Section: Miscellaneous

Original Research Article

A STUDY TO EVALUATE THE IMPACT OF MATERNAL VITAMIN D DEFICIENCY ON NEONATAL OUTCOMES IN A PROSPECTIVE COHORT

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ABSTRACT

Background: Vitamin D deficiency during pregnancy has been associated with adverse neonatal outcomes, including low birth weight, preterm birth, and neonatal complications. This study aimed to evaluate the impact of maternal vitamin D deficiency on neonatal outcomes in a prospective cohort.

Materials and Methods: A prospective observational study was conducted with 88 pregnant women. Serum 25-hydroxyvitamin D [25(OH)D] levels were measured during the third trimester. Neonatal outcomes, including birth weight, gestational age at delivery, Apgar scores, and incidence of neonatal complications, were recorded. Vitamin D deficiency was defined as serum 25(OH)D < 20 ng/mL.

Results: Among the 88 participants, 42 (47.7%) were vitamin D deficient. Neonates born to vitamin D-deficient mothers had significantly lower birth weights (2.8 ± 0.4 kg vs. 3.2 ± 0.5 kg, p = 0.01) and higher rates of preterm birth (23.8% vs. 8.7%, p = 0.04) compared to neonates of sufficient mothers. Apgar scores at 1 and 5 minutes were also lower in the deficient group (p < 0.05).

Conclusion: Maternal vitamin D deficiency is associated with adverse neonatal outcomes, including lower birth weight, higher preterm birth rates, and poorer Apgar scores. Routine screening and supplementation in deficient pregnant women may improve neonatal health.

Keywords: Vitamin D deficiency, pregnancy, neonatal outcomes, preterm birth, birth weight.

INTRODUCTION

Vitamin D, a fat-soluble secosteroid, is essential for maintaining calcium-phosphate homeostasis, bone mineralization, and immune regulation.[1] During pregnancy, its role extends to fetal skeletal development, placental function, and modulation of inflammatory responses.[2] Despite its critical importance, vitamin D deficiency remains a global health concern, particularly among pregnant women, with prevalence rates ranging from 20% to 80%, depending on geographic location, skin pigmentation, dietary habits, and sun exposure.[3]

Maternal vitamin D status has been increasingly recognized as a determinant of pregnancy outcomes. A growing body of evidence suggests that deficiency is associated with an elevated risk of gestational diabetes mellitus (GDM), preeclampsia, and cesarean delivery.[4] Furthermore, inadequate vitamin D levels may impair fetal growth, leading to low birth weight (LBW), small-for-gestational-age (SGA) infants, and preterm birth (PTB).[5] The proposed mechanisms include dysregulation of placental angiogenesis, altered immune responses, and impaired fetal calcium absorption, which may compromise neonatal health.[6]

Neonatal consequences of maternal vitamin D deficiency extend beyond birth weight and gestational age. Emerging studies suggest associations with neonatal hypocalcemia, respiratory distress syndrome (RDS), and even long-term developmental disorders such as autism and schizophrenia.[7] However, findings remain inconsistent, with some studies reporting no significant correlation between maternal vitamin D levels and adverse neonatal outcomes.[8] These discrepancies may stem from variations in study design, population characteristics, and definitions of

vitamin D deficiency. This study aimed to evaluate the association between maternal vitamin D deficiency (defined as serum 25(OH)D < 20 ng/mL) and neonatal outcomes. By elucidating these relationships, this study contributes to the growing body of evidence supporting the importance of maternal vitamin D sufficiency and may inform clinical guidelines on screening and supplementation in prenatal care.

MATERIALS AND METHODS

Study design, population and settings

This study employed a prospective observational design to examine the association between maternal vitamin D deficiency and neonatal outcomes. Pregnant women were enrolled during their third trimester, and their vitamin D levels were measured. Neonatal outcomes were assessed at birth and during the immediate postpartum period. The study was conducted at the AFMS Hospital, West Bengal. Data collection took place between Oct 2023 to June 2025.

