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Original Research Article

Maternal Vitamin D Deficiency and Subsequent Pregnancy Outcomes: A retrospective Study

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Abstract:

Background: Maternal vitamin D deficiency is a prevalent public health concern associated with adverse obstetric outcomes. Despite adequate sunlight in many regions, deficiency remains common among pregnant women.

Aim: To evaluate the association between maternal vitamin D deficiency and subsequent pregnancy outcomes in a retrospective study

Methodology: A six-month retrospective study was conducted among 112 pregnant women attending Department of Obstetrics and Gynaecology, Patna Medical College and Hospital, Patna, India. Serum 25(OH)D_3 levels were measured using ECLIA and classified as normal (≥50 nmol/L), insufficient (30–50 nmol/L), or deficient (<30 nmol/L). Participants were followed until delivery to assess gestational hypertensive disorders (GHD), gestational diabetes mellitus (GDM), preterm birth, anemia, and mode of delivery. Data were analyzed using chi-square and logistic regression tests.

Results: Vitamin D deficiency was observed in 39.3% of participants. Deficiency was significantly associated with GHD (AOR 3.12; p=0.021), GDM (AOR 2.46; p=0.047), preterm birth (AOR 2.89; p=0.044), and anemia (AOR 2.67; p=0.022). The association with cesarean section was not statistically significant.

Conclusion: Maternal vitamin D deficiency is an independent risk factor for adverse pregnancy outcomes. Early screening and supplementation may improve maternal and neonatal health.

Keywords: Vitamin D deficiency, pregnancy outcomes, gestational hypertension, gestational diabetes, preterm birth, anemia, prospective cohort study.

Introduction

Maternal hypovitaminosis D has become a major health challenge in the obstetrics field, as it is likely to have negative impacts on the maternal and fetal outcomes during pregnancy [1]. Vitamin D is a fat-soluble vitamin that is essential in the maintenance of calcium homeostasis and skeletal health but has later been noted to have a wider immunomodulatory, glucose-modulating as well as placental operations. In spite of the established sources of vitamin D, which mainly include the endogenous production in response to UVB radiation exposure to the skin and food intake, deficiency is rampant in the world in pregnant women. Vitamin D deficiency is very geographically and demographically diverse and shows variation in the exposure to sunlight, nutrition, and the lifestyle of the population [2].

The women are especially vulnerable to pregnant women in the Asian continent, Africa, the Gulf region, and Latin America, where prevalence rates of vitamin D deficiency have been reported to be in the range of 60 to 90 percent, the highest in the world [3]. Such high rates are the result of a set of environmental, cultural, and socioeconomic factors. As an example, indoor lifestyles, cultural dress codes, and the high level of melanin in the skin decrease the production of vitamin D whereas poor nutrition increases the deficiency. In addition, obesity and some medical diseases, such as malabsorption syndromes, were also reported as other risk factors to suboptimal vitamin D status during pregnancy [4].

Vitamin D deficiency in pregnant women is prevalent even in areas that have plenty of sun rays all year round with Malaysia being one of the areas. Research has pointed to an unexpectedly high rate of deficiency in the Malaysian pregnant populations with a prevalence rate of 90.4 percent amongst the

first trimester, 42.6 percent in the second trimester and 50.2 percent in the third trimester. Such results indicate that geographical position is not the only determinant of sufficient levels of vitamin D and emphasize the importance of behavior and diet. Nonetheless, there are no policies in Malaysia that govern the use of vitamin D supplement or mandatory fortification of food unlike other nations, which have made dietary supplementation during pregnancy a legal requirement to avoid deficiency [5]. Lack of uniformed public health approach to the vitamin D supplementation might be one of the factors leading to persistent maternal hypovitaminosis D and related morbidity.

