Research Square

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Sunlight Exposed Body Surface Area is Associated With Serum 25-hydroxyvitamin D (25(OH)D) Level in Pregnant Minangkabau Women, Indonesia

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Research article

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Abstract

Background: Vitamin D deficiency is highly prevalent in women, while living in a tropical country with year-round abundance of sunlight as the main source of vitamin D does not seem to guarantee adequate serum 25(OH)D. While living in the tropics, Minangkabau women are known to dress specifically according to their culture. This study was aimed to elucidate the association of sunlight exposed body surface area with serum 25(OH)D in pregnant Minangkabau women of Indonesia. Methods: A cross-sectional study was carried out on 88 Minangkabau women in late pregnancy. Data were collected by using questionnaire and 24-hour food recall, skin pigmentation was determined by Fitzpatrick scale, body surface area exposed to sunlight was assessed and serum 25(OH)D was quantified by ELISA method. Results: Nearly half of the subjects (n=40; 45.5%) were deficient in vitamin D (<20 ng/ml) with serum 25(OH)D level23.0±10.0 ng/ml (mean±SD) and estimated daily intake of vitamin D 5.6±3.9 µg/1000 kcal/day (mean±SD). Median percentage of body area exposed to sunlight was 15.8%. There were no differences in serum 25(OH)D levels according to sunlight exposure time, skin pigmentation type, and sunscreen use. Percentage of body area exposed to sunlight was positively correlated with serum 25(OH)D level (Spearman's ρ =0.403; p<0.001). Conclusions: Vitamin D deficiency is prevalent in pregnant Minangkabau women and they need to consider increasing their body area exposure to sunlight.

Keywords: body surface area, pregnant, sunlight exposure, vitamin D

Background

More than one billion people were deficient in vitamin D (Holick, 2011) making in a public health concern (Mithal, 2009). In South Asia, the prevalence of vitamin D deficiency (VDD) was estimated to be 70% or more while in South-East Asia it varies between 6-70% (Nimitphong & Holick, 2013). In China, it is reported that 63.7% pregnant women were vitamin D deficient (25(OH)D <50 nmol/L) (Yuan *et al*, 2017), while in Turkey the number was 94.8% (Pehlivan *et al*, 2002). In Vietnam, 60% of women in late pregnancy had low serum 25(OH)D level (<75 nmol/L) (Hanieh *et al*, 2014). A study in Kenya, a tropical country, showed that 51% of women had insufficient (<75 nmol/L) and 21% had deficient serum 25(OH)D level (<50 nmol/L) (Toko *et al*, 2016). VDD in pregnant women needs particular attention because of the potential unwanted birth outcome.

VDD during pregnancy may adversely affect the fetus, the newborn child, and even the early childhood. Monitoring serum level of 25(OH)D during antenatal period is warranted as a preventive measure to decrease morbidity during pregnancy and lactation period, and to mitigate adverse effect on the fetus, newborn, and child (Urrutia-Pereira & Sole, 2015). Studies in Poland and the US found that VDD in pregnant women with serum 25(OH)D <75 nmol/L was associated with increased risk of preeclampsia (Domaracki *et al*, 2016; Amegah *et al*, 2017). Lower serum 25(OH)D has been shown to associate with increased risk of macrosomy and vitamin D supplementation is advised during pregnancy (Wen *et al*, 2018). A study in Kenya showed that vitamin D insufficiency is associated with neonatal stunting (Toko

et al, 2016). Identifying factors related to serum 25(OH)D in a specific population is important to devise appropriate measures.

Geographical factor; like season (Van der Mei *et al*, 2008) and latitude (Kimlin *et al*, 2007), affects the intensity of ultraviolet B (UVB) radiation as the main source of vitamin D3 synthesis in the exposed skin (eds. Ross *et al*, 2011). Other factors such as skin pigmentation type (Nair & Maseeh, 2012), amount of sunlight exposed body surface area (Lee & Choi, 2009), sunscreen application and dressing (Misra *et al*, 2008) may also influence serum 25(OH)D level. Daily dressing habit may affect serum 25(OH)D level because the type of fabric used may prevent UVB radiation absorption by the skin. Moreover, the size of body surface area exposed to sunlight determines the amount of vitamin D synthesis in the skin (Misra *et al*, 2008).

