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ORIGINAL RESEARCH

Prevalence of Vitamin D Deficiency Among Iranian Pregnant Women

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Background: Vitamin D deficiency (VDD) is a common concern. A high prevalence of VDD has been reported among pregnant women in different countries. The aim of this study was to assess the prevalence of VDD in the first trimester of pregnancy.

Methods: This cross-sectional study was conducted on 267 pregnant women (before 14 weeks of gestation). The level of 25-hydroxyvitamin D (25(OH)D) was measured. Demographic data (age, educational level, season of blood sampling, and vitamin D supplementation intake) were collected using a questionnaire.

Results: Based on the results of the study, 205 out of 267 subjects (76.8%) had deficient vitamin D levels (<20 ng/mL), 39 (14.6%) had insufficient levels (20–29 ng/mL), and 23 (8.6%) had sufficient levels (≥30 ng/mL). In addition, 133 women (49.8%) had severe VDD. VDD was more prevalent in autumn/winter than in spring/summer (P=0.03). The prevalence of VDD was higher among the younger age group than in the older group (P=0.04). In multivariate analysis, the only variable that was significantly associated with low vitamin D status was taking supplements. Those who were not receiving vitamin D supplements had higher odds of VDD status (adjusted odds ratio=77.3, 95% CI 23.9–249.6).

Conclusion: VDD is a public health problem in the first trimester of pregnancy. Greater awareness among healthcare providers and the community is required for prevention and appropriate treatment.

Keywords: pregnancy, vitamin D deficiency, vitamin D insufficiency

Introduction

Vitamin D deficiency (VDD) is a worldwide public health issue,[1] which increases the risk of serious diseases, including cancers, cardiovascular diseases, and autoimmune diseases such as type 1 diabetes.[2] A high prevalence of VDD has been reported among pregnant women and neonates in different countries.[3,4] The prevalence of VDD in pregnant women varies from 18% to 84%.[4] The prevalence of VDD is high in the Middle Eastern countries, such as Iran, Saudi Arabia, and the United Arab Emirates, owing to low exposure to the sun because of cultural factors.[2,5]

The prevalence rates of severe, moderate, and mild VDD among the Iranian adult population have been reported as 26.7%, 23.9%, and 19.6%, respectively.[6] According to the results of a previous study in Iran, about 75.1% of women and 72.1% of men were suffering from VDD.[6]

VDD can lead to osteomalacia in pregnancy. Other consequences of VDD in pregnancy include an increased risk of gestational diabetes mellitus, preeclampsia, intrauterine growth retardation, and low birth weight.[7,8] The present investigation

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has been conducted to study the prevalence of VDD among pregnant women (before 14 weeks of gestation).

Materials and Methods

Study Design and Sample Size

This cross-sectional study was conducted in Tehran, Iran, on 267 pregnant women (before 14 weeks of gestation) who visited the Gynaecology and Obstetrics Clinic of Baqiyatallah Hospital for a routine check-up from March 21, 2014 to March 20, 2015. The study size was calculated using the following formula:

$$n = \frac{z_{\propto}^{2} \times p(1-p)}{d^{2}} = 246$$

where, α=0.05, d=0.05, and the prevalence of VDD (p)=0.8.[9]

Eligibility Criteria, Variables, and Sampling Method

The eligibility criteria were pregnant women before 14 weeks of gestation and availability of related data. All of the study participants were residing in Tehran (36°21′N). The study sample was determined by a systematic random sampling method from all qualifying pregnant women. Demographic data (age, educational level, season of blood sampling, and vitamin D supplementation intake) were collected using a questionnaire, and body mass index (BMI) was calculated from weight in kg divided by height in m^2. Volumes of about 5 mL of the fasting blood samples from all study subjects were collected and serum was separated via centrifugation (Sigma 4-16KHS) at 3500 rpm for 10 minutes. The serum level of 25-hydroxyvitamin D (25(OH)D) was measured using the chemiluminescent immunoassay (CLIA) method (Liaison® 25-OH Vitamin D CLIA kit; DiaSorin, Stillwater, MN, USA); the kit's expected range was 3–150 ng/mL, which is based on an interassay precision that approximated 20% CV (functional sensitivity). A serum vitamin D level <20 ng/mL indicates VDD, 20–29 ng/mL indicates suboptimal status, and 30–50 ng/mL indicates an optimal level of 25(OH)D for maximal effect on parathyroid hormone.[8,10]