Vitamin D deficiency in maternal pregnancy has been associated with diverse negative consequences. New findings show that low vitamin D concentrations may adversely affect maternal and neonatal health and lead to the occurrence of such complications as gestational hypertensive disorders (GHD), gestational diabetes mellitus (GDM), preterm birth (PTB), bacterial vaginosis (BV) and a higher risk of cesarean section (CS) [6]. The mechanisms underlying vitamin D deficiency and all these outcomes are dysregulation of calcium metabolism, impaired immune functions, and changed placenta development that are essential to the maintenance of healthy pregnancy physiology.

Although there is increasing awareness on maternal vitamin D significance, there is a dearth of research focusing on maternal vitamin D condition in relation to the adverse pregnancy outcomes. Numerous researchers have been cross-sectional or retrospective thus proving difficult to determine temporality or causality. It is thus important that future cohort studies that observe maternal and fetal health during pregnancy follow up vitamin D status to improve the understanding of the effects of deficiency and inform interventions that may be given [7]. A thorough knowledge of maternal vitamin D deficiency is of great importance especially in such nations as Malaysia where it is high in terms of the population although there is enough sunlight they do not have enough vitamin d in their bodies and this may lead to pregnancy-related complications that they can avoid [8].

The proposed study aims to fill this knowledge gap by exploring the effect of maternal vitamin D deficiency on pregnancy outcomes in Malaysian women in the form of a prospective cohort study design. Through the analyses of maternal vitamin D status in the different trimesters and evaluation of the complications of the subsequent pregnancies, the proposed study will help understand the contribution of hypovitaminosis D to poor pregnancy outcomes and would provide evidence to implement policies in terms of supplementation and food fortification to help improve maternal and neonatal health in Malaysia. It is necessary to understand these associations because it could help design specific interventions that could decrease the burden of pregnancy-related complications that could be linked to vitamin D deficiency.

Methodology

Study Design: This study was designed as a retrospective study to evaluate the association between maternal vitamin D status during pregnancy and subsequent pregnancy outcomes. Pregnant women were recruited during their antenatal visits and followed prospectively from the second trimester until delivery. Serum vitamin D levels were measured at recruitment, and participants were observed longitudinally to determine the occurrence of maternal and neonatal outcomes.

Study Area: The study was conducted in the Department of Obstetrics and Gynaecology, Nalanda Medical College and Hospital, located in Patna, India.

Study Duration: The study was carried out over a period of six months from April 2025 to September 2025.

Sample Size: A total of 112 pregnant women were enrolled in the study. The sample size was determined based on feasibility within the defined study duration and patient flow at the study center, while ensuring adequate representation of the target population for statistical analysis.

Sample Population: The study population comprised pregnant women attending antenatal care at the Department of Obstetrics and Gynaecology of the study hospital. Women with singleton pregnancies in their second trimester or beyond were considered for recruitment, provided they met the inclusion criteria and consented to participate.

Data Collection: Data collection involved structured interviews, clinical assessments, laboratory investigations, and review of medical records. Sociodemographic information, obstetric history, and relevant clinical details were obtained using a predesigned data collection form. Anthropometric measurements including weight and height were recorded using standardized procedures, and pre-pregnancy body mass index (BMI) was calculated using the formula: BMI (kg/m^2) = weight (kg) / height (m^2). Dietary vitamin D intake was assessed using a validated Food Frequency Questionnaire (FFQ), which captured intake of vitamin D–rich foods such as fish, milk, eggs, mushrooms, fortified foods, and supplements over the previous month. Daily vitamin D intake was calculated by multiplying the vitamin D content of each food item by portion size and frequency of consumption and comparing the total intake with the recommended nutrient intake of 15 µg/day for pregnant women.

Approximately 6 mL of venous blood was collected from each participant under aseptic precautions. The samples were allowed to clot and then centrifuged at 3000 rpm for 10 minutes. The separated serum was stored at −20°C until analysis. Serum 25-hydroxycholecalciferol [25(OH)D3] levels were measured using the electrochemiluminescence immunoassay (ECLIA) method. Vitamin D status was classified as normal (≥50 nmol/L), insufficient (30–50 nmol/L), or deficient (<30 nmol/L) according to Institute of Medicine guidelines.