Minangkabau women living in West Sumatra, Indonesia, are known to adhere to culturally acceptable dressing code in their daily life. It is common to cover whole body area except the face, hands and feet. A recent study in young Minangkabau women found that 97% of subjects were vitamin D deficient and that sleep quality, dietary intake, and sunscreen use were predictors of serum 25(OH)D (Silvia, 2019a). The research underlines that residing in tropical country does not guarantee the adequacy of serum vitamin D and other factors need to be considered. Considering the highly prevalent low 25(OH)D serum in Indonesian women, the mostly body-covering dressing characteristic of Minangkabau women, and the limited study on pregnant women, we undertook a research examining the association of sunlight exposed body surface area with serum 25(OH)D level in Minangkabau women during late pregnancy.

Methods

This study was approved by the ethics committee of Faculty of Medicine Andalas University (Approval No.005/KEP/FK/2019). Eighty-eight last trimester pregnant women were recruited from February to June 2019 from a public health center in Padang by purposive sampling.

Subjects were interviewed by using a standardized questionnaire and 24-hour food recall for the last two days was employed to assess vitamin D intake. Questionnaire-guided interview was performed to obtain data on duration of sunlight exposure during the last two days (in minute) (Kato *et al,* 2011), on habitual dressing when going outdoor (percentage of body surface area exposed to sunlight) (Lee and Choi, 2009), on skin pigmentation (Fitzpatrick's scale) (D'Orazio *et al*, 2013), and on sunscreen application (regular, irregular, non-user) (Misra *et al*, 2008). Skin pigmentation type was also assessed by observation (Sachdeva, 2009).

Serum 25(OH)D level was measured by ELISA method by using 25(OH)D ELISA Kit (Can-VD-510) produced by Diagnostic Biochem Canada (DBC®) (Silvia *et al*, 2019b; Aji *et al*, 2019).

Statistical analysis was performed using parametric tests (Pearson correlation and One-Way ANOVA) on normally distributed data. Data with non-normal distribution were logarithmically transformed (*log*10) to approximate normal distribution. Non-parametric test (Spearman correlation) was performed on data with non-normal distribution. Data with normal distribution are described as mean±SD while data with non-normal distribution are described as median and range.

Results

Our findings showed that serum 25(OH)D level in third trimester pregnant Minangkabau women was 23.0±10.0 ng/ml (mean±SD) and estimated daily intake of vitamin D 5.6±3.9 µg/1000 kcal/day (mean±SD). Nearly a third (29.5%) of the women were exposed to sunlight <30 minutes/day and median body surface area (BSA) exposed to sunlight was 15.8%. Most of the subjects were of type V skin pigmentation (86.4%) and were non-sunscreen user (79.5%). Other characteristics of subjects are presented in **Table 1**.

Comparisons were performed to examine whether the level of serum 25(OH)D in our subjects was different according to the duration of sunlight exposure, skin pigmentation type, and sunscreen use. The results showed that there was no statistically significant difference in serum 25(OH)D level according to the duration of sunlight exposure (<30, 30-60, >60-120, and >120 min/day; One-Way ANOVA; p=0.63; **Figure 1**), to skin pigmentation type (type III, IV, and V; One-Way ANOVA; p= 0.51, **Figure 2**), and to sunscreen use (regular, irregular, and non-user; One-Way ANOVA; p=0.72, **Figure 3**).

To examine the correlation between serum 25(OH)D level with sunlight exposed BSA, Spearman's correlation test was performed and the results showed that there was a statistically significant linear correlation between serum 25(OH)D level and percentage of BSA exposed to sunlight (R^2 linear=0.153; Spearman's ρ= 0.403; p=<0.001; **Figure 4**).