Statistical Analysis

The Kolmogorov–Smirnov test was used to evaluate the normality of data distribution. Factors related to VDD were identified through univariate and multivariate logistic regression analysis after adjusting for age (18–29 and 30–39 years), educational level (≤12 and >12 years), BMI (underweight <18.5 kg/m^2, normal 18.5–24.9 kg/m^2, overweight 25–29.9 kg/m^2, and obese ≥30 kg/m^2), season of blood sampling (spring/summer and autumn/winter), and vitamin D supplementation intake (yes or no). Age and BMI were considered as continuous variables in logistic regression analysis. The differences were considered significant at P-values of less than 0.05. Statistical analysis was conducted using SPSS software (version 16) (SPSS, Chicago, IL, USA).

Ethical Considerations

This study was approved by the ethics committee of Baqiyatallah University of Medical Sciences (Code: 5904). All subjects provided the study with voluntary informed consent prior to participation. Those who were not willing to participate in the study were not included (two women).

Results

During the study, 267 pregnant women, aged 18–39 years, were investigated. The mean age was 28.5±5.0 years. The median of serum 25(OH)D concentrations of all participants was 10 ng/mL (interquartile range [IQR]=5.4–18.6 ng/mL) and the highest reading recorded among subjects was 71.8 ng/mL.

The baseline characteristics of participants are shown in Table 1. The overall prevalence of VDD and vitamin D insufficiency was 76.7% and 14.6%, respectively. Among them, 140 women (52.4%) had severe VDD (25(OH)D <10 ng/mL). As shown in Table 2, in autumn/winter, VDD was prevalent among 82.3% of the pregnant women and in spring/summer VDD was prevalent among 71.5% of the pregnant women (P=0.03). Almost 15% of participants took vitamin D as a nutrient supplement. The median level of 25(OH)D in the age group 30–39 years was higher than in the age group 18–29 years (13.4 vs 8 ng/mL, P=0.0001). The prevalence of VDD was higher among the younger age group (P=0.04). The median (IQR) level of 25(OH)D was 10 (5.2–17.6)ng/mL in participants with a high level of education (>12 years) and 9.1 (6.1–18.9) ng/mL in those with a low level (≤12 years). Educated women (with a college degree) had a lower prevalence of VDD than those with lower educational levels (75.4% vs 77.9%, P=0.6).

The median (IQR) levels of 25(OH)D in spring/summer and autumn/winter were 12.1 (5.8–20.7) ng/mL and 8.3 (5.2–16.1) ng/mL, respectively (P=0.07). Many of the participants were overweight (38.2%) or obese (16.9%). Overweight and obese women had a lower prevalence of VDD (74.5% and 71.1%, respectively) compared to those with normal body weight (82.6%).

Table 1 Baseline Characteristics of 267 Iranian Pregnant Women

Characteristics			**n (%)**
Vitamin D Status	SVDD/VDD	<10 ng/mL	140 (52.4)
		10–20 ng/mL	65 (24.3)
	Insufficiency (20–29 ng/mL)		39 (14.6)
	Optimal level (30–50 ng/mL)		23 (8.6)
Age (years)	**18–29**		183 (68.5)
	30–39		84 (31.5)
Season[a]	**Spring/summer**		137 (51.3)
	Autumn/winter		130 (48.7)
Education (years)	**≤12**		149 (55.8)
	>12		118 (44.2)
BMI (kg/m^2)	**Underweight (<18.5)**		109 (40.8)
	Normal (18.5–24.9)		11 (4.1)
	Overweight (25–29.9)		102 (38.2)
	Obese (≥30)		45 (16.9)
Vitamin D Supplementation	**Yes**		39 (14.6)
	No		228 (85.4)

Note: [a]Season of 25(OH)D measurements.
Abbreviations: VDD, vitamin D deficiency; SVDD, severe vitamin D deficiency.

