

An Observational Study to Determine Association Between Maternal Vitamin D Levels in Term Pregnancy and Neonatal Vitamin D Levels in The Department of Obstetrics and Gynaecology, SMS Medical College, Jaipur

¹Dr. Akanksha Arya, Senior Resident, Department of Obstetrics & Gynaecology, RNT Medical College, Udaipur

²Dr. Rashma Gera, Department of Obstetrics & Gynaecology, SMS Medical College, Jaipur

³Dr. Asha Verma, Department of Obstetrics & Gynaecology, SMS Medical College, Jaipur

Corresponding Author: Dr. Akanksha Arya, Senior Resident, Department of Obstetrics & Gynaecology, RNT Medical College, Udaipur

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Abstract

Background: Vitamin D plays a vital role in maternal and fetal health, with neonatal levels entirely dependent on maternal 25(OH)D status.

Aim: To determine the association between maternal vitamin D levels in term pregnancy and neonatal vitamin D levels, and to assess neonatal outcomes in relation to vitamin D status.

Methods: This observational, hospital-based cross-sectional study included 150 primigravida women with live singleton term pregnancies delivering vaginally at SMS Medical College, Jaipur. Maternal venous blood was collected at term and cord blood immediately after delivery to measure serum 25(OH)D using enzyme immunoassay. Vitamin D status was classified as sufficient, insufficient, or deficient. Maternal–neonatal vitamin D association was analysed using correlation statistics; other variables were assessed using t-tests and chi-square tests.

Results: Maternal vitamin D deficiency was highly prevalent (74.67%), with only 12% being sufficient.

Neonatal deficiency was also common (57.33%), with 22% sufficient. Maternal serum calcium levels differed significantly across vitamin D categories ($p = 0.02$), while neonatal calcium did not ($p = 0.52$). Neonatal vitamin D levels varied significantly across deficiency categories ($p < 0.001$), but birth weight did not ($p = 0.35$). Maternal vitamin D values were significantly higher than neonatal levels in all groups ($p < 0.001$). A moderate positive correlation was observed between maternal and neonatal vitamin D concentrations ($r = 0.445$; $p = 0.001$).

Conclusion: Vitamin D deficiency is highly prevalent among both pregnant women and their newborns. Neonatal vitamin D status strongly reflects maternal levels, underscoring the need for routine screening and effective supplementation strategies during pregnancy to improve neonatal outcomes and reduce preventable health risks.

Keywords: Vitamin D deficiency; Maternal 25(OH)D; Neonatal vitamin D; Cord blood; Pregnancy; Calcium homeostasis; Term pregnancy; Primigravida.

Introduction

Vitamin D plays a key role in calcium balance, skeletal development, immune regulation, and fetal growth. During pregnancy, the fetus relies entirely on maternal 25-hydroxyvitamin D [25(OH)D], making maternal vitamin D status the primary determinant of neonatal levels¹. Despite abundant sunlight, vitamin D deficiency is extremely common in India, with 60–90% of pregnant women affected due to limited sun exposure, skin pigmentation, diet, and lifestyle factors²⁻⁴. Maternal deficiency can lead to low neonatal vitamin D stores, increasing the risk of hypocalcemia, impaired bone mineralization, and susceptibility to infections⁵.

Studies consistently demonstrate a strong correlation between maternal and neonatal 25(OH)D levels, with cord blood values typically reflecting 50–80% of maternal concentrations^{6,7}. This relationship highlights the importance of maternal screening and supplementation to prevent neonatal deficiency. However, data from Rajasthan remain limited, particularly from tertiary care centers.

The present study evaluates the association between maternal vitamin D levels at term and neonatal vitamin D status in babies born at SMS Medical College, Jaipur. Understanding this relationship will help guide region-specific strategies for screening, prevention, and management of vitamin D deficiency during pregnancy.

