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Original Article

# Sleep deprivation in the last trimester of pregnancy and inadequate vitamin D: Is there a relationship?

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**Abstract**

*Background*: Disturbed sleep is a significant health issue for pregnant women. Inadequate vitamin D intake is common among pregnant women and can affect many bodily systems. The purpose of this cross-sectional study was to test the hypothesis that serum vitamin D levels are low in pregnant women who have poor sleep quality in their last trimester.

*Methods*: We enrolled 92 pregnant women who were admitted to the Maternity Clinic of Turgut Ozal University (Ankara, Turkey) in their last trimester. Venous blood sampling was performed to determine serum 25-hydroxyvitamin D levels. Sleep quality was measured by the Pittsburgh Sleep Questionnaire. The Student *t* test and Chi-square test were used to evaluate the relationships between variables. Logistic regression analysis was used to identify independent predictors of the vitamin D level.

*Results*: The median score of the Pittsburgh Sleep Questionnaire was 6.2 ± 3.3 (range, 1–17). We determined that 43.5% (40) of participants had poor sleep quality. The mean number of sleep hours at night was 8.6 ± 1 hours (range, 6.30–11 hours), and the mean sleep latency was 20.3 ± 12.7 minutes (range, 5–60 minutes). Vitamin D levels were measured for 87 participants; the median serum level of 25 (OH) vitamin D was 22.9 ± 16.2 ng/mL (range, 4.9–99 ng/mL). Among all patients, we did not determine any significance between the vitamin D-deficient group and the non–vitamin D-deficient group with regard to the Pittsburgh Sleep Questionnaire Inventory (PSQI) total score and subcomponents scores of the questionnaire ($p > 0.05$). Among 37 patients with poor sleep quality and for whom the vitamin D level was measured, 56.8% (21) women had vitamin D deficiency, and 81% (30) women had vitamin D insufficiency. However, we did not find any significance between participants with poor sleep and participants with good sleep quality with regard to age, occupational status, relationship with her partner, prepregnancy body mass index (BMI), weight gain during pregnancy, being primiparus, length of labor, and mode of delivery. Our findings further showed that being in a low income family was associated with poor sleep quality.

*Conclusion*: Inadequate vitamin D and poor sleep quality are prevalent in pregnant women, but low levels of vitamin D are not associated with poor sleep quality. Further studies with larger sample sizes and studies that include preterm deliveries and special sleep disorders should be performed to understand this issue better.



*Keywords:* inadequate vitamin D; poor sleep quality; pregnancy

Conflicts of interests: The authors declare that they have no conflicts of interest related to the subject matter or materials discussed in this article.

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## 1. Introduction

Sleep is a physiological need of all human beings. Sleep needs may vary by age and sex; however, the National Sleep Foundation has recommended that adults obtain 7−8 hours of sleep per 24 hours.[1] Pregnancy is an extraordinary time of life for women and it is well-established that sleep is altered during human pregnancy.[2] Pregnant women particularly need sufficient sleep to nourish the development of their infants and for the energy they need for the labor and delivery process; however, the optimal sleep duration in pregnancy is unknown. Hormonal changes during pregnancy have many effects on sleep[3] and may cause fatigue and energy loss.[4] Severe sleepiness and poor sleep quality are common complaints among women during the third trimester of pregnancy. Many women describe low back pain, heartburn, and urinary frequency as the main causes of difficulty in falling asleep and frequent awakenings during sleep.[5]

Sleep deprivation and sleep disturbances during pregnancy may actually increase the risk of adverse pregnancy outcomes (e.g., gestational hypertension, preeclampsia, gestational diabetes, preterm delivery, unplanned cesarean delivery, growth restriction of the fetus, and postpartum depression).[6,7]

Vitamin D is a hormone that interacts with nuclear receptors to affect transcriptional changes in many cell types such as cells in the gut, bone, breast, prostate, brain, skeletal muscles, and immune system.[8] Vitamin D deficiency or insufficiency is common among pregnant women and leads to many adverse pregnancy outcomes. The supplementation of vitamin D during pregnancy may safely improve pregnancy and infant outcomes.[9]

The relationship between vitamin D deficiency/insufficiency and sleep disorders is not well understood, although recent reports suggest that inadequate vitamin D is involved in the development of symptoms of wake impairment commonly associated with sleep disorders.[10] The sleep-regulating substances tumor necrosis factor-alpha and interleukin 1 exhibit inverse relationships with 25 hydroxy vitamin D (25OHD).[11] McCarthy et al[12] found that more than one-half of patients in their sleep clinic who complained of sleep disruption and nonspecific somatic pain also exhibited vitamin D deficiency. In postmenopausal women, Grandner and colleagues[13] found a significant relationship between the circadian phase of sleep and dietary vitamin D intake. A later sleep acrophase, which is an indicator of sleep timing, was associated with increased level of dietary vitamin D.

