that study was higher than the finding in this study (only 31.6 nmol/L). This study also found out the prevalence of vitamin D deficiency among the childbearing aged women who worked for 8.4 hours for five days in a week at a garment factory, PT Gunung Salak, was higher than that in a study by Islam *et al.* (2010) who found that 87% the subjects had serum 25(OH)D <20 nmol/L. Islam *et al.* (2008) mention that the women who worked for 14-16 hours everyday in a garment factory have low serum 25(OH)D, that is, 36.7 nmol/L on average.

The impacts of vitamin D deficiency, among others, are bad tooth health, problems of bone health, an increasing risk of suffering diabetes type 1, cardiovascular diseases and increasing prevalence of fracture as well as increasing prevalence of cancer (Holick 2004).

In Tabel 27 is presented correlation between nutritional status and vitamin D status. The result of a statistical test showed that there was no correlation between nutritional status and vitamin D status. No correlation between the nutritional status and vitamin D status was hypothesized because their nutritional status was normal in general and there was only very few who were thin.

Table 27 Correlation between nutritional status and vitamin D status [n (%)]

Body Mass Index (kg/m^2)	Indeficient (n=81)	Deficient (n=73)	Total (n=154)	p
Thin (<18.5)	1 (20.0)	4 (80.0)	5 (100.0)	0.437
Normal (18.5–25.0)	54 (55.7)	43 (44.3)	97 (100.0)	
Overweight (>25.0-27.0)	14 (48.3)	15 (51.7)	29 (100.0)	
Obese (>27.0)	12 (52.2)	11 (47.8)	23 (100.0)	

This study which was conducted toward the female factory workers showed there was prevalence of vitamin D deficiency (<30 nmol/L), which was high (47.4%). This problem of vitamin D deficiency did not only occur in subtropical countries, which experience four seasons but also occur in tropical countries.

This study result is in line with a systematic revies done by Palacios and Gonzalez (2014), which show that vitamin D deficiency has become a health problem of the people from all age groups, even in countries with enough sunlight exposure all year round, such as in Middle East, especially women. Therefore, to know the factors that affect vitamin D deficiency, the nine independent variables which have a significant value $p<0.25$ by a chi square test were included in the logistic regression. This model was able to predict 68.2% of the vitamin D deficiency condition which happened correctly.

The home-to-office distance and veil wearing were significant variables which affected vitaminD status. The longer the distance of one's house to his/her office is the lower the possibility to suffer vitamin D deficiency will be. If viewed from the logistic regression equation, every 1 km increase in home-to-office distance will decrease the possibility of vitamin D deficiency as much as 0.141%. People whose houses are far from their office will spend longer time to sunlight exposure compared to those whose houses are closer to their offices. The result of a review by Kulie *et al.* (2009) shows that the time needed to produce enough inside the skin depends on the power of ultraviolet B (UVB) light, length of time to sunlight exposure, and amount of skin pigmen.

Vitamin D is a hormon precursor which exists in two forms, namely ergocalsiferol (vitamin D_2) which exists in food and cholecalsiferol (vitamin D_3) which is synthesized inside the skin by the sunlight. People can fulfill their need of vitamin D from food containing vitamin D or synthesis in the skin through the sunlight exposure (Kulie *et al.* 2009). The low contribution of consumption of food containing vitamin D in this study made no correlation between the adequacy level of vitamin D and serum vitamin D ($p>0.25$). Accordingly, food consumption was not included in this regression model.

The women who wore a veil have a risk of vitamin D deficiency 5 times higher than the women who did not. This can happen because the entire skin surface which is covered with clothes block the sunlight exposure. Studies in Libanon and Tunisia also showed similar results (Gannage-Yared *et al.* 2000; Meddeb *et al.* 2005). The veil wearing is not a direct cause of vitamin D deficiency.

Studies in Bangladesh and Jordan showed that there was no significant difference between serum vitamin D among the women who wore a veil and the women who did not (Mishal 2001; Islam *et al.* 2006). Kulie *et al.* (2009) states that people are able to meet their vitamin D need from food containing vitamin D or synthetis in the skin through sunlight exposure.

