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Vitamin D Status in Pregnant Women and Their Newborns in Karaj: A Cross-Sectional Study in Iran

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Abstract

Background

Pregnant women and newborns are at risk of vitamin D deficiency. This study aimed to determine the vitamin D status in pregnant women and their newborns in Karaj, Iran.

Materials and Methods

This cross-sectional study was conducted from March 2014 to October 2015. A total of 151 pregnant women and 154 newborns (three twin cases) were included in the study. After obtaining 5 ml venous blood samples from mothers and 5 ml blood from the umbilical cord of newborns, 25-hydroxy vitamin D [25(OH)D] was measured by ELISA method. Serum level of 25(OH)D below 20 ng/ml was considered deficiency, 21-29 ng/ml was considered insufficient and 30-100 ng/ml was considered sufficient. Data were analyzed using SPSS software version 20.0.

Results

The prevalence of vitamin D deficiency and its insufficiency was 93.5% and 6.5% for pregnant women, 94.2% and 3.9% for newborns, respectively. The mean 25(OH)D concentration in pregnant women and newborns was estimated to be 10.649±5.967 ng/ml and 10.574±6.280 ng/ml, respectively. There was a significant correlation between the mean 25(OH)D concentration in mothers and their newborns ($r=0.913$ and $p<0.001$); 92.9% of mothers and their newborns had vitamin D deficiency simultaneously.

Conclusion

The results of this study showed that overall prevalence of vitamin D deficiencies (levels <30 ng/ml) in pregnant women and their newborns was estimated to be 100% and 98.1%, respectively and mean concentration of 25(OH)D for pregnant women and their newborns is very low. Therefore, vitamin D deficiency should be considered as a serious health priority.

Key Words: Iran, Pregnant women, Newborns, Vitamin D.

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1- INTRODUCTION

Among the micronutrient deficiencies, vitamin D deficiency is now considered a global pandemic, and more than one billion people are suffering from vitamin D deficiency (1). Pregnancy is an important period in women's lives, which is associated with physiological changes, including changes in micronutrient requirement. (1-2). The prevalence of vitamin D deficiency in pregnant women is higher than the general population, and its prevalence is reported to be 85% in review articles (3-5). There are different sources of vitamin D; its internal source is 7-Dehydrocholesterol, which converts to cholecalciferol in exposure to UV ray and eventually converts to vitamin D_3. This vitamin is absorbed via diet in the form of ergocalciferol (vitamin D_2). Vitamin D_2 and D_3 are converted to 25-hydroxy vitamin D [25(OH)D] in the liver pathway (6-7). Vitamin D plays an important role in calcium metabolism and has multifactorial effects on pregnancy, and maternal and fetal health (8).

Vitamin D deficiency can cause many maternal and fetal complications. Maternal complications include increased insulin resistance and gestational diabetes, increased risk of preeclampsia, bacterial vaginosis, increase in cesarean section and fetal and neonatal complications, including type 1 diabetes, autism, delayed fetal development, low birth weight, respiratory infections in the infant, increase in the transmission of Human Immunodeficiency Virus (HIV) from mother to fetus, asthma, and eczema in newborns, neonatal craniotabes, neonatal seizures and neonatal sepsis (9-17). The role of vitamin D deficiency is also known in chronic diseases, including autoimmune diseases (18), lupus (19), multiple sclerosis (20), and malignancies (21). The severity of sunlight and seasonal changes, skin color, lifestyle, clothing type, and geographical area are the determining factors in vitamin D deficiency (1, 3). Several studies have reported vitamin D deficiency in pregnant women in various parts of the world, such as Britain (22), US (23), Belgium (24), and even in sunny countries such as India (25), Kuwait (26) and Lebanon (27). Several studies have been conducted In Iran regarding the prevalence of vitamin D deficiency in pregnant women and newborns, and the results are different (28-32). On the other hand, the prevalence of vitamin D deficiency is affected by the location and time, as well as certain conditions such as sun exposure, lifestyle changes, and the type of nutrition. Therefore, the present study was conducted to determine the prevalence of deficiency and the mean concentration of vitamin D in mothers and umbilical cord blood of newborns born in Kamali Hospital of Alborz University and the relationship between the concentration of 25(OH)D in pregnant women and their newborns.