Material and Methods

This observational, hospital-based cross-sectional study was carried out in the Department of Obstetrics and Gynaecology, SMS Medical College, Jaipur, from July 2023 for one year, followed by two months for data analysis. Primigravida women with live singleton term pregnancies (37–42 weeks) admitted for vaginal delivery were enrolled after obtaining ethical clearance and written informed consent.

Women with systemic illnesses, high-risk pregnancies, fetal anomalies, congenital vitamin D disorders, or on medications affecting vitamin D metabolism were excluded. A total sample of 150 was calculated using a previously reported maternal–neonatal vitamin D correlation coefficient ($r = 0.94$).

Detailed obstetric history, examination, and routine antenatal investigations were performed. Maternal venous blood (5 ml) was collected at term to measure serum vitamin D using enzyme immunoassay. Cord blood samples were collected after delivery to assess neonatal vitamin D levels. Vitamin D status was classified as sufficient, insufficient, or deficient based on predefined cut-offs for mothers and neonates.

Continuous variables were expressed as mean \pm SD and compared using the unpaired t-test. Categorical variables were analyzed using chi-square or Fisher's exact test. A p-value < 0.05 was considered statistically significant.

Results

A total of 150 primigravida women with live, singleton term pregnancies were included in the study. The mean maternal age was 25.33 ± 4.28 years, demonstrating moderate age variability within the cohort, and the age-group distribution was statistically significant ($p < 0.001$). The majority of participants were Hindu (74.67%), followed by Muslims (25.33%). A predominant rural representation was observed, with 78% of women residing in rural areas and 22% belonging to urban regions. Socioeconomic assessment showed that most women were from the middle class (58.67%), followed by the lower class (28%), with smaller proportions in the lower middle (5.33%), upper (6%), and upper middle (2%) classes. Regarding educational status, 47.33% had primary-level education, 44.67% were illiterate, and only 8% had completed secondary schooling.

BMI-based nutritional evaluation revealed that 10% of women were underweight (mean BMI 16.79 ± 1.13 kg/m²), 14.67% had a normal BMI (23.74 ± 0.83 kg/m²), half of the cohort (50%) were overweight (27.86 ± 1.33 kg/m²), and 25.33% were obese (32.09 ± 1.57 kg/m²). The overall mean BMI was 27.22 ± 5.54 kg/m², with significant variation across categories ($p < 0.001$). Dietary assessment indicated that 64% followed a vegetarian diet, while 36% consumed a non-vegetarian diet.

Maternal vitamin D deficiency was widespread, with 74.67% of women classified as deficient, 13.33% as insufficient, and only 12% as sufficient. The mean maternal vitamin D concentration was 29.62 ± 3.21 ng/mL. Serum calcium levels differed significantly across vitamin D categories ($p = 0.02$), being lowest in the deficient group (7.2 ± 0.49 mg/dL), higher in the insufficient group (9.36 ± 0.46 mg/dL), and highest in the sufficient group (13.1 ± 0.49 mg/dL).

Neonatal vitamin D deficiency was also prominent: 57.33% were deficient, 20.67% insufficient, and 22% sufficient. Neonatal birth weight did not vary significantly between groups ($p = 0.35$), with mean weights of 2.95 ± 0.24 kg (deficient), 2.98 ± 0.23 kg (insufficient), and 2.87 ± 0.28 kg (sufficient). Neonatal serum 25(OH)D levels showed clear, statistically significant differences across categories ($p < 0.001$): 6.74 ± 3.05 ng/mL in deficient neonates, 23.67 ± 2.16 ng/mL in insufficient neonates, and 32.70 ± 2.30 ng/mL in sufficient neonates. Serum calcium levels in neonates showed no significant variation ($p = 0.52$), indicating stable calcium levels across vitamin D groups.