Table 28 Factors affecting vitamin D deficiency

Variable	B	Sig	OR (95% CI)
Intercept	1.186		
Age (0=18–29 years, 1=30–40 years)	-0.520	0.165	0.595 (0.286–1.238)
Proportion of the mother income to the household income (%)	-0.002	0.798	0.998 (0.979–1.016)
Home-to office distance (km)	-0.141	0.018	0.868 (0.772–0.976)
Wearing gloves when riding motorcycle (0=No, 1=Yes)	-0.933	0.088	0.393 (0.134–1.150)
Wearing jacket when riding motorcycle (0=No, 1=Yes)	0.926	0.093	2.525 (0.858–7.431)
Length of time for being exposed to sunlight without any cosmestic (minute)	-0.012	0.316	0.988 (0.964–1.012)
Wearing veil (0=No, 1=Yes)	1.676	0.000	5.344 (2.374–12.025)
Habit of aerobics (0=ya, 1=tidak)	-0.736	0.176	0.479 (0.165–1.390)
Habit of jogging (0=ya, 1=tidak)	-0.602	0.252	0.548 (0.196–1.534)

The low sunlight exposure might be because the subjects worked indoor for 8 hours (from 07.00 to 16.00). The subjects left for the factory at 06.00–06.45. This made the subjects lack of exposure to UVB radiation from the sunlight because the UVB sunlight is present in the morning up to before noon. The UVB sunlight is required to synthesize vitamin D inside the skin. Holick (2004) stated that more than 90% of the vitamin D need is fulfilled from sunlight exposure. Skin has a great capacity to produce vitamin D. In addition, there are very few kinds of food which naturally contain vitamin D, such as fatty fish, namely, salmon, mackerel, sardines, mushroom, and liver oil of cod fish.

A 5 to 10 minute sunlight exposure in the hands and legs or in the hand, legs and face for two to three times per week, improving consumption of food containing vitamin D, and vitamin D supplements are methods which can be done to meet the vitamin D need. Melanin pigment is a natural sunscreen; therefore to get a similar amount of vitamin D_3, the people who have greater melanin pigments (the darker brown skin) need to a longer sunlight exposure compared to the people whose skin color is pale (Holick 2004).

Sunlight exposure to the whole body for 10–15 minutes (until the skin gets rather red) in the morning before the noon is equal to a vitamin D intake orally as much as 15,000 IU (375μg). Whereas, sunlight exposure to the hands, face, and legs (15% of the body surface) is equal to 1000 IU vitamin D (Diamond *et al.* 2005). The vitamin D adequacy of childbearing women in Indonesia based on the recomended dietary adequacy of 2013 is as much as 600 IU or 15 μg. Because the production of vitamin D in the skin depends on the power of UVB light, the length of sunlight exposure, the amount of skin pigment, to lower the risk of vitamin D deficiency, the length of the sunlight exposure period for women wearing a veil and having dark brown skin is necessary to be increased to 2-3 times (30-45 minutes) compared to the women who do not wear any veil or who have light-coloured skin.

10
Conclusions and Recommendations

10.1 Conclusions

1. The female factory workers got an income of Rp1,110,000/cap/month. The ages of the subjects ranged ranged from 18 to 40 years. The subjects whose household members were <4 were 43.5% and those with 4–6 household members were 51.9%. In general, the last education was SD (44.8%), followed by SMP (35.7%) and SMA 18.2%. The majority of the subjects in this study was Sundanese (87.7%).
2. The female factory workers gave contribution to their household income as much as 62.1%. This shows a significant role of women as a pillar of household economy.
3. 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.
4. The subjects' average intakes of energy, protein, fat, calsium and vitamin D were 70%, 86%, 71%, 39%, and 5% of the RDA respectively. These intakes were still low to meet the daiy nutritional need. The nutritional status of the female factory workers showed that the prevalence of overweight and obesity was 33.7%.

5. Most of the subjects were not exposed to sunlight due to long working hours and working indoor, in addition to the subjects' application of cosmestic with high SPF (20–30 SPF). Besides that, the majority of the subjects wore veil everyday, and this reduced sunlight exposure.
6. Based on the result of serum 25(OH)D analysis it was found that the prevalence of being 'sufficient' was just 5.2%. The rest belonged to category deficient (47.4%) and insufficient (47.4%).
7. The factor which affected the prevalence of vitamin D defficiency was wearing veil. The women who wore veil had a risk of having vitamin D defficiency five times greater than the women who did not wear veil.

10.2 Recommendations

1. Education on the importance of sunlight as the main source of vitamin D needs to be socialized either to the female factory workers or to the management of PT Gunung Salak. Because the source of vitamin D in food is very limited, it is suggested that they consume vitamin D supplements.
2. Outside their working hours (free days) the female factory workers are suggested to increase their physical activities outdoor to increase their sunlight exposure. Physical activities are also necessary to overcome obesity.
3. The government (the Manpower Department) as a manufacture controller is suggested to check the health and nutrition of the female factory workers to prevent nutrition deficiency and to improve their productivity.
4. It is necessary to conduct further studies on multiple intervention, namely, simultaneous provision of food supplements, food fortified with vitamin D, and nutritional education.

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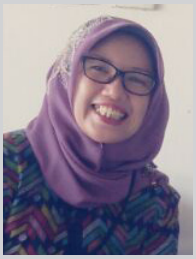

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