2- MATERIALS AND METHODS

2-1. Study design and participants

This cross-sectional study was approved by the Ethics Committee Alborz University of Medical Sciences. The sample size was estimated to be 121 using the formula $1/d^2\ [z^2\ P\ (1\text{-}P)]$ with a 95% confidence interval and 7% as a margin of error and a prevalence of 81% for vitamin D deficiency in pregnant women (3). Sampling was done randomly from pregnant women who referred to Kamali Hospital affiliated to Alborz University of Medical Sciences from Iran in March 2014 to October 2015. Karaj is one of the major metropolises in Iran and also the center of Alborz province. According to the official statistics of 2016, the population of this city is 1,973,470 people, which is currently the fourth most populous city in Iran (**Figure.1**). The study began after obtaining the informed consent of the participants. Data were collected based on a demographic questionnaire including age, education, socioeconomic status as well as delivery status, birth status, gestational age, delivery season, use of vitamin D supplements during pregnancy, history of diseases such as liver, kidney, thyroid, gestational diabetes, type 2 diabetes, hypertension, metabolic bone disease and history of drug use.

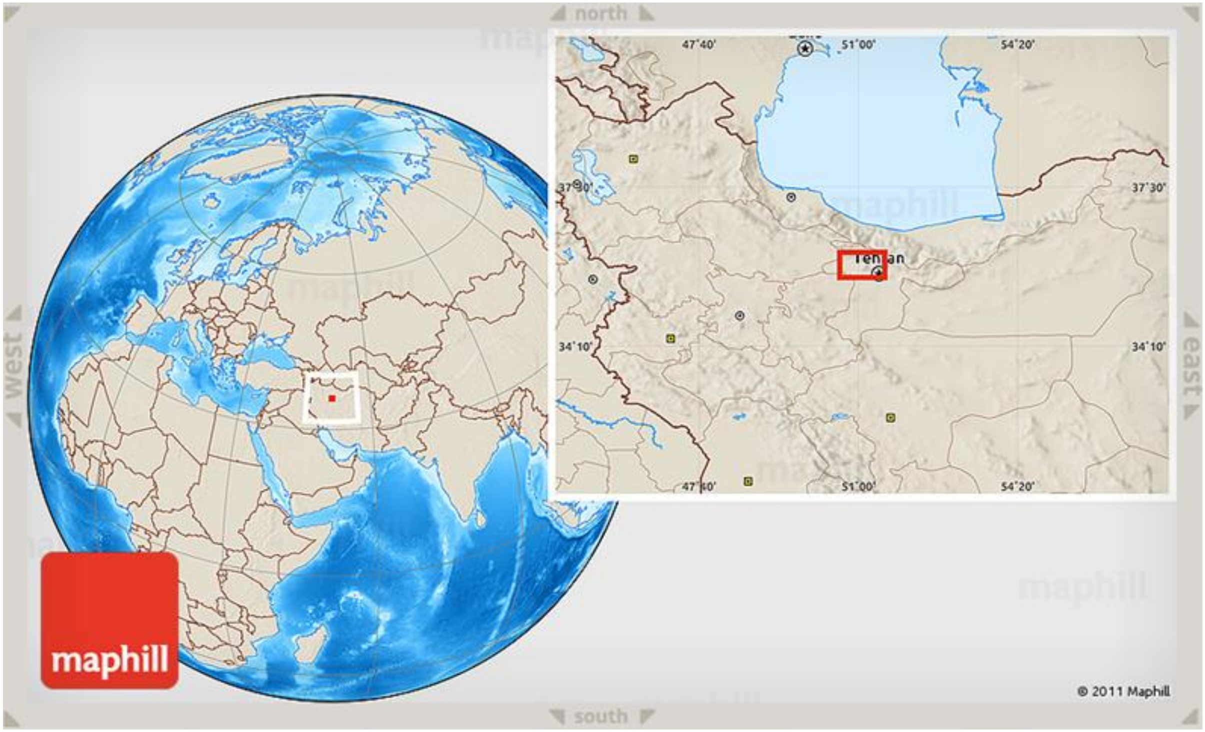

Fig1: Physical Map of Karaj city, Alborz province, Iran.

