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Effect of vitamin d deficiency during pregnancy in Indian women

Seema Kumari
Teacher, Middle School, Bhoj Pandaul, Madhubani, Bihar, India

Abstract
Vitamin D, an essential fat-soluble vitamin or steroid prohormone, plays an important role in the regulation of calcium and phosphorus homeostasis and bone mineralization. There are three main sources of vitamin D which include sunlight exposure, dietary sources, and supplement intake. Sunlight exposure is the primary source of vitamin D and is mainly influenced by environmental and personal factors such as seasons, geographic latitude, skin type, the percentage of body surface exposed to sunlight, and clothing. In addition, gestational vitamin D deficiency is associated with fetal intrauterine growth restriction and various adverse fetal and neonatal health outcomes, including higher risk of premature birth, abortion, low birth weight, neonatal hypocalcaemia, and childhood obesity. Given the high prevalence of vitamin D deficiency among pregnant women and its adverse pregnancy outcomes, there is an urgent need to determine factors contributing to vitamin D deficiency during pregnancy.

Keywords: Vitamin D, deficiency, pregnancy, homeostasis and neonatal health

Introduction

Vitamin D is not only a lipid-soluble vitamin, but also a steroid hormone that can be synthesized endogenously. It has an important role in calcium (Ca)-phosphorus (P) homeostasis and its deficiency causes rickets in children and osteomalacia in adults. Vitamin D deficiency may also result in impairment of immune function, predisposition to cancer, cardiovascular disease, diabetes, rheumatic disease, muscle weakness, chronic pain and neuropsychiatric dysfunction. The lack of vitamin D during pregnancy is the most important risk factor for infantile rickets and may also result in poor fetal growth and neonatal development. In addition, its deficiency in pregnant women may predispose to gestational diabetes mellitus and preeclampsia. Vitamin D deficiency continues to be a serious health problem in India despite a general improvement in socio-economic status in recent years.

Vitamin D, an essential fat-soluble vitamin or steroid prohormone, plays an important role in the regulation of calcium and phosphorus homeostasis and bone mineralization. There are three main sources of vitamin D which include sunlight exposure, dietary sources, and supplement intake. Sunlight exposure is the primary source of vitamin D and is mainly influenced by environmental and personal factors such as seasons, geographic latitude, skin type, the percentage of body surface exposed to sunlight, and clothing. Once ingested or produced by the body through skin exposure to the ultraviolet B radiation from the sun, both vitamin D2 (ergocalciferol) and vitamin D3 (cholecalciferol) are transported to the liver and is hydroxylated to 25-hydroxyvitamin D (25(OH) D. 25(OH)D is the major circulating form of vitamin D in human body. Serum 25 (OH) D is widely recognized as the best biochemical indicator of vitamin D status as it reflects the cumulative exposure to sunlight and dietary vitamin D intake of an individual. Identifying the level of circulating 25(OH) D is important for diagnosis and monitoring of vitamin D deficiency. Though there is no consensus on optimal 25(OH)D levels, vitamin D deficiency has been identified as a global health problem and has affected more than 1 billion people globally, especially among pregnant women. Low maternal vitamin D levels during pregnancy have been linked with multiple adverse obstetric outcomes such as maternal osteomalacia, gestational diabetes, preeclampsia, and primary cesarean section. In addition, gestational vitamin D deficiency is associated with fetal intrauterine growth restriction and various adverse fetal and neonatal health outcomes, including higher risk of premature birth, abortion, low birth weight, neonatal hypocalcaemia, and childhood obesity. Given the high prevalence of vitamin D deficiency among pregnant women and its adverse pregnancy outcomes, there is an urgent need to determine factors contributing to vitamin D deficiency during pregnancy.

Review of Literature

Review of related literature provides an opportunity of gaining insight into the method, measures, subject and approaches employed. A careful review of research, journals, books, dissertations, thesis and other sources of information about the problem to be investigated is one of the important steps in the planning of any studied.

Shukla, K, Sharma, S, Gupta, A, Raizada, A, Vinayak, K. (2016) [6] Nowadays vitamin D deficiency has become the widely investigational topic as the role of vitamin D deficiency has been identified in various disorders besides its worldwide known skeletal side effects. Chronic vitamin D deficiency in adults results in osteomalacia, osteoporosis, muscle weakness.

Tandon, V.R, Sharma, S, Mahajan, S, Raina, K, Mahajan, A, Khajuria, V, *et al*. (2017) [7] As per the report of International Osteoporosis Foundation, in North India, 96% of noenates, 91% of healthy school girls, 78% of healthy hospital staff, and 84% of pregnant women were found to have hypovitaminosis D. On the other hand, prevalence of vitamin D deficiency in southern India was estimated tobe

40% among males and 70% among females. There was also a significant rural urban variation in the vitamin D deficiency status that was attributed to the diversity of occupation which the people were involved in.

