# Determinants of sun exposure time among Sri Lankan pregnant women

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(Key words: ethnicity, pregnancy, Sri Lanka, sunlight, vitamin D)

## Abstract

*Introduction:* Sun exposure becomes extremely important for primary prevention of vitamin D deficiency (VDD) for high-risk populations who do not receive supplemental vitamin D. The present study investigated the determinants of sun exposure time and its association to vitamin D among Sri Lankan pregnant women in a primary health care population from the Colombo District.

*Methods:* This is part of a cross-sectional study of 383 third trimester pregnant mothers from primary healthcare (PHC) units in the Colombo District in Western Sri Lanka. A newly developed interviewer-administrated questionnaire was used as the main study instrument. In addition, a venous blood sample was collected for 25(OH)D levels. The univariate and multivariate analysis examined the determinants of sun exposure time. One-way ANOVA and Tukey post hoc test described the association between sun exposure time and vitamin D level.

*Results:* Most (56.9%) had <30 minutes of sun exposure per day. Low sun exposure time observed with Moor ethnicity (OR:7.45, 95% CI: 3.764, 14.741, p<0.001), lower parity (OR:0.53, 95%CI: 0.369, 0.753, p<0.001) and higher educational level (OR: 3.10, 95% CI: 1.606, 5.976, p=0.001). Women who spent ≥30 minutes exposed to sun between 9am to 3pm [F(3,373)=10.1, p<0.001] had higher vitamin D levels.

*Conclusions:* Educational level, parity, and ethnicity are important determinants of sun exposure time. A significantly lower serum vitamin D is demonstrated in pregnant women with exposure time <30 minutes. This evidence will allow health personnel to individualize the advice to improve vitamin D-related sun exposure behaviour in this population who are not routinely supplemented with vitamin D.

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## Introduction

Vitamin D deficiency is considered a growing public health issue in developing and developed countries [1, 2]. Potential adverse outcomes of vitamin D deficiency (VDD) during the perinatal period have received increasing attention [3, 4]. In brief, evidence suggests a connection between VDD during pregnancy and preeclampsia, gestational diabetes, and preterm delivery [3,4].

Sunlight is the main source of vitamin D and Sri Lanka has abundant sunlight throughout the year. Yet, vitamin D deficiency is high in all age groups [5,6]. The authors of this manuscript have previously reported high VDD rates among pregnant women in this population [7]. Thus, it can be assumed that living in a tropical country does not ensure adequate serum vitamin D. Factors such as season and latitude affect vitamin D production in the exposed skin. Also, colour, exposed Body Surface Area (BSA), dressing style, and sunscreen use may impact serum vitamin D level [8-11].

Disparities in vitamin D status are also related to ethnicity and cultural practices. For example, women of Muslim ethnicity wearing burka in Istanbul were vitamin D deficient compared to women in other clothing styles [12]. Sri Lanka has a multiethnic community. Yet, these factors related to sun exposure and vitamin D health have not been explored among pregnant women adequately. Since a primary health care population, as an important target group, mapping of individual characteristics would facilitate designing preventive interventions. Thus, this study analyzed determinants of sun exposure time and its relationship to serum vitamin D level in pregnant women in a primary healthcare population in the Colombo District, Sri Lanka.

## Materials and methods

*Study participants*

This was part of a cross-sectional study of pregnant women from primary healthcare units in Western Sri Lanka from October 2018 to May 2019 [7]. In brief, pregnant mothers in the third trimester were enrolled using stratified random sampling according to the population proportions of primary health care units. In the first stage, all the primary healthcare divisions of the Colombo District (n=15) were taken. In the second stage, two to four community clinics proportionate to the population density of each division were randomly selected. In the third stage, all the subjects in their third trimester of pregnancy were invited to participate on the data collection days. Invited participants were screened for eligibility. Women on multivitamin supplements having vitamin D, women with chronic medical and bone disorders, or using long-term medication that influences vitamin D metabolism were excluded. Informed consent was obtained before data collection. The guidelines of the Declaration of Helsinki were followed where necessary, and institutional ethical clearance was obtained from the Faculty of Medical Sciences of the University of Sri Jayewardenepura (ERC: USJP.FMS 20/18).