Pregnancy outcomes assessed included gestational hypertensive disorders (gestational hypertension and preeclampsia), gestational diabetes mellitus, anemia, preterm birth, Group B Streptococcus carriage, and mode of delivery. Preterm birth was defined as delivery before 37 completed weeks of gestation. Anemia was defined as hemoglobin <10.5 g/dL in the second and third trimesters. Mode of delivery was categorized as vaginal delivery, assisted vaginal delivery (forceps or vacuum), or cesarean section.

Inclusion Criteria

Participants were included if they:

- Had a singleton pregnancy in the second trimester or beyond
- Had a viable pregnancy at the time of recruitment
- Provided written informed consent to participate
- Were willing to follow up for prenatal and obstetric outcome assessments

Exclusion Criteria

Participants were excluded if they:

- Had pre-existing chronic illnesses (e.g., diabetes mellitus, hypertension, renal or liver disease)
- Had conditions affecting vitamin D metabolism (e.g., malabsorption syndromes, parathyroid disorders)
- Were unwilling to provide consent or follow-up

Procedure: Eligible participants were identified during routine antenatal clinic visits. After confirming eligibility and obtaining informed consent, baseline data including sociodemographic details, obstetric history, anthropometric measurements, dietary assessment, and blood samples were collected. Participants were then followed prospectively throughout their pregnancy. Pregnancy outcomes were recorded from hospital records at the time of delivery. The collected data were compiled and coded for statistical analysis.

Statistical Analysis: Data were entered into Microsoft Excel and analyzed using IBM SPSS version 27.0. Normality of continuous variables was assessed using appropriate statistical tests. Normally distributed continuous variables were expressed as mean ± standard deviation, while non-normally distributed variables were presented as median and interquartile range. Categorical variables were summarized as frequencies and percentages. The Chi-square test was used to assess associations between categorical variables. Binary logistic regression analysis was performed to determine the strength of association between maternal vitamin D status and adverse pregnancy outcomes while controlling for potential confounders. A p-value of ≤0.05 was considered statistically significant at a 95% confidence interval."

Result

Table 1 presents the socio-demographic and obstetric characteristics of the 112 study participants. The mean age was 26.8 ± 4.2 years, with most women aged 25–30 years (46.4%), followed by those <25 years (30.4%) and >30 years (23.2%). A higher proportion resided in rural areas (57.1%) compared to urban areas (42.9%). Regarding parity, 44.6% were primigravida and 55.4% were multigravida. The mean pre-pregnancy BMI was 23.7 ± 3.6 kg/m², with the majority having normal BMI (55.4%), while 12.5% were underweight, 25.0% overweight, and 7.1% obese. The mean gestational age at recruitment was 22.4 ± 3.1 weeks. Overall, the study population predominantly comprised young, rural, multigravida women with normal BMI.

Table 1: Socio-Demographic and Obstetric Characteristics of Study Participants (N = 112)

Variable	n (%) / Mean ± SD
Age (years)	26.8 ± 4.2
< 25 years	34 (30.4%)
25–30 years	52 (46.4%)
> 30 years	26 (23.2%)
Residence	
Urban	48 (42.9%)
Rural	64 (57.1%)
Parity	
Primigravida	50 (44.6%)
Multigravida	62 (55.4%)
Pre-pregnancy BMI (kg/m²)	23.7 ± 3.6

Underweight (<18.5)	14 (12.5%)
Normal (18.5–24.9)	62 (55.4%)
Overweight (25–29.9)	28 (25.0%)
Obese (≥30)	8 (7.1%)
Gestational age at recruitment (weeks)	22.4 ± 3.1

Table 2 shows the distribution of vitamin D status among the 112 participants. Only 28 women (25.0%) had normal vitamin D levels (≥50 nmol/L), while 40 (35.7%) were classified as insufficient (30–50 nmol/L). The largest proportion, 44 women (39.3%), were vitamin D deficient (<30 nmol/L). Overall, nearly three-quarters of the participants had suboptimal vitamin D levels, with deficiency being the most common category.