This study aimed to assess sleep practices and sleep quality in women during the last trimester of pregnancy, and to document the association of these sleep factors with vitamin D levels. To our knowledge, this is the first study to investigate the effect of inadequate vitamin D on sleep disturbance in pregnant women.

## 2. Methods

### 2.1. Design and study population

This cross-sectional investigation was conducted in the Turgut Ozal University Maternity Clinic (Ankara, Turkey) between January 1, 2013 and July 1, 2013. Ninety-two women were enrolled.

The sample size was estimated to detect a minimum clinically significant difference in the association between the vitamin D level and postpartum depression with 80% power with 5% type I error level. The estimated sample size was 79 patients.

The study was approved by the Ethics Committee of the Fatih University Medical School (Istanbul, Turkey). Written informed consent was obtained from all participating women.

The participants met all of the following inclusion criteria: 18−45 years old, delivered an infant after at least 37 weeks gestation; singleton pregnancy; no systemic or psychiatric disorders; no previous diagnosis by a physician of a sleep disorder such as sleep apnea syndrome, restless legs syndrome, insomnia, or parasomnia; no use of any sleep medication; the woman was not a nightshift worker; and the woman took vitamin D supplement (500 IU/day) throughout the pregnancy.

### 2.2. Blood samples

Pregnant women who were in their 36$^{th}$ gestational week had their blood sampled for 25OHD. These venous blood samples were centrifuged at 4000*g*/min for 10 minutes. The serum was collected and stored at −80°C. Serum 25OHD concentrations were analyzed by high-performance liquid chromatography (DGU-20A3; Shimadzu, Kyoto, Japan). Serum 25OHD3 levels <20 ng/mL (i.e., 50 nmol/L) was classified as "vitamin D deficient" and levels < 32 ng/mL (i.e., 75 nmol/L) was deemed "vitamin D insufficient."[8]

### 2.3. Measure of sleep

The Pittsburgh Sleep Questionnaire Inventory (PSQI), was used to collect information about sleep quality during a 1-month time interval. The PSQI is a subjective sleep quality questionnaire that contains 19 multiple choice questions regarding sleep quality, the time taken to fall asleep, sleep problems, somnifacient use before sleep, and daytime sleepiness that interfered with daily activities. There are seven components scores that give a total score which reflects subjective sleep quality (range, 0−21). Each item received a score from 0 to 3, and a mean score greater than 5 indicated poor quality sleep.[14]

### 2.4. Other study factors

#### 2.4.1. Maternal data

Demographic information was collected such as maternal age and occupation, monthly income, gravida and parity, prepregnancy body mass index (BMI), weight gain during pregnancy, and the mother's relationship with her partner.

#### 2.4.2. Infancy data

Information collected and included the mode of delivery, any complications in childbirth, and the APGAR score.

### 2.5. Statistical analysis

For statistical analyses, we used the SPSS version 17.0 software (SPSS Inc., Chicago, IL, USA) for the Windows program. The Kolmogorov−Smirnov test was used to determine normal distribution. Descriptive statistics were presented as the mean ± standard deviation (SD) for continuous variables and as the count and percentage for categorical data. Groups with normal distribution and with homogeneous variances were compared by the Student *t* test. The Mann−Whitney test was used for data not normally distributed. The Chi-square test was used to evaluate relationship between categorical variables. The statistical significance level was set at $p < 0.05$.

## 3. Results

Ninety-two pregnant women participated in the present study. The characteristics of the mothers and their children are shown in Table 1. For all participating mothers, the mean PSQI score ± the SD was 6.2 ± 3.3 (range, 1−17). We determined that 43.5% (40) of participants had poor sleep quality.

For all participants, the median sleep time at night was 11:00 PM and the median time of waking up in the morning was 7:00 AM. The mean number of sleep hours at night was 8.6 ± 1.0 hours (range, 6.30−11.0 hours). The mean sleep latency was 20.3 ± 12.7 minutes (range, 5−60 minutes). Among all participants, 7.3% of the women self-reported snoring >3 days a week. Thirty-four percent of the participants rated their sleep as fairly bad or very bad.

The serum vitamin D levels were measured for 87 participants. The median level of serum 25OHD was 22.9 ± 16.2 ng/mL (range, 4.9−99 ng/mL). Among the 87 participants, 78% (68) women were vitamin D insufficient and 55.4% (51) women were vitamin D deficient. Among the 37 participants who had poor sleep quality and for whom the vitamin D level was measured, 56.8% (21) women had vitamin D deficiency, and 81% (30) women had vitamin D insufficiency.

Among all patients, we did not determine any significance between the vitamin D-deficient group and the vitamin D-nondeficient group with regard to the PSQI total score and subcomponents scores ($p > 0.05$). This information is presented in Table 2.