Inclusion and Exclusion Criteria

Inclusion Criteria

- Singleton pregnancy
- Gestational age ≥28 weeks at enrollment
- Willingness to provide informed consent

Exclusion Criteria

- Multiple pregnancies (twins, triplets)
- Chronic medical conditions (pre-existing diabetes, hypertension, renal disease)
- Current use of high-dose vitamin D supplements (>1000 IU/day)
- Fetal congenital anomalies detected on ultrasound

Sample Size Calculation: Based on previous studies (Aghajafari et al., 2013)5, the prevalence of vitamin D deficiency in pregnant women was estimated at 40%. Assuming a 20% difference in adverse neonatal outcomes between deficient and sufficient groups, with 80% power and 5% significance level, a minimum sample size of 80 participants was required. Accounting for a 10% attrition rate, 88 participants were recruited.

Procedure for Data Collection

Maternal Data

- **Baseline Assessment:**
  - Demographic details (age, parity, socioeconomic status)
  - Medical and obstetric history
  - Sun exposure and dietary habits (via questionnaire)
- **Blood Sample**
  - 5 mL venous blood collected for 25(OH)D assay (ELISA method)

Neonatal Data

- **At Delivery**
  - Birth weight (measured using digital scale)
  - Gestational age (confirmed by early ultrasound or last menstrual period)
  - Apgar scores (recorded at 1 and 5 minutes)
- **Postnatal Assessment**
  - Neonatal complications (recorded from medical charts)

Statistical Analysis: Data were entered into Microsoft Excel and analyzed using SPSS v26.Independent t-test (continuous variables) andChi-square test (categorical variables). P-value was set at 0.05.

RESULTS

Table 1: Baseline Characteristics of Study Participants (N=88)

Characteristic	Vitamin D Deficient (n=42)	Vitamin D Sufficient (n=46)	p-value
Maternal Age (years)	27.4 ± 4.1	29.1 ± 3.8	0.12
Gestational Age at Enrollment (weeks)	30.2 ± 1.5	30.5 ± 1.3	0.45
BMI (kg/m²)	26.3 ± 3.2	25.8 ± 2.9	0.38
Parity (Nulliparous)	22 (52.4%)	24 (52.2%)	0.98
Socioeconomic Status (Low Income)	28 (66.7%)	25 (54.3%)	0.25
Sun Exposure (Low)	35 (83.3%)	30 (65.2%)	0.04
Dietary Vitamin D Intake (Inadequate)	38 (90.5%)	32 (69.6%)	0.01

Data presented as mean ± SD or n (%). p-values from t-test (continuous) or χ^2 test (categorical).

The study included 88 pregnant women, stratified into vitamin D-deficient (n=42, 47.7%) and sufficient (n=46, 52.3%) groups. Both groups were comparable in maternal age (27.4 ± 4.1 vs. 29.1 ± 3.8 years, p=0.12), BMI (26.3 ± 3.2 vs. 25.8 ± 2.9 kg/m², p=0.38), and parity (52.4% vs. 52.2% nulliparous, p=0.98). However, deficient mothers had significantly lower sun exposure (83.3% vs. 65.2%, p=0.04) and inadequate dietary vitamin D intake (90.5% vs. 69.6%, p=0.01), suggesting lifestyle contributors to deficiency.

Table 2: Neonatal Outcomes by Maternal Vitamin D Status

Outcome	Deficient Group (n=42)	Sufficient Group (n=46)	p-value	Adjusted OR (95% CI)*
Birth Weight (kg)	2.8 ± 0.4	3.2 ± 0.5	0.01	–
Low Birth Weight (<2.5 kg)	12 (28.6%)	5 (10.9%)	0.03	3.1 (1.1–8.9)
Preterm Birth (<37 weeks)	10 (23.8%)	4 (8.7%)	0.04	2.8 (1.2–7.3)
Apgar Score (1-min)	6.5 ± 1.2	7.8 ± 1.0	<0.001	–
Apgar Score (5-min)	8.2 ± 0.8	9.0 ± 0.6	<0.001	–
Neonatal Complications	14 (33.3%)	8 (17.4%)	0.08	1.9 (0.9–4.2)

*Data as mean ± SD or n (%). Adjusted for maternal age, BMI, and socioeconomic status.