*Study instruments and the data collection procedure*

An interviewer-administered questionnaire was developed and used as the main study instrument. A pilot study assessed the clarity and the comprehensibility of the questionnaire. Section one obtained data on socio-demographic characteristics such as age, civil status, ethnicity, religion, and household income. In section two, the duration of sunlight exposure from 9 am to 3 pm was recorded. The skin colour scale measures were recorded using the New Immigrant Survey (NIS) skin colour scale [13,14]. In NIS, the interviewer rated the respondents' skin colour on a scale of "0 to 10", where "0" is the lightest possible skin colour (such as that of a person with albinism), and 10 is the darkest possible skin colour. The BSA exposed to sunlight in their usual attire was recorded with the aid of the rule of nine [15]. A venous blood sample was collected between 8 am and 12 noon and stored at –80°C until analyzed for 25(OH)D levels. DiaSorin LIAISON (DiaSorin Inc, Minnesota, USA) was used for vitamin D analysis. The limit of quantification is 4.0ng/mL. Analysis was carried out at the Biochemistry Laboratory of the University of Sri Jayewardenepura.

*Statistical analysis*

The SPSS® version 22.0 (SPSS, Chicago, IL, USA) was used for statistical analyses. Continuous variables were presented as mean with standard deviation (SD) or the median with an interquartile range (IQR) or the maximum and minimum where necessary and categorical variables were expressed as frequencies (n) and percentages (%). The factors associated with sun exposure time (<30 minutes/day vs. ≥30 minutes/day) were examined with simple logistic regression. Significant variables were taken as candidates for multivariate analysis. Covariates were excluded from the model if they were non-significant. Also, covariates with multicollinearity were not considered. The goodness of fit of the logistic model was checked with the Hosmer-Lemeshow test and found acceptable.

BSA exposed to sun was dichotomized based on previous literature (<20% vs. ≥20%) [16]. The other categorical variables were employment status (income-generating activity vs. homemaker), educational status (less than tertiary vs. tertiary) and BMI (underweight: <18.5 kg/m$^2$, normal:18.5 to <25 kg/m$^2$, overweight: 25.0 to <30 kg/m$^2$ and obesity ≥30 kg/m$^2$ [17]. According to Endocrine Society, USA [18], vitamin D deficiency is defined as serum 25(OH)D <20 ng/mL, insufficiency as 20-29 ng/mL and sufficiency as >30 ng/mL.

## Results

A total of 411 participants were enrolled. The response rate was 93.2%. Reasons for exclusion were incomplete questionnaires, and haemolysed blood samples. Three hundred and eighty-three were included in the final analysis. The mean age (SD) of the study subjects was 28.4 (5.9) years (Table 1). Most belonged to the Sinhalese ethnic group (75.3%). Most were not employed in an income-generating activity (76.6%). Thirteen percent had tertiary education. Most respondents (55%) had NIS skin colour scale of four or five.

Most (56.9%) of the participants had less than 30 minutes of sun exposure per day. We examined the association between sun exposure time (<30 minutes vs. ≥30 minutes) and potential predictors (age, ethnicity, PHC area, education, employment, income, parity, BMI, skin colour) (Table 2). Only the significant variables (age, ethnicity, education, parity, and skin colour) were considered multivariate analysis (Table 3). We examined the mediator effect of age on parity by carrying out univariate regression analysis with the interaction variable. The results showed that the impact of age as a mediator was not significant (OR: 0.96, 95% CI: 0.912, 1.019, p=0.19). Variables that did not contribute significantly to the model were excluded (employment, income, skin colour and age and parity interaction variable). Women of Moor ethnicity had a seven times higher likelihood of having low sun exposure time than Sinhalese (Table 3). Women with tertiary education had three times lesser sun exposure time than women with lower educational attainment. Higher parity increases the likelihood of having higher sun exposure time.