Sachan, A, Gupta, R, Das, V, Agarwal, A, Awasthi, P.K, Bhatia, V, *et al*. (2005) [4] studied the 207 pregnant women from the Queen Mary Hospital, King George Medical University Lucknow for the maternal vitamin 25(OH)D level along with the cord blood vitamin 25(OH)D levels in the neonates. The result of the study was that the 42.5% of the women had the vitamin D level was 10 ng/ml.

Goswami, R, Gupta, N, Goswami, D, Marwaha, R.K, Tandon, N, Kochupilli, N. (2000) [8] showed that despite of abundant sunlight, healthy persons in Delhi remained vitamin D deficient. This may be because of skin pigmentation, inadequate direct sun exposure as well as low-calcium, high-phytate diets, pregnancy, and winter-related reduced sunlight exposure which may affect vitamin D levels.

Objectives of the study

The aim of this study was to evaluate maternal vitamin D status and its effect on neonatal vitamin D status, following the introduction of the support programme for pregnant women. A second aim was to identify risk factors for vitamin D deficiency in women in Madhubani District, Bihar a low socio-economic condition.

Materials and methods

This study was conducted at six selected government Maternal and Child Health clinics in Madhubani, Bihar Written informed consent was obtained from the respondents prior to data collection. Between November 2017 and January 2018, women aged 18 years and above with singleton pregnancies of more than 28 weeks of gestations were invited to participate in the study during their routine prenatal check-ups at the selected clinics. Women with multiple pregnancies and planned to move out of the study area in the next one year were excluded from the study. Out of 1000 pregnant women who were

Maternal characteristics

Socio-demographic data including age, ethnicity, educational level, working status, monthly household income, and obstetrical history such as parity and gravidity were obtained from the respondents through a face-to-face interview. Pre-pregnancy body weight and height were obtained from medical records. Pre-pregnancy Body Mass Index (BMI) was calculated and classified based on World Health Organization (WHO) cut-off points.

Maternal vitamin D intake and supplementation

Vitamin D intake and supplementation were assessed using a Vitamin D Food Frequency Questionnaire (FFQ) over the past month. The vitamin D FFQ consists of foods derived from three categories; namely, foods that naturally contained vitamin D, foods that were fortified with vitamin D, and supplements that contained vitamin D. The daily average vitamin D intake (µg/day) was calculated by multiplying the frequency of consumption per day, serving size consumed, and vitamin D content of the food. The vitamin D intake was then compared with the Recommended Nutrient Intakes (RNI) to determine the nutrient intake adequacy. The percentage contribution of each food group to total vitamin D intake was calculated to determine the main food sources of vitamin D.

Maternal Sun Exposure

Sun exposure was assessed by using a Seven-day Sun Exposure Recall. Respondents were required to record their outdoor activities over the past one week (from 7am to 7pm) in terms of type of activity, duration (in minutes), frequency (per week), clothing, sunscreen use, gloves, and umbrellas. Body surface area (BSA) exposed to sunlight was estimated by using the "Rule of Nine" adopted from Hall *et al*. Sun exposure index (SEI) was calculated by multiplying the amount of time spent outdoors with BSA exposed.

Results

The mean serum 25(OH)D concentration for the total 535 pregnant women was 33.8 nmol/L (SD = 12.9), the prevalence of vitamin D deficiency (< 30 nmol/L), vitamin D insufficiency (30–50 nmol/L), and normal vitamin D ($\geq$ 50 nmol/L) was 42.6%, 49.3%, and 8.0%, respectively. The mean age at conception of the respondents was 29.9 (SD = 4.1) years. Attained a tertiary education (81.7%), and had a moderate Factors associated with maternal vitamin D deficiency of household income (52.3%). Most of them were employed (69.0%), In relation to pre-pregnancy BMI, the prevalence of underweight, overweight, and obesity was 9.0%, 25.0%, and 11.8%, respectively. The respondents consumed an average of 8.7 ± 6.7 µg of vitamin D daily, with three-quarters of them did not achieve the RNI for vitamin D which is 15 µg/day (74.4%).