Across all categories, neonatal vitamin D concentrations were consistently lower than corresponding maternal levels. Among deficient pairs, maternal levels averaged 7.70 ± 4.07 ng/mL compared to 6.74 ± 3.05 ng/mL in

neonates. In insufficient pairs, maternal levels were 29.49 ± 4.59 ng/mL versus 23.67 ± 2.16 ng/mL in neonates. For sufficient mothers, levels averaged 51.66 ± 0.98 ng/mL compared to 32.70 ± 2.30 ng/mL in neonates. Overall, maternal vitamin D levels were significantly higher than neonatal levels ($p < 0.001$).

Correlation analysis demonstrated a moderate, statistically significant positive association between maternal and neonatal vitamin D status ($r = 0.445$; $p = 0.001$), indicating that higher maternal levels were associated with higher neonatal concentrations.

Discussion

In this hospital-based cross-sectional study, a substantial burden of maternal vitamin D deficiency was observed, with 74.67% of pregnant women classified as deficient and only 12% achieving sufficiency. This pattern aligns with the widespread hypovitaminosis D reported among Indian antenatal women. Previous studies have similarly reported high maternal deficiency rates, with mean levels around 16–17 ng/mL and low sufficiency proportions^{8,9}. Some international reports have shown comparatively higher maternal concentrations, averaging around 25 ng/mL¹⁰. The maternal mean level in the present study (29.62 ± 3.21 ng/mL) was moderately higher than several Indian reports^{9,11,12}, possibly due to routine antenatal supplementation, better sunlight exposure in rural settings, and increasing awareness of maternal nutrition. Despite this, the high prevalence of insufficiency (64%) underscores the continued need for stronger maternal vitamin D screening and supplementation programmes, given the established associations with adverse pregnancy outcomes such as preeclampsia, gestational diabetes, and low birth weight¹³.

A significant association was seen between maternal vitamin D and serum calcium levels, with deficient women exhibiting markedly lower calcium levels than

insufficient or sufficient groups ($p \approx 0.02$). Similar findings have been consistently documented in earlier literature, which reported lower calcium levels in deficient pregnant women and higher levels in vitamin D-replete mothers¹⁴⁻¹⁶. These findings align with the known physiological role of vitamin D in regulating calcium absorption and homeostasis. Although unusually large standard deviations reported in some datasets likely reflect reporting errors, the direction and significance of the association remain clinically meaningful.

Neonatal vitamin D status closely reflected maternal levels, with 57.33% of newborns being deficient and only 22% achieving sufficiency. Comparable neonatal deficiency rates have been reported across India, where more than two-thirds of newborns fall below adequate vitamin D levels^{8,15,17-19}. This consistent trend reinforces maternal vitamin D status as the primary determinant of neonatal levels, as the fetus relies entirely on maternal stores.

In this study, neonatal birth weight did not differ significantly across vitamin D categories ($p \approx 0.35$). This contrasts with several earlier studies that reported higher birth weights and lower prevalence of small-for-gestational-age births among vitamin D-sufficient mothers^{9,12,13,18}. A large meta-analysis involving over 10,000 participants also indicated that deficiency increases the risk of low birth weight by approximately 150–200 g²⁰. The absence of significance in the present study may be due to uniform antenatal nutrition, limited variability in gestational age and maternal BMI, or exclusion of high-risk pregnancies.

Neonatal serum 25(OH)D levels across deficiency, insufficiency, and sufficiency groups showed strong and statistically significant differences ($p < 0.001$), confirming the validity of the classification. Similar neonatal vitamin D values have been documented in prior

research, further highlighting the global concern regarding neonatal hypovitaminosis D⁸⁻¹⁰.

Neonatal serum calcium levels did not vary significantly across vitamin D categories ($p \approx 0.52$). This is consistent with prior research showing normal neonatal calcium in most cases, regardless of vitamin D status^{8,15}. Some studies reported significant differences between maternal and neonatal calcium levels and weak correlations between the two⁸, indicating that neonatal calcium homeostasis is influenced by mechanisms such as placental transport, fetal parathyroid activity, and renal conservation, rather than vitamin D status alone.