Eight percent (8%) exposed <20% of BSA to sunlight. Maternity frocks/skirts/blouses were the commonest attire; 7.6% wore an enveloping cloak from the top of the head to the ground (Abaya). Mean (SD) vitamin D concentration was 18.61 (7.57) and 62.4 % had VDD (<20ng/mL) and 31.3% had vitamin D insufficiency. One-way ANOVA showed a significant difference in vitamin D concentration between sun exposure groups [F(3,373) =10.1, p<0.001] (Figure 1). Subsequent Tukey post hoc test showed that vitamin D level was higher in exposure for >30 minutes compared to “not at all” (p<0.001), “<15 minutes” (p=0.001) and “15 - <30 minutes” (p=0.04). Serum vitamin D levels were significantly higher among the participants exposed ≥20% of BSA to sunlight compared to <20% [F (1,375) =37.18, p<0,001]

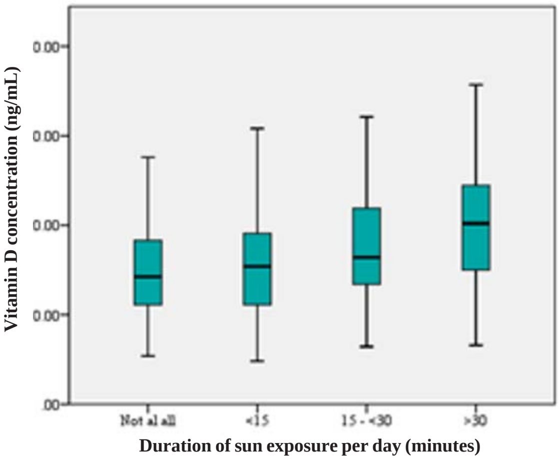


Figure 1. **Serum vitamin D level vs. duration of sun exposure during 9 am - 3 pm.**

**Table 1. Baseline characteristics of the respondents**

| *Characteristics* | *n (%)* |
|---|---|
| Age (years), mean (SD) | 28.4 (5.9) |
| Education | |
| Less than tertiary | 332 (86.7) |
| Tertiary | 51 (13.3) |
| Ethnicity | |
| Sinhalese | 289 (75.5) |
| Tamils | 42 (11) |
| Moors | 52 (13.6) |
| Primary health care area | |
| Urban | 293 (76.5) |
| Non-urban | 90 (23.5) |
| Occupation | |
| Homemaker | 293 (76.5) |
| Income-generating activity | 90 (23.5) |
| Parity | |
| Nulliparous | 188 (49.1) |
| Multiparous | 195 (50.9) |
| Pre-pregnancy BMI (n=383) | |
| Underweight | 57 (14.9) |
| Normal | 290 (75.7) |
| Overweight/obese | 36 (9.4) |
| Sun exposure during 9am - 3pm (min) | |
| Not at all | 60 (15.7) |
| <15 | 46 (12) |
| 15 - <30 | 112 (29.2) |
| >30 | 165 (43.1) |
| NIS skin color scale | |
| 2 | 38 (9.9) |
| 3 | 60 (15.7) |
| 4 | 105 (27.4) |
| 5 | 106 (27.7) |
| 6 | 53 (13.8) |
| 7 | 21 (5.5) |

Abbreviations: BMI: Body mass index, BSA: Body surface area

**Table 2. Univariate analysis for determinates of sun time**

| | *Standardized co-efficient (B)* | *95.0% C.I for B* | | *p-value* |
|---|---|---|---|---|
| | | *Lower* | *Upper* | |
| Age | 0.98 | 0.937 | 1.014 | 0.21 |
| Parity | 0.51 | 0.362 | 0.725 | **<0.001** |
| Education of the mother | | | | |
| Less than tertiary | Ref | | | |
| Tertiary | 2.71 | 1.475 | 4.989 | **0.001** |
| Ethnicity | | | | |
| Sinhalese | Ref | | | |
| Moor | 6.28 | 3.301 | 11.857 | **<0.001** |
| Tamil | 0.99 | 0.448 | 2.191 | 0.98 |
| Employment (homemaker) | 2.05 | 1.229 | 3.419 | **0.006** |
| *Income (>median) | 2.42 | 1.409 | 4.147 | **0.001** |
| Pre-pregnancy BMI | | | | |
| Normal | Ref | | | |
| Underweight | 0.99 | 0.507 | 1.911 | 0.96 |
| Overweight/obese | 0.95 | 0.577 | 1.561 | 0.84 |
| Skin colour | 0.70 | 0.578 | 0.833 | **<0.001** |

*More than median income for Colombo District in Sri Lanka.