In Table 3, participants with poor quality and good sleep quality were compared by using the Student *t* test and the Chi-square test. However, we did not find any statistical difference between the two groups with regard to age, prepregnancy BMI, weight gain during pregnancy, length of labor stages, being primiparus, mode of delivery, occupational status, and relationship with the partner. Only patients in low income families had poor sleep quality ($p = 0.001$).

## 4. Discussion

This study supported the findings of previous investigations that indicate that pregnant women have poor sleep quality, and further supported the finding that inadequate vitamin D is common among pregnant women.[15] The relationship between inadequate vitamin D and sleep disorders is a new field of research.[16] Additional studies should be undertaken.

Table 1
Characteristics of the mothers and children in the study.

| | |
|---|---|
| Mother | |
| Age at child's birth (y) | 30.4 ± 4.6 (18−40) |
| Occupational status | |
| Housewife | 54 (58.7) |
| Officeholder | 26 (28.3) |
| Private sector employee | 12 (13) |
| Monthly income | |
| Low | 13 (14.1) |
| Medium | 59 (64.1) |
| High | 26 (21.7) |
| Relationship with the partner | |
| Bad | 0 (0) |
| Medium | 30 (32.6) |
| Good | 62 (67.4) |
| Parity | 1.8 ± 0.8 (1−4) |
| BMI prepregnancy | 24.2 ± 3.2 (17.5−32.1) |
| Weight gain during pregnancy | 13.5 ± 4.0 (5−24) |
| PSQI total score | 6.2 ± 3.3 (1−17) |
| Subjective sleep quality (component 1) | 1.1 ± 0.7 (0−3) |
| Sleep latency (component 2) | 1.2 ± 0.6 (0−3) |
| Sleep duration (component 3) | 0.5 ± 1.0 (0−5) |
| Habitual sleep efficiency (component 4) | 0.5 ± 0.9 |
| Sleep disturbances (component 5) | 1.5 ± 0.6 (0−3) |
| Use of sleeping medication (component 6) | 0 |
| Daytime dysfunction (component 7) | 1.1 ± 0.8 (0−3) |
| Serum 25OHD (ng/mL) | 22.9 ± 16.2 (4.9−99) |
| Child | |
| APGAR score | 8.9 ± 0.5 (6−10) |
| Complication at childbirth | 3 (3.3) |

Data are presented as *n* (%) or mean ± SD (range).
25OHD = 25 hydroxy vitamin D; BMI = body mass index; PSQI = Pittsburgh Sleep Questionnaire Inventory.

Table 2
Comparision of the total score of the PSQI and the scores of its subcomponents with regard to vitamin D-deficient and vitamin D-nondeficient groups.

| Sleep quality | Scores of the vitamin D-deficient group | Scores of the vitamin D-nondeficient group | *p* |
|---|---|---|---|
| | ($n = 46$) | ($n = 41$) | |
| PSQ total score | 6.5 ± 3.7 | 5.8 ± 2.9 | 0.32 |
| Subjective sleep quality (component 1) | 1.3 ± 0.7 | 1.0 ± 0.6 | 0.08 |
| Sleep latency (component 2) | 1.1 ± 0.6 | 1.2 ± 0.7 | 0.75 |
| Sleep duration (component 3) | 0.7 ± 1.2 | 0.3 ± 0.6 | 0.09 |
| Habitual sleep efficiency (component 4) | 0.5 ± 0.9 | 0.4 ± 0.8 | 0.66 |
| Sleep disturbances (component 5) | 1.5 ± 0.6 | 1.5 ± 0.4 | 0.33 |
| Use of sleeping medication (component 6) | | | |
| Daytime dysfunction (component 7) | 1.1 ± 0.8 (range, 0−3) | 1.2 ± 0.8 | 0.32 |

Data are presented as mean ± SD.
PSQI = Pittsburgh Sleep Questionnaire Inventory.

Table 3
Comparision of the participants, based on sleep quality.

| | Poor sleep quality | Good sleep quality | *p* |
|---|---|---|---|
| | (*n* = 58) | (*n* = 34) | |
| Age (y) | 29.7 ± 4.8 | 30.5 ± 4.2 | 0.47 |
| 25OHD level (ng/mL) | 22.1 ± 16.4 | 24.3 ± 16.1 | 0.54 |
| Prepregnancy BMI | 24 ± 3.2 | 24.5 ± 3.3 | 0.53 |
| Weight gain during pregnancy (kg) | 13.6 ± 4.5 | 13.3 ± 3.2 | 0.66 |
| Primiparus | 23 (39.6) | 18 (52.9) | 0.47 |
| Length of labor stages (h) | 6 ± 2.5 | 5.7 ± 2.3 | 0.63 |
| Mode of delivery | | | 0.51 |
| Cesarean section | 28 (48) | 14 (41) | |
| Vaginal delivery | 30 (52) | 20 (59) | |
| Occupational status | | | 0.65 |
| Housewife | 34 (58.6) | 20 (58.8) | |
| Officeholder | 15 (25.8) | 11 (32.3) | |
| Private sector employee | 9 (15.5) | 3 (8.8) | |
| Monthly income | | | 0.21 |
| Low | 1 (1.7) | 2 (15.4) | |
| Medium | 35 (60.3) | 24 (40.7) | |
| High | 22 (37.9) | 8 (40) | |
| Relationship with the partner | | | 0.06 |
| Bad | 0 (0) | 0 (0) | |
| Medium | 23 (39.6) | 7 (20.5) | |
| Good | 35 (60.4) | 27 (79.5) | |