A key finding of this study was the moderate positive correlation between maternal and neonatal vitamin D levels ($r = 0.445$; $p = 0.001$). This supports existing evidence demonstrating that maternal levels are the major determinant of neonatal vitamin D status. Earlier reports have shown even stronger correlations ($r = 0.779$, $r = 0.79$, $r = 0.94$)^{8,14}. Although the correlation observed in this study was comparatively weaker, it remained statistically significant and clinically relevant, highlighting the need for routine maternal vitamin D assessment during pregnancy.

Overall, the findings indicate a significant burden of vitamin D deficiency among pregnant women and newborns and reaffirm the direct influence of maternal levels on neonatal status. The persistence of deficiency despite routine supplementation highlights the need for improved antenatal strategies, including higher-dose supplementation, earlier screening, and community-focused education, particularly in rural areas. Enhancing maternal vitamin D sufficiency has the potential to improve neonatal biochemical outcomes and reduce the risk of metabolic, skeletal, and immunological complications in early life.

Conclusion

This study demonstrated a high prevalence of vitamin D deficiency in both mothers and their newborns. Neonatal vitamin D levels closely mirrored maternal status, supported by a moderate positive correlation. Birth weight and neonatal calcium levels showed no significant variation across vitamin D categories, indicating

preserved physiological regulation. Overall, the findings highlight the importance of routine maternal vitamin D screening and adequate supplementation to improve neonatal vitamin D status and reduce preventable health risks.

Table 1: Comparison Between Maternal and Neonatal Serum 25(OH) Vitamin D Levels According to Vitamin D Category

Serum Vitamin D Category	Serum 25 (OH) Vitamin D (ng/mL)	
	Mean ± SD (n=150)	
	Maternal	Neonatal
Deficient	7.70 ± 4.07	6.74 ± 3.05
Insufficient	29.49 ± 4.59	23.67 ± 2.16
Sufficient	51.66 ± 0.98	32.7 ± 2.3
Total	29.62 ± 3.21	15.95 ± 11.41
P Value	< 0.001	

Table 2: Neonatal Vitamin D Status and Associated Clinical Parameters

Neonatal Vitamin D Category	n (%)	Neonatal Weight (kg) Mean ± SD	Neonatal Serum 25(OH)D (ng/mL) >Mean ± SD	Neonatal Serum Calcium (mg/dL) Mean ± SD
Deficient	86 (57.33%)	2.95 ± 0.24	6.74 ± 3.05	10.02 ± 1.10
Insufficient	31 (20.67%)	2.98 ± 0.23	23.67 ± 2.16	10.01 ± 0.98
Sufficient	33 (22.00%)	2.87 ± 0.28	32.70 ± 2.30	10.21 ± 1.15
Total (n = 150)	150 (100%)	2.90 ± 0.25	15.95 ± 11.41	10.06 ± 1.09

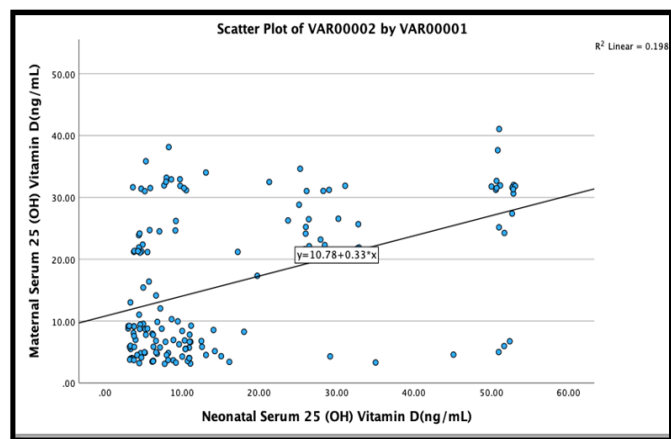


Figure 1: Graphical representation of Correlation between Maternal Serum Vitamin D levels and Neonatal Serum Vitamin D levels

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