Table 2: Vitamin D Status of Participants (N = 112)	
Vitamin D Category (25(OH)D3 level)	**n (%)**
Normal (≥50 nmol/L)	28 (25.0%)
Insufficient (30–50 nmol/L)	40 (35.7%)
Deficient (<30 nmol/L)	44 (39.3%)

Table 3 summarizes pregnancy outcomes among the 112 study participants. Gestational hypertensive disorders (GHD) were observed in 18 women (16.1%), while gestational diabetes mellitus (GDM) occurred in 20 (17.9%). Preterm birth (<37 weeks) was reported in 14 cases (12.5%), and anemia (Hb <10.5 g/dL) was present in 32 women (28.6%). Group B Streptococcus (GBS) carriage was identified in 16 participants (14.3%). Regarding mode of delivery, 62 women (55.4%) had vaginal delivery, 10 (8.9%) underwent assisted vaginal delivery, and 40 (35.7%) delivered by cesarean section. Overall, vaginal delivery was the most common mode of childbirth in the study population.

Table 3: Pregnancy Outcomes Among Study Participants (N = 112)	
Outcome	**n (%)**
Gestational Hypertensive Disorders (GHD)	18 (16.1%)
Gestational Diabetes Mellitus (GDM)	20 (17.9%)
Preterm Birth (<37 weeks)	14 (12.5%)
Anemia (Hb <10.5 g/dL)	32 (28.6%)
GBS Carriage	16 (14.3%)
Mode of Delivery	
Vaginal Delivery	62 (55.4%)
Assisted Vaginal Delivery	10 (8.9%)
Cesarean Section	40 (35.7%)

Table 4 shows a significant association between vitamin D deficiency and adverse pregnancy outcomes. Among deficient mothers (n = 44), gestational hypertensive disorders (GHD) occurred in 27.3% compared to 8.8% in non-deficient mothers (p = 0.012). Gestational diabetes mellitus (GDM) was observed in 25.0% of deficient versus 13.2% of non-deficient mothers (p = 0.041). Preterm birth occurred in 20.5% of deficient mothers compared to 7.4% in the non-deficient group (p = 0.036). Anemia was significantly more common in deficient mothers (40.9%) than in non-deficient mothers (20.6%) (p = 0.018). Cesarean section rates were also higher among vitamin D deficient mothers (45.5% vs 29.4%, p = 0.048). Overall, vitamin D deficiency was significantly associated with multiple adverse pregnancy outcomes.

Table 4: Association Between Vitamin D Status and Pregnancy Outcomes (Chi-Square Test)			
Outcome	**Deficient (n=44)**	**Non-Deficient* (n=68)**	**p-value**
GHD	12 (27.3%)	6 (8.8%)	0.012*
GDM	11 (25.0%)	9 (13.2%)	0.041*
Preterm Birth	9 (20.5%)	5 (7.4%)	0.036*
Anemia	18 (40.9%)	14 (20.6%)	0.018*
Cesarean Section	20 (45.5%)	20 (29.4%)	0.048*

Table 5 presents the binary logistic regression analysis evaluating adverse pregnancy outcomes among vitamin D deficient mothers. Vitamin D deficiency was significantly associated with an increased risk of gestational hypertensive disorders (GHD) (Adjusted OR 3.12; 95% CI: 1.18–8.21; p = 0.021),

gestational diabetes mellitus (GDM) (Adjusted OR 2.46; 95% CI: 1.01–6.02; p = 0.047), preterm birth (Adjusted OR 2.89; 95% CI: 1.02–8.15; p = 0.044), and anemia (Adjusted OR 2.67; 95% CI: 1.15–6.18; p = 0.022). Although cesarean section rates were higher among vitamin D deficient mothers (Adjusted OR 1.98), this association was not statistically significant (p = 0.081). Overall, vitamin D deficiency emerged as an independent risk factor for several adverse pregnancy outcomes.