Table 1: Characteristics of the Respondents (N=535)

Characteristics		**N**	**%**
Age	Mean SD	29.9 (4.1)	
Education	Secondary	98	18.3
	Tertiary	437	81.7
Monthly Income	Low	93	17.4
	Moderate	280	52.3
	High	162	30.3
Work Status	Non-working	166	31.0
	Working	369	69.0
Pre-Pregnancy BMI (kg/m^2)	Mean SD	24.1 (4.9)	
	Under weight	48	9.0
	Normal weight	290	54.0
	Over weight	134	25.0
	Obesity	63	11.8
Dietary Vitamin D intake (µg/day)	Mean SD	10.2 (7.9)	
	Below RNI	398	74.4
	Above RNI	137	25.6
Intake of Supplements containing Vitamin D	NO	355	66.4
	S	180	33.6
Total minutes of Sum Exposure per day	Median (IQR)	4.29 (0.00,17.14)	
Total % BSA per day	Median (IQR)	1.14 (0.00,5.14)	
SEI per day	Median (IQR)	0.57 (0.00, 0.57)	

Source: Based on Field Survey.

Table 2: Contribution of food items towards the daily intake of vitamin D

Food Items	Contribution (%)
Fish and Fish products	35.87
Indian mackerel	13.78
Prawn	4.59
Milk and milk products	28.19
Fresh Milk	19.31
Powder milk	4.82
Condensed milk	0.49
Cheese	0.41
Ice Cream	0.25
Butter	0.20
Eggs	9.13
Meat and Meat products	3.85
Chicken	3.54
Mushroom	0.38
Potatoes	0.05
Beverages	1.22
Cultured milk drinks	1.21
Fortified soy drinks	0.01
Cereals and cereals products	0.86
Cereals drinks	0.83
Supplements Containing Vitamin D	19.57

Source: Based on Field Survey.

A total of 80.4% of the vitamin D were obtained from the food sources, while the rest were from dietary supplements (19.6%). Only one in three of the respondents took supplements containing vitamin D during pregnancy (33.6%). Fish and fish products (35.8%) showed the highest contribution to vitamin D intake, followed by milk and milk products (28.2%), eggs (9.1%), meat and meat products (3.9%), others (1.3%), beverages (1.2%), and cereal and cereal products (0.9%).

Discussions

The present study revealed that 42.6% of the pregnant women were vitamin D deficient and almost half were vitamin D insufficient (49.3%). Women who had higher intake of dietary vitamin D were less likely to have vitamin D deficiency during pregnancy. High prevalence of vitamin D deficiency and insufficiency have been reported in several studies in the tropical countries. The prevalence of vitamin D deficiency and insufficiency in the present study was much higher than those reported in the aforementioned studies which used different serum 25(OH)D cut-off level of < 75 nmol/L. To date, there is still lack of consensus on the definition of vitamin D levels. While IOM defined a serum 25 (OH)D level less than 30 nmol/L as deficiency and 30–50 nmol/L as insufficiency. In this study, pregnant women who had higher intake vitamin D were more likely to have lower odds of vitamin D deficiency. This finding is in agreement with Shiraishi *et al*. that found higher vitamin D intake significantly contributed to higher serum 25(OH)D concentration among pregnant women. This could be attributed to the high consumption of vitamin D containing food. Similarly, a recent local study conducted by Yong *et al*. demonstrated that milk and dairy products were the major food sources contributing to vitamin D intake among pregnant women. In the current study, we found that among third trimester pregnant women, those who were at a higher risk for vitamin D deficiency. The significant ethnic differences in the prevalence of vitamin D deficiency was in line with previous studies conducted among general population and pregnant women. The high prevalence of vitamin D deficiency might be due to religious and cultural reasons. Muslim women are compulsory to cover entire body parts and this reduces the probability for the Indian pregnant women to get sufficient sunlight, which will then lower the vitamin D production in their body. Only one in three women in the study were taking dietary supplements containing vitamin D, such as multivitamins and calcium supplements enriched with vitamin D. Intake of supplements containing vitamin D significantly lowered the risk of vitamin D deficiency in the bivariable model but was no longer significant in the multivariable model. This finding was inconsistent with previous studies conducted among pregnant women, in which the use of vitamin D supplements and multivitamins were associated with higher serum 25(OH) D levels.

Conclusion

Although a vitamin D support programme was launched for pregnant women by the Ministry of Health, Govt. of India. Vitamin D deficiency in pregnant women and their infants is still serious health problem in India. Also, the data from this study indicate that the usage rate of the dose recommended by the support programme was very low and the prescribed supplements were generally multivitamin preparations. Therefore, the support programme should be continued, more widely promoted and physicians should be more informed about the content of the support programme in pregnancy. Future interventions for the prevention and control of maternal vitamin D deficiency should take into account of the differences. Considering the long term health complications of vitamin D deficiency during pregnancy, future nutrition education should emphasise on vitamin D-fortified foods consumption among pregnant women.

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