Data are presented as mean ± SD.
25OHD = 25 hydroxy vitamin D; BMI = body mass index.

Several studies have suggested that inadequate vitamin D has a role in sleep disorders in adults and in postmenopausal women.[10,11,17−20] However, most of these studies took place in sleep specialty clinics and neurology clinics and the patients had serious sleep disorders with symptoms such as chronic nonspecific pain, reduced subjective sleep quality, impaired wakefulness, restless legs syndrome, obstructive sleep apnea, and excessive daytime sleepiness. This finding was particularly true in the study by McCarty, a physician working in a sleep medicine clinic who observed inadequate vitamin D in patients with excessive daytime sleepiness, hypersomnia, and nonspecific somatic pain.[10,12,17−21]

In the present study, we detected particularly poor sleep quality in the women by using the PSQI. We evaluated the association between poor sleep quality and inadequate vitamin D levels, in the total scores and in the subcomponents of the questionnaire. Special sleep disorders were also evaluated, but no statistical significance was encountered in the vitamin D-deficient and -nondeficient groups.

In the present study, we found that the mean sleep hours at night was 8.6 hours and was higher than the amount reported in various studies from other countries (which ranged 7.0−7.8 hours).[22,23] Pregnancy is a special time of the life for Turkish women and for their families. However, trying to optimize the health of the newborn suggests an ongoing need for women to act responsibly in their decisions that affect the amount of sleep they obtain and the amount of healthy foods they consume during the pregnancy.

In this study, 43.5% (40) of participants had poor sleep quality. This percentage is less than that reported in the studies of Hung et al,[24] Tsai et al,[25] and Naud et al,[26] who noted poor sleep quality in 66%, 50%, and 56% of their participants, respectively.

In the present study, poor sleep quality was associated with low family income. This result was consistent with the findings of the Naud et al[26] study. However, Naud et al[26] also observed low or high weight gain during pregnancy and Hung et al[24] observed that an unemployed status was correlated with poor sleep quality. However, we did not find any such relationship in the present study.[24−26]

Pregnant women who self- reported snoring >3 days a week had an elevated body weight (range, 10−28%) in various studies,[22,23] compared to the present study. In the present study, the elevated BMI can be attributed to what is considered the ideal weight gain during pregnancy and the appropriate prepregnancy BMI.

A few studies have evaluated the relationship between sleep loss, insomnia, and length of labor.[6,27] According to findings from these studies, short sleep duration and poor sleep quality may increase the risk of extended labor and cesarean delivery. The present study results are in contrast to these findings.

Some studies also evaluated the impact of sleep disturbance on pregnancy outcomes, preterm birth, fetal growth, hypertension−pre-eclampsia, gestational diabetes, and prenatal depression.[28−30] However, premature deliveries were not observed in the present study. We also did not investigate prenatal depression. Only three of the pregnant women had complications during childbirth (e.g., uterine atony, pre-eclampsia, Marfan syndrome), and none of the women had gestational diabetes. The mean APGAR score was 8.9.

This study has some limitations. The sample size was small, which makes generalizing the results problematic. In addition, only term babies were included in our study. Therefore, we cannot comment on other outcomes of sleep disturbance such as preterm birth. In the present study we did not evaluate pregnancy outcomes in detail. We did not measure pregnancy-related hormones and size or weight of the fetus and we also did not search physical activity of the participants. These factors may influence the sleep quality of pregnant women.

In conclusion, this is the first study that has investigated the relationship between inadequate vitamin D levels and quality of sleep in pregnant women. However, poor sleep quality and inadequate vitamin D levels are common among pregnant women. Therefore, our findings do not support the hypothesis that inadequate vitamin D levels can influence sleep quality in pregnant women during the last trimester. We suggest that prenatal health care providers should focus greater attention on vitamin D levels and the sleep disturbance conditions of pregnant women and take precautions. In addition to poor sleep quality, special sleep disorders are also frequently encountered among pregnant women. Further studies with larger sample sizes that include preterm deliveries and special sleep disorders should be performed.

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