**Table 3. Determinants of sun time with multivariate analysis**

| | *Standardized co-efficient (B)* | *95.0% C.I for B* | | *p-value* |
|---|---|---|---|---|
| | | *Lower* | *Upper* | |
| Education | | | | |
| Less than tertiary | Ref | | | |
| Tertiary | 3.10 | 1.606 | 5.976 | **0.001** |
| Ethnicity | | | | |
| Sinhalese | Ref | | | |
| Moor | 7.45 | 3.764 | 14.741 | **<0.001** |
| Tamil | 0.96 | 0.419 | 2.179 | 0.91 |
| Parity | 0.53 | 0.369 | 0.753 | **<0.001** |

Log-likelihood-ratio=374.0, Nagelkerke $R^2$ = 0.22, Chi squared ($\chi^2$)= 61.49, p<0.001

## Discussion

This is the first study to investigate sun exposure time and its determinants in Sri Lankan pregnant women. Beyond the local value of this information, it may be of interest to other Asian countries in the tropical belt with high vitamin D deficiency rates. It would provide information to the primary health care personnel to mediate individualized advice regarding sun exposure.

Sun time was highly dependent on ethnicity; Moor women had seven times lesser sun exposure than Sinhalese. High level of vitamin D deficiency has been found among Arab-American women in Michigan, attributed to conservative dresses [19]. Burka-clad pregnant women in Delhi were deficient in vitamin D with associated adverse maternal and foetal outcomes [20]. In addition to the dress of Moor females, they are expected to have specific culturally acceptable behaviour [21]. For example, unless they find a suitable outdoor environment that allows privacy, they would not engage in much outdoor activity.

Low sun exposure was observed among individuals with higher educational levels. The reasons for this remain uncertain, but the possible explanation might be differences in knowledge and perceptions on the risk and benefits of sun exposure (viz. skin cancer, cosmetic reasons). For example, women with higher educational levels may perceive skin cancer, cataracts, and skin burning as health threats and avoid the sun more than the less educated [22, 23]. In that context, advising extra sun exposure could be impractical and ineffective. Therefore, supplementing at least the pregnant women at high risk for deficiency is recommended.

Parity and skin colour influenced sun exposure time. The propensity to have a higher sun exposure was seen among women with higher parity compared to lower parity. It is likely that women with higher parity may be spending more time outdoors with work related to child rearing. In univariate analysis, sun exposure time was longer among participants in higher NIS scale. It can be hypothesised that dark-skinned subject can tolerate prolonged sun exposure without skin burns than light-skinned subjects [24, 25]. Thus, it supports the concept of individually adjusted advice on sun protection, rather than a more generalized approach.

The women who had less than 30 minutes of sun exposure during mid-day had lower vitamin D level. Previous research has confirmed that mid-day sunlight exposure is essential for adequate vitamin D production [26]. Regular sunlight exposure (forearms, hands and lower legs), without sunscreen, for 10 to 15 minutes, between 11 am to 3 pm helps maintain levels for Caucasians [27]. However, recommended sun exposure time is higher for South Asians: more than one hour daily to avoid vitamin D deficiency [28].

This study should be interpreted with the following limitations. The sample was obtained from primary health care units of one district; the findings cannot be extrapolated to the whole country. In addition, the present study utilized self-reported data which may be subjected to social desirability and recall bias. Lastly, we acknowledge that other potential determinants of sun exposure time such as type of occupation, available outdoor space, and time of the year (i.e. rainy season or not) were not assessed adequately and should be the objective of future studies.

## Conclusions and recommendations

Educational level, parity, and ethnicity are important determinants of sun exposure time. A significantly lower serum vitamin D is demonstrated in pregnant women with exposure time <30 minutes. This evidence will allow health personnel to individualize the advice to improve vitamin D-related sun exposure behaviour in this population who are not routinely supplemented with vitamin D.

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## Author contributions

Anusha Kaneshapillai: Conceptualization, Methodology, Data curation and, Formal analysis, Writing the original draft, Usha Hettiaratchi: Conceptualization, Methodology, Supervision Shamini Prathapan: Conceptualization, Methodology, Formal analysis, Supervision, Guwani Liyanage: Conceptualization, Funding acquisition, Methodology, Supervision, Formal analysis, Writing, Reviewing and Editing,

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## Conflict of interests

There are no conflict of interests.

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