2-2. Inclusion and exclusion criteria

The inclusion criteria included healthy and white pregnant women who were admitted at their third trimester for delivery. The exclusion criteria included lack of cooperation, metabolic bone disease, liver and kidney disease, use of vitamin D supplements during pregnancy, use of corticosteroids and anti-seizure medication and incomplete laboratory data.

2-3. Biochemical parameter

Five ml venous blood samples from mothers and 5 ml blood from the umbilical cord of newborns were collected by a clinical pathologist. Samples were stored at -80 °C to be prepared for testing. Mother and newborns serum samples were collected to measure 25(OH)D by enzyme-linked immunosorbent assay (ELISA) using a kit manufactured by IDS Company (England).

2-4. Definition of vitamin D deficiency

In the current study, vitamin D cut-off was divided based on United States Endocrine Society; of 25(OH)D below 20 ng/ml was considered deficiency, 21-29 ng/ml was considered insufficient, and 30-100 ng/ml was considered sufficient (21).

2-5. Statistical analysis

Statistical analysis was performed using statistical package for social science (SPSS) software version 20.0. Statistical methods (descriptive and analytical statistics) were used. In descriptive statistics, the frequency was obtained and the central indices (mean) and dispersion indices (standard deviation) were used. In analytical statistics, t-test was used to compare variables (quantitative and qualitative). In addition, the Levin test, which examines the homogeneity of variances in different samples, was used to determine the type and degree of the relationship between quantitative variables in normal conditions using Pearson correlation coefficient. The significance level was considered to be less than 0.05.

3- RESULTS

3-1. General Characteristics

During the study, 151 pregnant women and 154 newborns (three twin cases) were included. The mean age of mothers and mean gestational age was 27.8 ± 6.04 years and 37.6 ± 2.2 weeks, respectively. The mean neonatal weight was 3048 ± 52.05 grams. Other demographic and clinical features of participants are shown in **Table.1**.

3-2. Vitamin D Status

The mean concentration of 25(OH)D in pregnant women and newborns was estimated to be 10.649 ± 5.967 and 10.574 ± 6.280 ng/ml, respectively. The overall prevalence of vitamin D deficiencies (levels <30 ng/ml) in pregnant women and newborns was estimated to be 100% and 98.1%, respectively. The prevalence of vitamin D deficiency and its insufficiency in pregnant women was 93.5% and 6.5%, respectively. The prevalence of vitamin D deficiency and its insufficiency in newborns was 94.2% and 3.9%, respectively (**Table.2**).

3-3. Association between Mean 25(OH)D Concentration in Mothers and Their Newborns

There was a significant correlation between the mean concentration of 25(OH)D in mothers and their newborns (r = 0.913 and p<0.001). In 92.9% of mothers and their newborns, there was a vitamin D deficiency (**Table.3, Figure.2**). There was no significant difference in mean 25(OH)D concentration in mothers between mothers with term and pre-term deliveries (based on Levine test (p = 0.347 and F = 0.89) and t-test (p = 0.087) and mothers with term and post-term deliveries (based on Levine test [p = 0.80 and F = 0.065] and t-test [p = 0.31]). Moreover, there was no significant difference in mean 25(OH)D concentration between term newborns and pre-term newborns (based on Levine test [p = 0.963 and F = 0.002] and t-test [p = 0.366]) and term newborns and post-term newborns (based on Levine test [p = 0.715 and F = 0.135] and t-test [p = 0.548]).

3-4. Relationship between mean 25(OH)D concentration of mothers and their newborns and other variables

The relationship between the mean 25(OH)D concentration of mothers and their newborns and the economic status, the age of mothers, the history of the disease and the delivery season is shown in **Table.4**.

Table-1: Demographic and clinical characteristics in pregnant women and their newborns in Karaj, Iran.