Vitamin D-deficient mothers delivered neonates with lower birth weights (2.8 ± 0.4 kg vs. 3.2 ± 0.5 kg, p=0.01) and higher rates of low birth weight (28.6% vs. 10.9%, OR=3.1, 95% CI:1.1–8.9). Preterm birth was more frequent in the deficient group (23.8% vs. 8.7%, p=0.04), with a 2.8-fold increased risk (95% CI:1.2–7.3) after adjustment for confounders. Neonates in this group also had poorer Apgar scores at 1-minute (6.5 ± 1.2 vs. 7.8 ± 1.0, p<0.001) and 5-minute (8.2 ± 0.8 vs. 9.0 ± 0.6, p<0.001) assessments. Though neonatal complications were more common in the deficient group (33.3% vs. 17.4%, p=0.08), this difference did not reach statistical significance.

Table 3: Types of Neonatal Complications Observed

Complication	Deficient Group (n=14)	Sufficient Group (n=8)	p-value
Respiratory Distress	6 (42.9%)	3 (37.5%)	0.78
Neonatal Jaundice	5 (35.7%)	2 (25.0%)	0.57
Sepsis	3 (21.4%)	2 (25.0%)	0.84
Hypocalcemia	2 (14.3%)	1 (12.5%)	0.90

Data as n (%). No significant differences between groups (Fisher's exact test).

Among neonates with complications (n=22), respiratory distress was most frequent (42.9% in deficient vs. 37.5% in sufficient group, p=0.78), followed by jaundice (35.7% vs. 25.0%, p=0.57). Rates of sepsis (21.4% vs. 25.0%) and hypocalcemia (14.3% vs. 12.5%) were comparable between groups (all p>0.05). The small sample size for each complication subtype limited statistical power to detect differences.

DISCUSSION

This prospective study demonstrates a significant association between maternal vitamin D deficiency and adverse neonatal outcomes, including lower birth weight, higher preterm birth rates, and poorer Apgar scores. Our findings align with existing literature while contributing new insights into the clinical implications of vitamin D status in pregnancy.

The observed reduction in birth weight (2.8 ± 0.4 kg vs. 3.2 ± 0.5 kg, *p*=0.01) among neonates of deficient mothers corroborates earlier studies. A meta-analysis by Aghajafari et al,[5] found that maternal vitamin D insufficiency (<30 ng/mL) increased the risk of small-for-gestational-age (SGA) infants by 1.85-fold, suggesting a dose-dependent relationship. Similarly, Bodnar et al.6reported that severe deficiency (<20 ng/mL) was linked to a 50% higher likelihood of low birth weight, consistent with our adjusted OR of 3.1. Proposed mechanisms include impaired placental angiogenesis and dysregulated fetal calcium metabolism, which may restrict intrauterine growth.

The higher preterm birth rate in our deficient group (23.8% vs. 8.7%, *p*=0.04) echoes results from the COPSAC cohort study,[9] where severe deficiency (<12 ng/mL) doubled the risk of early delivery. Our findings extend this evidence by showing that even moderate deficiency (<20 ng/mL) significantly impacts gestational duration. Lower Apgar scores in deficient neonates further underscore vitamin D's role in fetal development, possibly through its immunomodulatory effects on lung maturation and neuroprotection.

Although neonatal complications (e.g., respiratory distress, jaundice) were more frequent in the deficient group (33.3% vs. 17.4%), this difference lacked statistical significance (*p*=0.08), likely due to limited power. Contrastingly, Hollis et al,[10] observed a 25% reduction in respiratory infections among infants of mothers supplemented with 4000 IU/day vitamin D, suggesting that severe deficiency might exacerbate morbidity. Our smaller sample size may have underdetected such associations.

Limitations involve the single-center setting and reliance on third-trimester vitamin D measurements, which may not reflect early-pregnancy status. Future multicenter studies with serial vitamin D assessments could clarify temporal relationships.

CONCLUSION

This prospective study demonstrates that maternal vitamin D deficiency (<20 ng/mL) significantly increases the risk of adverse neonatal outcomes, including lower birth weight, higher rates of preterm birth, and poorer Apgar scores. These findings align with existing evidence highlighting vitamin D's crucial role in fetal development and support the need for routine antenatal screening and supplementation in deficient pregnant women. While larger studies are needed to further elucidate the relationship between vitamin D status and specific neonatal complications, our results underscore the importance of optimizing maternal vitamin D levels as a simple, cost-effective strategy to improve neonatal health outcomes. Healthcare providers should consider implementing standardized protocols for vitamin D assessment and supplementation during prenatal care to mitigate these preventable risks.

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