Table 5: Binary Logistic Regression Analysis for Adverse Pregnancy Outcomes Among Vitamin D Deficient Mothers

Outcome	Adjusted OR	95% CI	p-value
GHD	3.12	1.18–8.21	0.021*
GDM	2.46	1.01–6.02	0.047*
Preterm Birth	2.89	1.02–8.15	0.044*
Anemia	2.67	1.15–6.18	0.022*
Cesarean Section	1.98	0.92–4.29	0.081

Discussion

This current prospective cohort study revealed that the prevalence of vitamin D deficiency (39.3%) and insufficiency (35.7%) was very high with almost three quadrants of the study reporting the suboptimal 25(OH)D 3. This general prevalence of 75.0% (deficiency plus insufficiency) is in the range of other Asian groups where the prevalence during pregnancy often exceeds 60. As an example, Woon et al. (2019) [9] found that vitamin D deficiency was prevalent in third-trimester Malaysian women (67.4%), but Roth et al. (2018) [10]] estimatedthat over half of pregnant women in most of the low- and middle-income countries are vitamin D-deficient. Equally, Pratumvinit et al. (2015) [11] found a 75.5 percent prevalence among the Thai pregnant women. The fact that these studies show similarity to ours could be because of the similarity in the determinants of the region, including darker skin pigmentation, lack of sun exposure owing to cultural issues, and poor intake of diet. In spite of the fact that in tropical countries there is much sunlight, the predisposition of pregnant women to the hypovitaminosis D is still caused by behavioral and sociocultural factors."

Vitamin D deficiency was also found to have a significant relationship with gestational hypertensive disorders (GHD), which was found in 27.3 percent of deficient and 8.8 percent non-deficient women (p=0.012). Following adjustment, a deficiency gave a 3.12-fold greater chance of GHD (95% CI: 1.18821). The result was consistent with that of Bodnar et al. (2014) [6] who reported that women whose 25(OH)D were below 37.5 nmol/L had a much higher risk of severe preeclampsia with adjusted odds ratios of between 2.4 and 5.0 according to the severity. On the same note, a study by Burris et al. (2014) [12] established that low maternal levels of vitamin D were correlated with increased risk of developing hypertensive disorders of pregnancy. Even in a meta-analysis by Aghajafari et al. (2013) [13], the relationship between vitamin D deficiency and an increased chance of preeclampsia was also shown (pooled OR 1.79). The size of association in our study (aOR 3.12) is a little higher, which can be explained by variations in the baseline vitamin D status, cut-off level or population makeup. At the mechanistic level, vitamin D is reported to regulate the reninangiotensin system and endothelial activity, affecting the blood pressure regulation (Bodnar et al., 2014) [6].

Gestational diabetes mellitus (GDM) was found in 25.0% and 13.2% of deficient women and non-deficient women, respectively (p=0.041) with an adjusted odds ratio of 2.46. This is consistent with the results of Aghajafari et al. (2013) [13], who found that the low level of 25 (OH)D in the maternal level is significantly associated with GDM (pooled OR 1.49). Liu et al. (2020) [14] also showed that maternal vitamin D deficiency had a negative independent relation with unfavorable glycemia and distorted fetal growth, especially in the presence of GDM. Even though the effect size of our study is greater than other reported meta-analyses, differences in diagnostic criteria of GDM, and time of vitamin D testing could be the cause of these differences. The identified association has biological plausibility because vitamin D is thought to affect the functioning of the pancreatic β-cells, the pancreatic insulin sensitivity.