Parameter	Value
Maternal age, year (Mean ± SD)	27.8 ± 6.04
Birth status / number (%)	
Preterm (born < 37 weeks)	59 (38.3%)
Near term/ Term/ Post date (37 weeks ≤ born < 42 weeks)	92 (59.8%)
Post term (born ≥ 42 weeks)	3 (1.9%)
Maternal educational degree / number (%)	
Under Diploma	97 (64.2%)
Diploma	46 (30.5%)

Post Diploma	8 (5.3%)
Economic situation/ number (%)	
Under 1 million income	71 (47%)
1-2 million income	67 (44.4%)
Upper 2 million income	1 (0.7%)
No response	12 (7.9%)
Delivery status / number (%)	
NVD	22 (14.6%)
C/S	129 (85.4%)
Delivery season / number (%)	
Spring	8 (5.3%)
Summer	0 (0%)
Autumn	45 (29.8%)
Winter	98 (64.9%)
Distribution of neonatal according to gestational age / number (%)	
Extremely Preterm (born < 28 weeks)	7(11.9%)
Early Preterm (born < 34 weeks)	12(20.3%)
Late Preterm (34 weeks ≤ born < 37 weeks)	40(67.8%)
Preterm (born < 37 weeks)	59(38.3%)
Near term/ Term/ Post date (37 weeks ≤ born < 42 weeks)	92(59.8%)
Post term (born ≥ 42 weeks)	3(1.9%)
Neonatal gender / number (%)	
Male	77 (50%)
Female	77 (50%)

SD: standard deviation; NVD: normal vaginal delivery; C/S: cesarean section.

Table-2: Vitamin D status in pregnant women and their newborns in Karaj, Iran.

Values of vitamin D, mean ± SD	Pregnant women	Newborns
Preterm (born < 37 weeks)	11.67±5.65	11.11±6.57
Near term/ Term/ Post date (37 weeks ≤ born < 42 weeks)	9.94±6.10	10.16±6.13
Post term (born ≥ 42 weeks)	13.66±5.85	12.33±5.68
All	10.64±5.96	10.57±6.28
Vitamin D, number (%)		
Deficiency	141 (93.5%)	145 (94.2%)
Insufficiency	10 (6.5%)	6 (3.9%)
Sufficient	0 (0%)	3 (1.9%)
All	151 (100%)	154 (100%)

SD: standard deviation.

Table-3: Contingency table vitamin D status in pregnant women and their newborns in Karaj, Iran.

Vitamin D in pregnant women	Vitamin D in newborns, number (%)			
	Deficient	Insufficient	Sufficient	Total
Deficient	143 (92.9%)	1 (0.65%)	0 (0%)	144 (93.5%)
Insufficient	5 (3.2%)	2 (1.3%)	3 (1.95%)	10 (6.5%)
Sufficient	0 (0%)	0 (0%)	0 (0%)	0 (0%)
Total	148 (96.1%)	3 (1.95%)	3 (1.95%)	154 (100%)