Discussion

Recent studies showed that VDD is common in Indonesian women (Aji *et al*, 2019; Putri *et al*, 2019; Silvia *et al*, 2019b). Our previous study in healthy young Minangkabau women found that 97.5% of subjects had VDD (Silvia *et al*, 2019b). In line with previous findings, in this study, we find that 81.8% of pregnant women have insufficient/deficient serum 25(OH)D level according to the scientific consensus (Grant &

Holick, 2005). Serum 25(OH)D level in our study (23.0±10.0 ng/ml (mean±SD)) is similar to those of pregnant women in other areas in West Sumatra (25.4 ng/ml; Putri *et al*, 2019), but higher than those of young Minangkabau women (median 10.5 ng/ml; Silvia *et al*, 2019b).

VDD in pregnancy is of particular importance because it may adversely impact the health of the newborn (Toko *et al*, 2016). Minangkabau women living in West Sumatra is known to dress according to their culture where only the face, hands, and occasionally feet are exposed to sunlight. As UVB radiation from sunlight plays a main role in the dermal synthesis of vitamin D from 7-dehydrocholesterol, the dressing habit that hinder sunlight exposure may affect serum vitamin D level (Misra *et al*, 2008). Our result supports this notion where we found that percentage of BSA exposed to sunlight correlates with serum 25(OH)D level, where 15.3% of serum 25(OH)D variability is explained by percentage of skin exposed to sunlight. Our result also in accordance with the finding of a cross-sectional study in Ethiopia where sunlight exposed BSA is a predictor of serum 25(OH)D level (Wayako *et al*, 2015). However, our finding is different from a study in healthy young Minangkabau women where no statistically significant correlation is found between sunlight exposed BSA and serum 25(OH)D (Silvia, 2019a). It is possible that the contrast between subjects is not enough in that study where 98% of the subjects wore hijab with median sunlight exposed BSA was 7.8%. In the current study, not all of our subject wear hijab when going outdoor, some subjects choose to wear sleeveless dress, creating a contrast in data sufficient to detect the correlation between the degree of sunlight exposed BSA and serum 25(OH)D level.

As most of the subjects in our study wears hijab (whole body-covering garment) only around 15% of their body surface area are exposed to sunlight. Characteristics of fabrics used for the garment, such as colors, thickness and weaving mode, may affect the garment's effectivity in blocking UVB absorption by the skin (Diehl & Chiu, 2010). Dark fabric two times more effective in absorbing UVB radiation compared to white one. There is a significant difference in vitamin D synthesis between whole body exposure compared to face-hands-feets only exposure to sunlight (Misra *et al*, 2008). Sunlight UVB stimulates vitamin D synthesis from 7-dehydrocholesterol, where it will be stored in adipose tissue or be hydroxylated in the liver into 25(OH)D and undergoes further hydroxylation in the kidney to form the active calcitriol (Vidailhet *et al*, 2012).

Sound advise for pregnant women is to monitor their serum 25(OH)D level and to exposed their skin to sunlight for 7-25 minutes from 10 am to 3 pm, at least twice a week, where face, arms and legs are exposed without sunscreen application should be adequate to induce vitamin D synthesis (Holick, 2002; 2007). Our study underlines the importance of skin exposure to sunlight in pregnant women living in a tropical country.

Conclusions

Vitamin D deficiency is prevalent in late pregnancy and increasing skin exposure to sunlight should be considered in pregnant Minangkabau women to mitigate this public health concern.

Declarations

Ethics approval and consent to participate

The research protocol was approved by the Committee of Medical Ethics (Approval No.005/KEP/FK/2019) of Faculty of Medicine Andalas. Thorough explanation of study objectives and protocol were given one week before the health examinations and written informed consent was obtained from each participant.

Consent for publication

Not applicable.

Availability of data and material

The dataset generated and/or analyzed during the current study are available from the corresponding author on a reasonable request.

Competing interests

None of the authors had any personal or financial conflict of interests.

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Authors' contributions

AO carried out the data collection, data analysis and wrote the manuscript. AF provided suggestions for the study design & data analysis. CI was responsible for obtaining funding, designing the study, providing feedback on data analysis and on manuscript writing and the overall management. All the authors approved the final version submitted for publication.