Only 14.6% of participants reported a history of vitamin D supplementation. About 16.1% of women with lower educational level and 12.7% of women with higher educational level had a history of supplementation (*P*=0.43). Twelve percent of the younger age group and 20.2% of the older age group had received vitamin D supplements (*P*=0.07). The relative frequency of taking vitamin D supplements among underweight, normal weight, overweight, and obese pregnant women was 14.7%, 18.2%, 12.7%, and 17.8%, respectively (*P*=0.8). The frequency of taking vitamin D supplements was 7.5% in spring/summer and 11.5% in autumn/winter (*P*=0.16) (data not shown in the tables).

In multivariate analysis, the only variable significantly related to low vitamin D status was taking supplements. Compared to pregnant women receiving vitamin D supplements, those who were not receiving vitamin D supplements had higher odds of VDD status (adjusted odds ratio [OR]=77.3, 95% CI 23.9–249.6) (Table 3).

Discussion

Our findings, which are consistent with previous studies, showed a high prevalence of VDD (76.8%) among Iranian pregnant women. VDD has previously been reported in Iranian pregnant women at prevalences of 78%,[11] 70.4%,[12] and 69.2%.[13] The high prevalence of VDD in women has also been observed in other countries. In New Zealand, the Netherlands, and Canada, respectively, 61%, 60%, and 46% of pregnant women were vitamin D deficient.[14–16]

Vitamin D status is typically influenced by factors such as latitude, season of the year, time of day, and air pollution.[17] Tehran ranks among the most populated cities in the world and this makes its inhabitants susceptible to VDD. Increased accommodation in apartments because of the increased population of the city and air pollution are among the factors limiting exposure to the sun in Tehran. Tehran is a sunny city, but with limited direct exposure to the sun.

Some studies have reported a higher prevalence of VDD among elderly people,[18] whereas, in the present study, as in another study conducted in Tehran,[19] the prevalence of VDD was higher among the younger age group. This may be due to lifestyle modifications among younger people. Younger people favor living in apartments and using electronic devices such as mobile phones and tablets, so they take less physical activity in the open air. Moreover, to prevent skin disorders, many young women like to apply anti-solar creams to their face. VDD among adolescents has been reported at higher rates in polluted areas than in non-polluted areas.[20] In 2017, Feizabad et al conducted a population-based study on 325 students in Tehran in the winter and reported that more than half of the students (52.9%) suffered from VDD (25(OH)D <20 ng/mL). VDD was more than twice as prevalent in girls (74.4%) as in boys and VDD was more prevalent in polluted areas than in non-polluted areas.[20] According to cultural aspects, in Iran and other Muslim countries, women wear a scarf and long-sleeved clothes. The prevalence of VDD was 50% among pregnant Saudi women, in an area highly exposed to the sun.[21] It should be noted the assessment of vitamin D status is important not only in pregnant women, but also in adolescents and young people.

In this study, the median serum 25(OH)D concentration of all participants was 10 ng/mL. In a study in Norway on five main immigrant groups, including Iranians, the median serum 25(OH)D level was 10.8 ng/mL in Iranian women.[22]

The median level of of vitamin D was higher in summer than in winter, showing that season, as an environmental factor, is capable of affecting the VDD. In the present study, the prevalence of VDD was significantly higher in autumn/winter than in spring/summer. These results are similar to those of preceding studies in China, Iran, and

Table 2 Maternal Characteristics and Vitamin D Status of 267 Iranian Pregnant Women

Characteristics		VDD (%)	*P*-value	SVDD (%)	*P*-value
Age (years)	**18–29** **30–39**	80.3 69	0.04	60.7 34.5	<0.001
Season[a]	**Spring/summer** **Autumn/winter**	71.5 82.3	0.03	46.7 58.5	0.05
Education (years)	**≤12** **>12**	77.9 75.4	0.6	51.0 54.2	0.6
BMI (kg/m^2)	**Underweight (<18.5)** **Normal (18.5–24.9)** **Overweight (25–29.9)** **Obese(≥30)**	63.6 82.6 74.5 71.1	0.2	56.0 27.3 54.9 44.4	0.19
Vitamin D Supplementation	**Yes** **No**	10.3 88.9	0.001	0 61.4	<0.001

Notes: [a]Season of 25(OH)D measurements. A *P*-value <0.05 was considered statistically significant.
Abbreviations: VDD, vitamin D deficiency (<20 ng/mL); SVDD, severe vitamin D deficiency (<10 ng/mL).