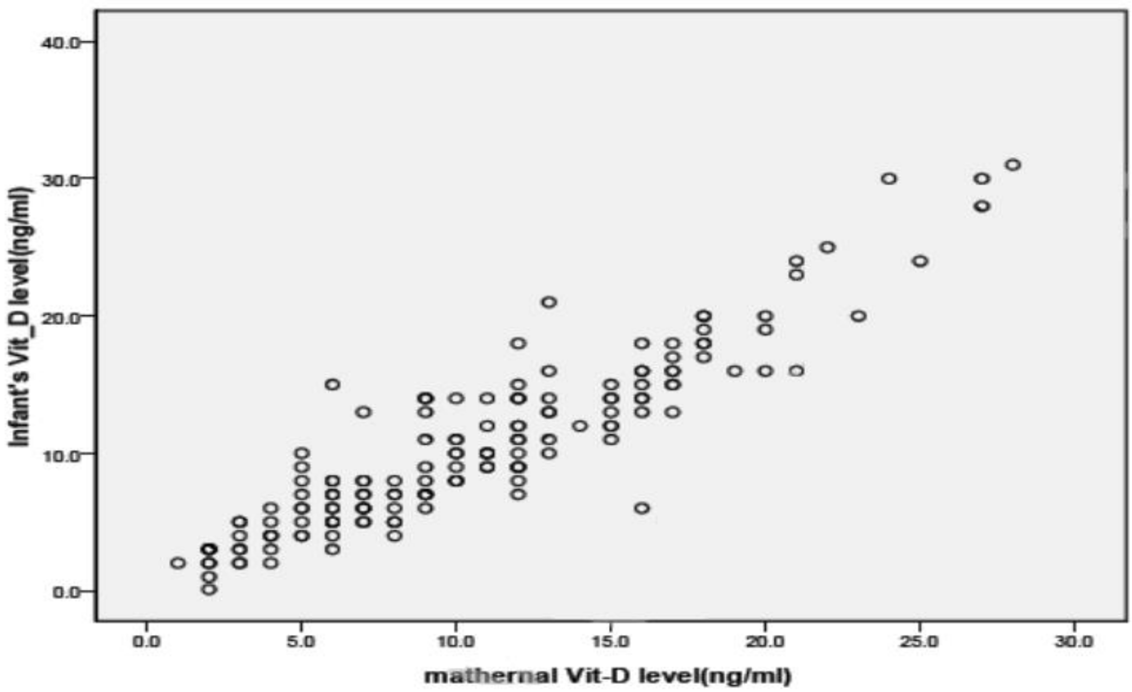

Fig.2: The correlation between mean 25(OH)D concentration of mothers and their newborns.

Table-4: The correlation between mean 25(OH)D concentration and variables in Karaj, Iran.

Variables	Correlation Coefficient	
	Pearson correlation coefficient	P-value
Mean 25(OH)D concentration in mothers and their newborns	0.913	<0.001
Economic situation		
Mean 25(OH)D concentration in pregnant women	0.113	0.182
Mean 25(OH)D concentration in newborns	0.039	0.643
Mother age		
Mean 25(OH)D concentration in pregnant women	0.011	0.924
Mean 25(OH)D concentration in newborns	0.042	0.729
History of past disease		
Diabetes mellitus		
Mean 25(OH)D concentration in pregnant women	- 0.023	0.77
Mean 25(OH)D concentration in newborns	0.019	0.81
Hypertension		
Mean 25(OH)D concentration in pregnant women	0.027	0.74
Mean 25(OH)D concentration in newborns	- 0.012	0.88
Thyroid Disease		
Mean 25(OH)D concentration in pregnant women	0.10	0.18
Mean 25(OH)D concentration in newborns	0.16	0.048

4- DISCUSSION

The results of this study indicated a high prevalence of vitamin D deficiency among pregnant women (93.5%) and newborns (94.2%) in Iranian population. In Iranian studies, the prevalence of vitamin D deficiency was 5-90% in pregnant women and 10-56% in newborns (28-32). In a meta-analysis study by Badfar et al., the prevalence of vitamin D deficiency at 10, 20 and 30 ng/ml was reported to be 42.42%, 55.84%, and 80.82%, respectively (3). Vitamin D deficiency has been reported to be different in pregnant women in other countries, including South India (31%), Korea (77.3%), China (96.8%) and Greece (19.5%) (33-36). In a systematic review, the prevalence of vitamin D deficiency (with a cut-off point of 20 ng/ml), according to the World Health Organization (WHO), was 64% among American, 57% among Europeans, 87%among South-East Asian, 83% among Western Pacific and 46% among the Eastern Mediterranean pregnant women (37). Therefore, the vitamin D status Iranian pregnant women is much weaker compared to the American, European and the Eastern Mediterranean countries (according to the WHO classification), but is close to the reported estimates for Western Pacific countries.