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Tables

Table 1. Characteristics of pregnant Minangkabau women in late pregnancy (n=88)

Characteristic	f	%	Mean	SD	Min	Max	Median
Age (year)			30.6	5:03	17	41	30.5
Gestational age (week)			32.6	3.7	28	40	32
Number of pregnancy			2.6	1.1	1	5	3
Upper arm circumference (cm)			27.6	3.9	20	38	27
Skinfold thickness (cm)			15.2	7.2	3	35	12
Serum 25(OH)D level (ng/ml)			23.0	10.0	7.4	51.5	21.1
Defficiency (<20 ng/ml)	40	45.5					
Insufficiency (20-31 ng/ml)	32	36.4					
Sufficiency (32-100 ng/ml)	16	18.2					
Vitamin D intake (µg/1000 kcal/day)			5.6	3.9	0.0	16.4	4.6
Sunlight exposed BSA (%)			15.2	6.8	4.9	28.4	15.8
Duration of sunlight exposure (minute/day)			110.8	156.7	0:00	990	60
<30	26	29.5					
30-60	18	20.5					
>60-120	25	28.4					
>120	19	21.6					
Skin pigmentation type (Fitzpatrick's scale)							
III	1	1.1					
IV	11	76					
V	76	86.4					
Sunscreen use							
Regular	7	8					
Irregular	11	12.5					
Non-user	70	79.5					

Figures

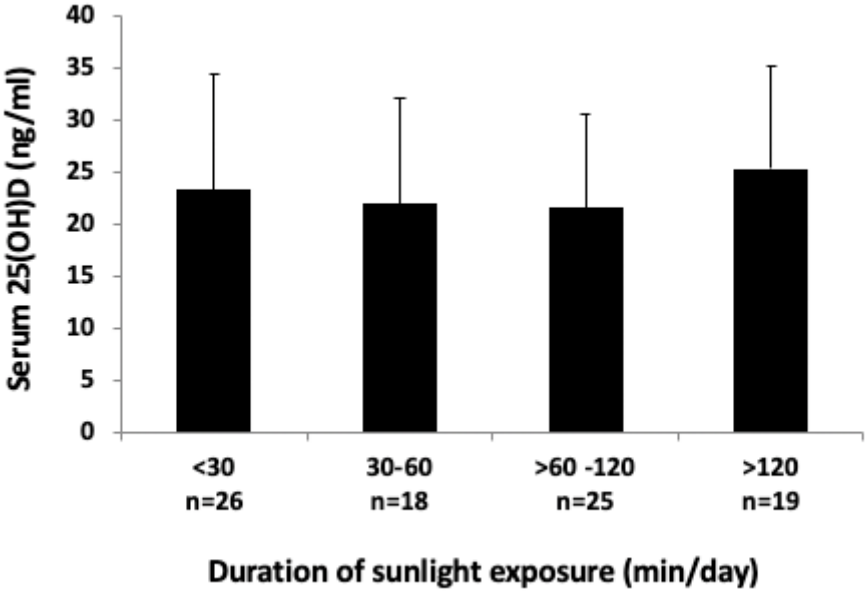

Figure 1

Serum 25(OH)D level (ng/ml) of pregnant Minangkabau women in late pregnancy according to the duration of sunlight exposure (min/day). No statistically significant difference in serum 25(OH)D between groups (p=0.63; One-Way ANOVA).