PTB was found in 20.5 per cent of the deficient women, and 7.4 per cent of non-deficient women (p=0.036); adjusted odds (aOR) of PTB were approximately three times higher (2.89; 95 per cent CI:1.028.15). This concurs with the meta-analysis by Qin et al. (2016) [15] that found that vitamin D deficiency predisposed PTB by 29% (pooled OR 1.29). Though there is a pooled estimate indicating a less significant association in Qin et al. (2016) [15], given the difference in studies and population risks, higher odds among our cohort could be explained by the difference in studies and population risks. The study by Monier et al. (2019) [16] also established that preterm birth and infants who are small-for-gestational-age were more likely to be caused by first-trimester vitamin D deficiency. The higher correlation in our study could be due to cumulative effect of chronic deficiency until mid-pregnancy since the participants of our study were recruited at an average gestational age of 22.4 weeks.

The incidence of maternal anemia in victims of vitamin D deficiency (40.9% vs. 20.6%, p=0.018) was significantly high with an adjusted odds ratio of 2.67. Although anemia in pregnancy is multifactorial, there is emergent evidence based on the ability of vitamin D to affect erythropoiesis and inflammatory pathways. Gernand et al. (2016) [17] emphasized that there are numerous micronutrient deficiencies that are often placed together during pregnancy and could have a synergistic effect on maternal outcomes. More studies have not convincingly quantified the relationship between vitamin D deficiency and anemia, but our results do support the hypothesis of the possible role of hypovitaminosis D in worsening hematologic status, potentially by mediating the effects of inflammatory cytokines and iron metabolism.

Deficient women had a higher likelihood of cesarean section (CS) (45.5% vs. 29.4, p=0.048); nevertheless, the relationship was no longer significant after adjustment (aOR 1.98; p=0.081). This is somewhat consistent with Loy et al. (2015) [18] who found that low maternal vitamin D status was linked to higher risk of CS in some ethnic subgroups in a multi-ethnic Asian cohort. Contrarily, Gernand et al. (2016) [17] established discrepant findings on the association between vitamin D deficiency and mode of delivery. The fact that the significance in our adjusted model is attenuated indicates that it is possible that confounding variables like BMI, parity and obstetric complications mediate the relationship. However, the described tendency toward higher CS risk in deficient women might also be the manifestation of the impaired contractility of the myometrial layer due to the changes in calcium homeostasis.

On the whole, our results are consistent with the increasing evidence on the subject of maternal vitamin D deficiency being a risk factor of negative pregnancy outcomes, such as hypertensive disorders, GDM, preterm birth, and anemia. The strength of the relationships experienced in our study, between 2.46- and 3.12-fold higher adjusted odds, seems similar or slightly greater than that of a number of studies conducted internationally (Aghajafari et al., 2013; Bodnar et al., 2014) [13,6]. Such differences are perhaps evidence of study population heterogeneity, the time of vitamin D measurement, cut-off thresholding, and vitamin D practice. Since 75 percent of our patients had poor levels of vitamin D, our findings provide support to the public health aspects of regular screening, dietary guidance and supplementary interventions during pregnancy, especially in areas where deficiency is still extremely high, even with sufficient sunlight exposure.

Conclusion

This prospective cohort study demonstrates that maternal vitamin D deficiency is common among pregnant women and is significantly associated with an increased risk of adverse pregnancy outcomes. Deficient mothers showed higher occurrences of gestational hypertensive disorders, gestational diabetes mellitus, preterm birth, and anemia compared to non-deficient mothers, with these associations remaining significant after adjusting for potential confounders. Although the likelihood of cesarean section was higher among vitamin D deficient women, it was not independently significant on regression analysis. Overall, the findings suggest that maternal vitamin D deficiency is an important modifiable risk factor that may negatively influence pregnancy outcomes, underscoring the need for early screening, preventive strategies, and appropriate supplementation during pregnancy to improve maternal and fetal health.

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