Many studies in Iran have concluded that pregnant women may suffer from vitamin D deficiency because of the type of clothing and use of sunscreens (28-32), although vitamin D deficiency is less severe in societies with no Islamic coverage. In addition, vitamin D deficiency is also common among men and clothing cannot be considered as the only cause of this deficiency. In a meta-analysis (2008), the prevalence of vitamin D deficiency in women and men was 75.1% and 72.1% (38). In other studies, the combination of factors such as geographical location, urbanization, lifestyle changes, diet, skin color, air pollution, or possibly genetic predisposition to vitamin D deficiency among Asian people has been mentioned as factors influencing vitamin D status (39). The mean 25(OH)D concentration in pregnant women in the present study was estimated to be 10.64 ng/ml. In a review study, the mean concentration of 25(OH)D in Iranian pregnant women was 15.2 ng/ml (3), which is close to the present study. The mean 25(OH)D concentration in pregnant women in Africa, the Americas, Western Oceania, Europe, Southeast Asia and the Eastern Mediterranean was reported to be 93, 60, 57, 30, 30, and 20 ng/ml, respectively (37). The mean 25(OH)D concentration in the studies in the general population of Iran is estimated to be 26-36 ng/ml (40-43), and it can be inferred that vitamin D deficiency is a serious health problem for the whole population of Iran, in addition to the pregnant women. However, estimates of this meta-analysis regarding the mean 25(OH)D concentration in pregnant women and Iranian newborns are much lower than the general population of Iran; and indicate the importance of the increased attention to this issue in pregnant women. In the present study, the mean concentration of 25(OH)D in Iranian newborns was 10.6 ng/ml. In a meta-analysis study in Iran, the mean concentration of 25(OH)D in umbilical cord was estimated to be 14.59 ng/ml (41).

The mean concentration of 25(OH)D in African and European newborns was 14 ng/ml, in Western Oceania was 22 ng/ml and in the American newborns was 32 ng/ml, respectively (37). In this study, there was a strong correlation between the mean 25(OH)D concentration in the umbilical cord blood of newborns and their mother's blood. The results of this study were consistent with the results of other studies such as Badfar et al. (3), Azami et al. (5), Holis et al. (44), Sachan et al. (25), Aly et al. (45) and Dovnik et al. (46), which confirmed the correlation between umbilical cord blood and mother's blood. Thus, it can be said that by correcting the maternal vitamin D deficiency during pregnancy, the deficiency of the infant can also be corrected. Light radiation changes with seasonal changes. In the present study, there was no correlation between seasonal changes and the mean concentration of 25(OH)D in mothers and their newborns. Inconsistent with these results, it has been shown that changes in the season do not affect the level of vitamin D considerably (44). In contrast, Bodnar's study on pregnant women showed that seasonal changes could affect 25(OH)D concentrations. As the season passes through the winter and spring, the concentration of 25(OH)D increases over time (23). It seems that the disagreement on this is due to the fact that with seasonal changes, the intensity of the light to synthesize vitamin D in the skin is not significant in some areas. In another study, air pollution in cities has been mentioned as a factor that can prevent the exposure of skin to sunlight for the synthesis of vitamin D (47-48).

Since this study is conducted in a city with a relatively high level of air pollution, the lack of relationship between seasonal changes and the mean concentration of 25(OH)D may be due to a high level of air pollution. Based on the results of this study, the socioeconomic status of the family had no significant effect on 25(OH)D concentration in mothers and their newborns. Several studies were consistent with the results of the study (47, 49-51). Cetinkaya et al. showed a strong correlation between the socioeconomic status of the family and vitamin D deficiency in mothers and their newborns (52). Brehm et al. (2009) also reported that there is a direct relationship between the socioeconomic status and the mean concentration of 25(OH)D (53). Studies show that the daily use of vitamin D supplements by mothers has a significant effect on the level of vitamin D in mothers and their newborns (54-55); according to the study of Badfar et al., the mean concentration of 25(OH)D in Iranian pregnant women have been significantly increasing during 1997 and 2015, one of the possible causes of which is the introduction of vitamin D supplements in women's health centers (3). One of the limitations of this study is the lack of examining the level of sunlight and failure to investigate its association with the concentration of 25(OH)D, as well as the nutritional habits of mothers during pregnancy, which may also affect the level of vitamin D.

5- CONCLUSION

The results of this study showed that overall prevalence of vitamin D deficiencies (levels <30 ng/ml) in pregnant women and their newborns was estimated to be 100% and 98.1%, respectively and mean concentration of 25(OH)D for pregnant women and their newborns is very low. Therefore, this issue should be considered as a serious health priority and appropriate preventive interventions should be taken. In this study, there was a strong correlation between the levels of vitamin D in the umbilical cord blood of newborns and their mother's blood. Thus, it can be said that by correcting the maternal vitamin D deficiency during pregnancy, the deficiency of the infant can also be corrected.

6- CONFLICT OF INTEREST: None.

7- ACKNOWLEDGMENTS

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