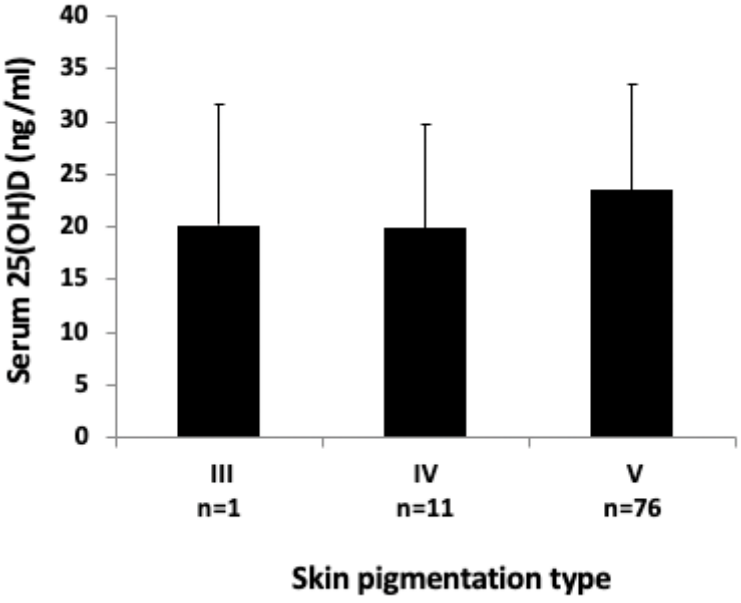

Figure 2

Serum 25(OH)D level (ng/ml) of pregnant Minangkabau women in late pregnancy according to their skin pigmentation type. No statistically significant difference in serum 25(OH)D between groups (p=0.51; One-Way ANOVA).

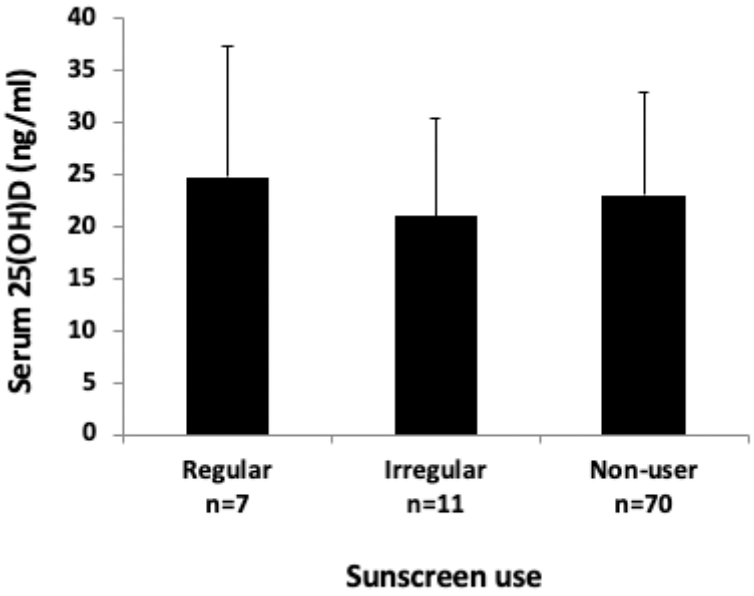

Figure 3

Serum 25(OH)D level (ng/ml) of pregnant Minangkabau women in late pregnancy according to their sunscreen use. No statistically significant difference in serum 25(OH)D between groups (p=0.72; One-Way ANOVA).

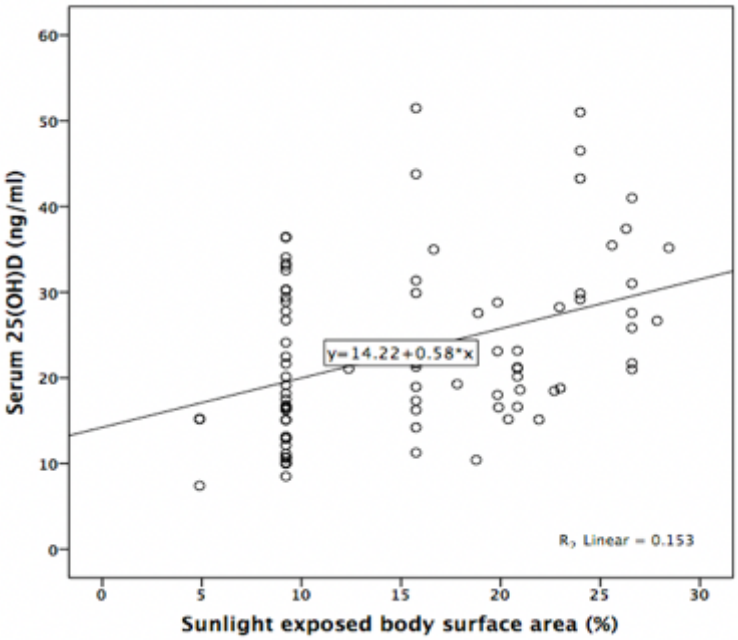

Figure 4

Correlation of serum 25(OH)D level (ng/ml) of pregnant Minangkabau women in late pregnancy with sunlight exposed body surface area (%) (Spearman's rho=0.403; p=<0.001).