Greece.[23–25] Kull et al argued that the mean serum 25(OH)D concentration in winter was meaningfully lower than in summer among the general population of Estonia.[26]

Our results, similarly to a previous study in Iran,[27] indicated no substantial relationship between vitamin D status and the level of education. But, in contrast to our results, Atiq et al reported a significantly higher level of 25(OH)D in uneducated mothers in Pakistan,[28] and another study in Norway, on five immigrant groups in Oslo, reported a positive relationship between education and vitamin D level in women born in Turkey and Iran.[29] Educated women may be consuming vitamin D-fortified food or be more exposed to sunlight. Factors such as style of clothing, air pollution, insufficient vitamin D intake, and lack of routine enrichment of foods with vitamin D in Iran could account for the results of our study.[19,23]

The results of the present study, in line with other studies,[30,31] showed that severe VDD was more prevalent among overweight and obese than in normal weight pregnant women. Therefore, it is more important to assess the vitamin D status in obese or overweight pregnant women.

According to the results of this study, after adjusting for other variables, taking vitamin D supplements was the only variable that was significantly related to vitamin D status. Vitamin D was taken by 14.6% of participants as a nutrient supplement. Compared to pregnant women taking vitamin D supplements, those not receiving vitamin D supplements had higher odds of VDD status (adjusted OR=77.3, 95% CI 23.9–249.6). This wide confidence interval may be due to the low number of pregnant women taking supplements. Vitamin D supplementation in pregnant women could be the most effective way to obtain adequate vitamin D. Unfortunately, however, vitamin D supplementation is not part of most of the ordinary pregnancy care programs in Iran and physicians have not reached a consensus in terms of the consumption of specific vitamin D supplementation. This disagreement is to some extent due to insufficient data on vitamin D status, vitamin D supplementation, and their links with pregnancy-related results to develop recommendations in Iran. Although the potential impact of VDD during pregnancy on maternal health has been much discussed recently, a contributing link between VDD during pregnancy and opposing pregnancy-related results should be determined using Hill's criteria.[32]

Because the most important source of vitamin D is sunlight, 10–15 minutes of sun exposure two to three times a week is highly recommended to absorb a suitable amount of vitamin D for women of childbearing age. Also, eating fortified foods that contain vitamin D is helpful to prevent VDD.

Table 3 Crude and Adjusted Odds Ratio for Vitamin D Deficiency in 267 Iranian Pregnant Women

Characteristics	Crude Odds Ratio (95% CI)	Adjusted Odds Ratio (95% CI)
Age	0.9 (0.8–0.9)	0.9 (0.8–1.0)
Autumn/winter season	1.8 (1.1–3.3)	1.93 (0.8–4.2)
Education ≤12 years	1.1 (0.6–2.0)	1.7 (0.8–3.8)
BMI	0.9 (0.9–1)	0.94 (0.8–1.0)
No supplementation	65.14 (21.50–197.60)	77.3 (23.9–249.6)

Since the hospital in which the study was conducted is one of the largest referral hospitals in Tehran, the results of this study could be generalized to the urban population. Our study also has several limitations that should be addressed in future investigations. These include ignoring the dietary vitamin D intake measurement, extent of exposure to sunlight, and other likely risk factors for VDD.

Conclusions

According to our results, VDD is a significant public health problem in the first trimester of pregnancy. The investigation of vitamin D nutritional status in pregnant women and increased awareness among healthcare providers could help to prevent the adverse effects of VDD as well as assist in choosing good treatments.

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Abbreviations

VDD, vitamin D deficiency; IQR, interquartile range.

Ethics/Copyright

This study was approved by the ethics committee of Baqiyatallah University of Medical Sciences (Code: 5904). All subjects provided the study with voluntary informed consent prior to participation. Those who were not willing to participate in the study were excluded.

Author Contributions

All authors made a significant contribution to the work reported, whether in the conception, study design, execution, acquisition of data, analysis and interpretation, or in all these areas; took part in drafting, revising or critically reviewing the article; gave final approval of the version to be published; have agreed on the journal to which the article has been submitted; and agree to be accountable for all aspects of the work.

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Disclosure

The authors report no conflicts of interest in this work.

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